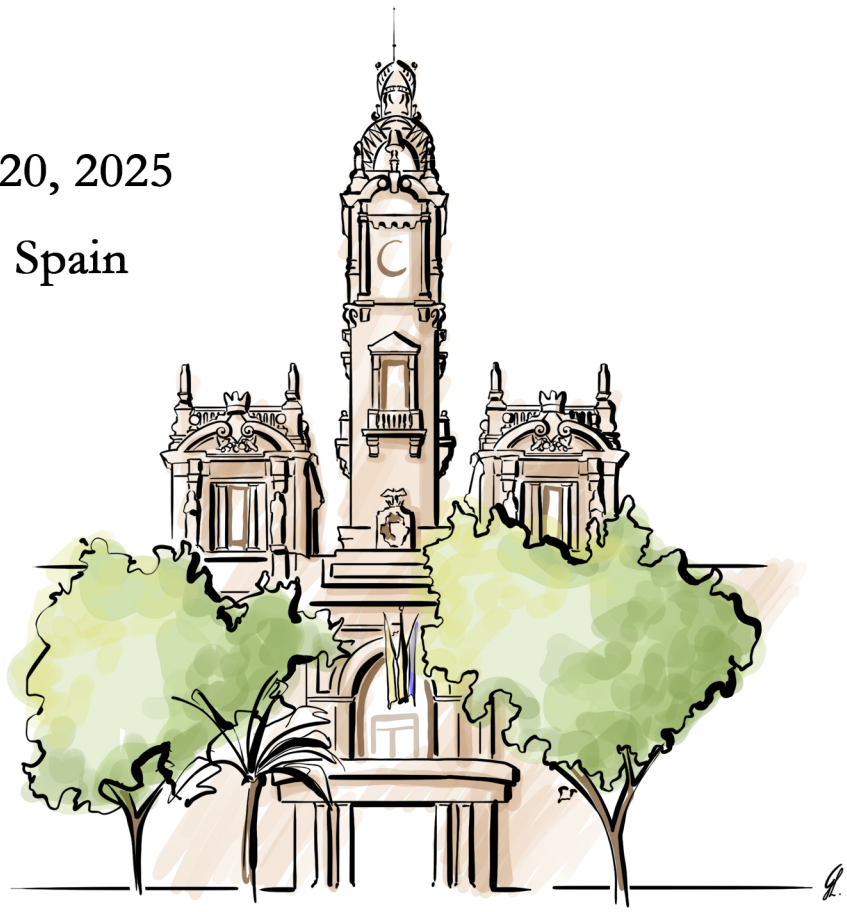
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Preface

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Abstract
This is the preface for the eleventh edition of the International Conference on Higher Education Advances (HEAd). HEAd'25 brought together researchers, educators, students, and professionals from around the world to exchange ideas and research findings on student preparation and higher education systems. The conference facilitated thought-provoking discussions, innovative ideas, and collaborative efforts to advance teaching, learning, and the overall higher education landscape. The scientific program, curated by a committee of 223 members from 45 countries, received 277 full paper submissions. Of these, 87 papers were accepted for full-paper presentation, while 37 short papers and 36 posters were also included. The contributions covered diverse topics such as pedagogical approaches, technology integration, student engagement, assessment methods, curriculum design, and educational policies. Additionally, three keynote speeches and four pre-conference workshops enriched the conference experience.

Keywords: *Higher education; innovative materials; educational technology; evaluation and assessment; globalization in education.*

1. Introduction to HEAd'25

This volume presents the proceedings of the Eleventh International Conference on Higher Education Advances (HEAd'25), held from 17 to 20 June 2025. Built upon a decade of academic engagement, HEAd'25 continued to serve as a platform for researchers, educators, students, and professionals from around the world to exchange insights on student preparation and the organization of higher education systems.

The selection of the papers for the scientific program of HEAd'25 was conducted by a team of 223 committee members representing 45 countries on all five continents. Following the call for papers, the conference received 277 full paper submissions with authors from 55 different countries. All the submitted papers were reviewed by at least two program committee members under a double-blind review process. Finally, 87 papers were accepted as full papers for oral presentation during regular sessions, representing an overall full paper acceptance rate of 31%

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reflecting the conference's commitment to showcasing the highest-quality work. Additionally, 37 submissions were accepted for short paper presentations and 36 for poster presentations, all of them receiving high review scores, and were published by UPV Press in this volume. The organization committee congratulates all the authors for having their papers accepted in the proceedings of such a competitive conference.

Contributions cover a wide range of topics, including innovative teaching and learning experiences, evaluation and assessment, emerging educational technologies such as Artificial Intelligence, Virtual Reality, and Augmented Reality, e-learning strategies, globalization and internationalization, employability and entrepreneurship, competency-based education, sustainability and Sustainable Development Goals in higher education, as well as STEM and health education.

The conference program featured three keynotes covering significant and timely topics. The first keynote, "Leading with Purpose," delivered by Janet Lord (Manchester Metropolitan University, UK), focused on how responsible leadership can provide a moral and strategic compass. The second keynote, "Reimagining Peer Feedback in Higher Education" by Omid Noroozi (Wageningen University and Research, the Netherlands), emphasized the role of Generative AI in supporting and optimizing peer feedback process. Lastly, the keynote titled "Building Transformative Digital Health Competency and Capability through Education," presented by Martin Curley (Maynooth University, Ireland), completed the set by highlighting how structured educational initiatives are essential to equip professionals with digital competencies. These keynotes provided valuable insights and sparked thought-provoking discussions, enriching the impact of HEAd'25.

HEAd'25 also hosted four pre-conference workshops to offer participants the opportunity to explore specific topics with a hands-on approach. The workshops included "Generative AI for Empowering Education," led by Monica Conti (Politecnico di Milano), "A Game-based approach to ESD and Digital Engagement," organized by Nataliya Romanyatova (South East Technological University) and Niamh Power (Munster Technological University), "Authentic Assessment in the 'Age of AI'", led by Tony Hall (University of Galway), Karen Buckley (Dublin City University) and Michelle Millar (University of Galway); and "Navigating Twin Transitions and Enhancing Civic Engagement in Higher Education," organized by Stefania Capogna and Maria Chiara De Angelis (Link Campus University, Italy).

The organizing committee extends its sincere gratitude to all contributors, including keynote speakers, authors, scientific committee members, session chairs, presenters and attendees, whose efforts and participation were essential in the success of HEAd'25. Special thanks are also due to the Faculty of Business Administration and Management of the Universitat Politècnica de València for their continued support in hosting the conference.

We hope that the insights and discussions generated during HEAd'25 will contribute to the ongoing advancement of higher education practices and policies worldwide.

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Fostering Innovation and Interdisciplinarity in Higher Education: A Project on Creative Writing for Marketing and Language Students

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Abstract

This paper presents an innovative pedagogical initiative integrating interdisciplinarity and interdepartmental collaboration in higher education. The project "From Marketing to Languages: The Art of Creative Writing" brought together marketing and language students to engage in creative writing and storytelling. Designed to respond to the growing demand for transversal skills such as creativity, critical thinking, and communication, the project employed active learning methodologies and a tailored workshop led by a renowned author. Students collaborated in interdisciplinary groups, addressing societal challenges through narrative while bridging knowledge from distinct academic fields. This initiative exemplifies the potential of interdisciplinary and interdepartmental practices to enhance student engagement, foster innovation, and develop competencies crucial for navigating complex professional and societal contexts. The outcomes underscore the importance and the challenges of such approaches in driving pedagogical transformation and equipping students for the challenges of a globalized, interconnected world.

Keywords: *Interdisciplinarity; Innovative Teaching and Learning Experiences; Active Learning; Transversal Skills; Marketing Education; Languages.*

1. Introduction

Higher education must equip students with the skills to successfully navigate complex professional and societal challenges in a rapidly evolving global landscape. Pedagogical innovation, experiential approaches, and the development of transversal competencies such as creativity, critical thinking, and collaboration (Carvalho et al., 2020) are crucial for enhancing student engagement and also for fostering adaptability and lifelong learning—essential traits for success in the modern workforce. Interdisciplinary and interdepartmental collaboration stands

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out as transformative approaches in higher education. Integrating perspectives and methodologies from distinct fields enriches the learning experience and prepares students for interdisciplinary work environments (Repko et al., 2020). Studies highlight how such collaborations amplify critical thinking, problem-solving, and communication skills (Frodeman & Klein, 2017).

Creative writing and storytelling, valued for their artistic and cultural contributions, have gained renewed attention as pedagogical tools. By enhancing narrative skills, students improve their capacity for self-expression, empathy, and persuasion—skills critical in diverse professional contexts (Li & Su, 2021). Storytelling also fosters deeper engagement with content, connecting theoretical concepts to real-world applications (Neira-Piñeiro & Montañez, 2017).

This article explores the project "From Marketing to Languages: The Art of Creative Writing," a pedagogical initiative integrating marketing and language students in an interdisciplinary framework. Employing storytelling as a central method, the project fostered collaboration, creativity, and communication skills while addressing the need for innovative pedagogical methods that bridge disciplines and enhance employability. Through this analysis, we explore how such an approach can serve as a model for innovation in higher education, contributing to the broader discourse, contributing to the broader discourse on interdisciplinary education and its role in preparing students for the complex demands of contemporary professional environments.

2. The Project

The University of Aveiro, where the project presented in this paper was conceived and implemented, has launched several initiatives aimed at promoting pedagogical innovation and enhancing opportunities for interaction and collaboration among faculty and students across different departments. Within this context, a competition was established to award incentives for Pedagogical Innovation Projects. These projects, developed within the framework of one or more curricular units, can be proposed by an individual lecturer or a group of lecturers. A monetary prize is granted each academic year, preceded by an evaluation conducted by a jury comprising lecturers from two universities. The prize supports teaching-related activities, including acquiring goods or services for the project's successful implementation. The case study presented in this paper originated from a competition application involving two lecturers, two curricular units, two departments, and eighty third-year students from three undergraduate degree programs.

Before delving into any other details about the project, it is essential to highlight that this project brought together two lecturers: one specializing in marketing and the other in languages, specifically in the teaching of German. The undergraduate programs involved the Bachelor's in Marketing (a daytime class and an evening class), the Bachelor's in Languages and Business

Relations, and the Bachelor's in Languages and Editorial Studies. The marketing students were enrolled in Marketing Seminars, and the language students were in German Vi - Communication Techniques. In total, approximately 80 students participated in the project.

2.1. Preparing the project

The project stemmed from a prior collaboration between two lecturers and the belief that interdisciplinarity between their fields would greatly benefit students in the respective degree programs. The project's goals had to be clearly defined to participate in the university competition and align shared interests between Marketing and Languages students. The aim was to create an initiative leveraging their skills while fostering transversal abilities essential for future challenges. The initial challenge was identifying a meaningful, engaging, and stimulating activity for all students.

The chosen initiative was a creative writing workshop, Storytelling: The Art of Writing Stories, led by a renowned Portuguese author. The workshop aimed to enhance participants' writing skills in Portuguese and foreign languages as well as their creativity and collaborative abilities. It explored narrative, dialogue, character development, structure, and writing style, providing a foundation for more effective and creative self-expression.

2.1.1. Background, relevance and assumptions

As background, the needs identified by final-year students in these courses were highlighted, as they pointed out the necessity to refine their writing skills, thus complementing their academic formation. Creativity plays a crucial role in enhancing employability and developing personal projects. This initiative aimed to bridge this gap, equipping students with essential tools to stand out in the labor market.

The growing demand for professionals who can use writing as a strategic and creative tool in an increasingly competitive job market underscores the relevance of this project. Final-year students, particularly those studying marketing and languages, must communicate effectively, persuasively, and creatively in various national and international contexts. Therefore, the workshop was designed to address these needs, providing an enriching experience and increasing the participants' employability. The underlying assumptions were based on the premise that creative writing is a valuable and versatile skill with transversal benefits. For the evening students (many working while studying), the workshop allowed them to apply what they had learned to their professional contexts. Many marketing students, already completing internships in companies, were able to direct their creative efforts toward producing texts within these environments. For language students about to enter the job market and work with various types of texts, this project represented a valuable asset in fostering their ability to work in multidisciplinary teams and enhance their writing and creative skills. The dynamic and

stimulating learning environment, guided by an experienced writer, sought to expand their worldview and encourage creative expression.

Another important aspect was the establishment of relationships between marketing and language students, which was also one of the project's key objectives. These two fields offer complementary perspectives that, when combined, can lead to innovative solutions. Interdisciplinarity and collaboration were essential to stimulate knowledge exchange, joint project development, and the formation of multidisciplinary teams.

2.1.1. Innovative approach

In addition to the assumptions already outlined for this project, ensuring that it had an innovative character was essential. Therefore, the innovative features that stand out the most, in our view, are, first and foremost, the combination of marketing, languages, and creative writing, which not only promotes interdisciplinarity but also introduces students to the importance of this intersection; the design of a customized workshop, tailored explicitly for final-year students in these fields, adapted to their needs and interests while aligning with the specific objectives of each course unit and ensuring they were respected; an active approach, where the learnings from the workshop could be immediately applied in the development of creative stories and the production of an e-book; and, finally, the involvement of a prestigious speaker, providing an inspiring experience.

As previously mentioned, focusing on the course units' specific objectives was also crucial. In the marketing case, within the Marketing Seminars unit, the focus was on helping students understand the role of marketing in various market contexts and the underlying dynamics and challenges. The German VI – Expression Techniques unit emphasized improving students' writing skills in different professional contexts.

2.2. Implementing the project

The implementation of this project involved several crucial phases for its success. Initially, the planning and design phases were paramount, followed by the necessary operational and logistical preparations to ensure the smooth execution of all activities. Each phase is detailed below, highlighting the steps that ensured effective implementation and alignment with the established objectives.

2.2.1. Planning and Design

The initial phase of this project included a thorough market survey to identify creative writing speakers who could lead a workshop with the specific characteristics required. Following this research, a writer was selected, which involved making contacts, requesting quotes, and coordinating dates, procedures, and logistics necessary for the workshop's implementation. At this stage, a suitable venue was identified, including round tables for the planned activities, a

seating capacity for around 40 participants (two groups), and all the necessary audiovisual resources to ensure the workshop ran smoothly. It is essential to highlight that the project encompassed two main dimensions: a pedagogical intervention, comprising several activities related to the workshop, and a study on the activities carried out, focusing on the perceived impact on students and the invited author.

Furthermore, the workshop's program was organized in close collaboration with the writer and the faculty members involved in the project. The preparation phase also included the development of data collection instruments, such as a final questionnaire for students to evaluate the activity and assess the pedagogical experience's impact.

2.2.2. Involving and Preparing Students in the Workshop

This phase marks the concrete operationalization of the project, beginning with sharing information with students. It is crucial that this communication clearly emphasizes the project's objectives and the benefits that the activity will bring to the participants. At this point, a date had already been set for the workshop, in line with the availability of the involved classes and the invited speaker. It was also decided that to develop the work, a draw would be conducted to form the working groups, ensuring a balanced composition with students from different degree programs. We conducted warm-up activities in the first in-person meeting, which gathered all participating students and where the interdisciplinary groups met for the first time. These activities aimed to create a pleasant and stimulating working environment conducive to multidisciplinary collaboration while helping reduce communication barriers and anxiety levels among students.

This was also the moment to explain to the students the final objective of the project: the collaborative production of an e-book to be published, outlining the key aspects and criteria related to this production. The students were encouraged to choose the theme of their creative story, guided by the prompt to reflect on the societal problems they perceive as the most pressing for their generation while anticipating future challenges. To prepare for the workshop, they were asked to think in advance about the problem they wanted to address and key elements of their story, such as the plot, characters, and other essential aspects. This preparatory phase aimed to stimulate critical thinking and creativity, providing a solid foundation for meaningful participation in the workshop and, most importantly, absorbing the valuable insights and knowledge shared by the author.

2.2.3. The Workshop

The highlight of the project was the creative writing workshop. The event was led by the author, who was carefully chosen to ensure the pedagogical relevance and impact of the experience. The workshop was structured to balance theory and practice, offering students a mix of technical foundations and creative applications. During the workshop, students explored key concepts

such as narrative construction, character development, dialogue, and textual structure for creative writing. Students were also challenged to apply their newly acquired knowledge through concrete examples and hands-on exercises, fostering experimentation and creativity.

Additionally, the speaker shared their experiences as an author, providing valuable insights into the creative process. The direct interaction with a professional in the field proved to be highly enriching, allowing students to understand the real-world demands and opportunities of creative writing. The workshop also served as an opportunity to foster teamwork, as students, organized into interdisciplinary groups, began outlining the stories that would form the final e-book. This moment of collaborative work, guided by the speaker and faculty members, was essential for aligning expectations, consolidating learning, and preparing the project's next steps.

2.3. Evaluating the Project

The survey conducted among participants provided valuable insights into their experiences and satisfaction levels with the pedagogical project. Thirty-four responses were collected, encompassing both quantitative ratings and qualitative feedback. This section focuses on its alignment with the objectives and analysing positive aspects and areas for improvement.

The project successfully fostered participant engagement and promoted interdisciplinary collaboration, two core objectives of the initiative. The warm-up session received an average rating of 5.6 out of 7, with half of the respondents rating it highly (6 or 7). Comments emphasized its engaging and interactive nature, which set a positive tone for the project and encouraged initial group cohesion. Similarly, the workshop with the author, although slightly lower rated (average of 5.1), was praised for its dynamic and creative approach, which inspired participants and provided a novel learning experience. Teamwork was one of the most positively rated components, with an average score of 5.8. Participants appreciated the opportunity to collaborate with peers from different departments, enriching their perspectives and fostering mutual respect. One respondent noted, "I learned to adapt and accept different ideas, even when they did not align with mine, which strengthened my communication and collaboration skills". Skill development was another notable success of the project. Respondents frequently mentioned improving competencies such as creativity, communication, and problem-solving. Many participants highlighted how the project's interdisciplinary nature pushed them out of their comfort zones, enhancing their adaptability and tolerance. Additionally, the project’s innovative approach was highly appreciated, with an average rating of 5.9, reflecting its ability to challenge traditional pedagogical methods and promote creativity.

Despite the positive outcomes, several aspects require refinement to align with the project’s goals. A recurring critique was the lack of clear connections between the activities and the overarching objective of creating short stories. One participant remarked, “The workshop was dynamic, but its relevance to creating the short story was unclear.” More explicit guidance on how each session contributed to the final goal would enhance coherence and focus.

Logistical issues were another significant challenge. Scheduling conflicts, especially between day and evening students, hindered collaboration. Group sizes were occasionally deemed too large, leading to uneven workload distribution and reduced engagement from some members. Addressing these logistical barriers through better scheduling and smaller, more manageable group structures could improve participant experiences.

Furthermore, while the interdisciplinary and interdepartmental nature of the groups was appreciated, it also posed challenges. Differences in departmental priorities and expectations sometimes created friction, which impacted group synergy. Providing structured support, such as facilitators or more explicit task distribution, could mitigate these issues.

The survey results indicate that the pedagogical project was a valuable and enriching experience for participants, achieving its goals of fostering engagement, creativity, and interdisciplinary collaboration. The positive aspects, such as high participant satisfaction, skill development, and innovative methodologies, highlight its success. However, addressing the areas for improvement—including more precise alignment of activities, better logistical planning, and enhanced group dynamics—will be crucial for future iterations. By building on this feedback, the project can further optimize its impact and continue to provide meaningful learning opportunities.

3. The Project's Outcomes

As a result of this project, 11 creative stories were developed by mixed groups of students from the bachelor's programs in Marketing, Languages and Business Relations, and Languages and Editorial Studies. Inspired by societal challenges concerning their generation, the teachers compiled the stories into an e-book titled "The Stories That Unite Us: Creative Writing and Linguistic Diversity," published by the university press.

These narratives address pressing issues such as loneliness, misinformation, high rents, the housing crisis, financial struggles, social anxiety, mental health, and emigration. Presented in Portuguese and German, the e-book celebrates linguistic and cultural diversity, reflecting the curricular units' learning objectives. Marketing students enhanced their intercultural skills through exposure to the German language and culture, while German language students applied their linguistic abilities in a specific and creative context. This project challenged students to collaborate across disciplines and aimed to inspire deeper reflection on contemporary issues and foster dialogue, inclusion, and mutual understanding. It represents a meaningful contribution to discussing societal challenges through creative and intercultural engagement.

4. Conclusion

The project "From Marketing to Languages: The Art of Creative Writing" was an innovative and enriching initiative that fostered interdisciplinary collaboration between marketing and

language students. This dynamic and creative learning environment significantly impacted participants' academic and personal development. By engaging students in practical activities like creative writing and group discussions, the project emphasized active learning, promoting the application of knowledge to real-world scenarios. It also facilitated the development of transversal skills, including creativity, critical thinking, teamwork, and effective communication, while encouraging self-expression and the exploration of diverse perspectives. The project's interdisciplinary nature expanded students' academic horizons, fostering collaboration across fields and stimulating innovation. The workshop format inspired participants to explore novel approaches, develop original solutions, and adopt an entrepreneurial mindset. The initiative also provided networking opportunities and culminated in the production of an e-book showcasing students' creative and linguistic achievements.

Despite challenges in bridging distinct academic perspectives, these obstacles became growth opportunities, reinforcing the value of interdisciplinarity in education. The project met its pedagogical objectives, leaving a lasting impact on participants and demonstrating the transformative potential of interdisciplinary collaborations in higher education. We hope that the experience shared here serves as a stimulus for new endeavours, continuing to advance creative and impactful educational approaches and inspire future interdepartmental collaborations that are equally transformative and impactful. Finally, it is important to reinforce that the success of this initiative owes much to the support of the University and the dedication of its students, whose creativity and commitment brought this unique project to life.

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References

Carvalho, A. Teixeira, S. J., Olim, L., Campanella, S. & Costa, T. (2020). Pedagogical innovation in higher education and active learning methodologies - a case study. *Education + Journal*, 63(1), 1-15.

Li, F., & Su, H. (2021). Storytelling engages a reader's interest through written texts. *Journal of Language and Linguistic Studies*, 17(1), 123–135.

Neira-Piñeiro, M. del R., & Montañez, M. L. (2017). Enhancing vocabulary and writing skills through digital storytelling in higher education. *Journal of Language and Linguistic Studies, 13(2)*, 366-377.

Repko, A.F., Szostak, R. & Buchberger, M.P. (2020). *Introduction to interdisciplinary studies (3rd ed.).*

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Exploring the integration of Mathematics and Music within the STEAM Framework: Insights from the Medieval Quadrivium

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Abstract

This paper explores the relationship between the medieval Quadrivium and contemporary STEM/STEAM methodologies, providing a valuable insight into educational practices. The Quadrivium conceived knowledge as an integrated entity, a concept that is reflected in contemporary STEM/STEAM model, which aims to overcome compartmentalized teaching by promoting critical thinking and creativity. Both approaches favour holistic learning, in which knowledge is not fragmented but part of a unified, interdisciplinary system. An experimental path is proposed in line with the activities of the Mathematical High School Project at the University of Salerno (Italy): an activity exploring the classical isoperimetric problem through mathematics, science, engineering and music. The study of mathematics becomes more concrete, engaging and meaningful, preparing students for an increasingly dynamic and multidisciplinary world.

Keywords: *Interdisciplinarity; STEAM; Mathematics; Music; Mathematical High School Project; Technology enhanced learning.*

1. Introduction

The connection between the Quadrivium model and the modern STEM (Science, Technology, Engineering and Mathematics) or STEAM (with the addition of Art) approach is very significant and offers a perspective that enriches the way of teaching by offering an integrated view of knowledge. The Quadrivium, literally "crossing of four roads", is an educational model first developed in the Pythagorean school. Around 500 B.C. Pythagoras founded a community in Croton based on equality in both moral and material terms. It was the first to divide education into two parts: the Trivium and the Quadrivium. The Trivium focused on language and expression—Grammar, Logic, and Rhetoric—key for public life and philosophy. The Quadrivium explored number and its role in understanding the universe, with four disciplines: Arithmetic (numbers), Geometry (space), Harmony/Music (time), Astronomy (motion). The

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importance of the Quadrivium didn't lay only in the acquisition of practical skills, but above all in the search for a higher order that would harmonize human knowledge with universal principles. Many philosophers and intellectuals contributed to the development of the Quadrivium, including Plato, Aristotle and Euclid. Throughout the Middle Ages and subsequent periods, scholars such as Dante, Kepler, Al-Kwarizmi investigated the connections among mathematics, music, astronomy and philosophy.

In Plato's Republic (Book VII), music guides the soul toward truth by teaching harmony and proportion. Geometry reveals eternal truths, encouraging philosophical thought. Astronomy should be studied like geometry—focused on problem-solving rather than observation—to strengthen the soul's intellect. Ultimately, these studies lead to the ideals of the True, the Beautiful, and the Good. Through the harmony of numbers and proportions, individuals can gain insights into the mechanisms of the cosmos and enhance their spiritual awareness (Ferguson, 2008), (De Maria, 2018). In Phaedo, Plato claims the soul is immortal and recalls truths known before birth—learning is thus remembering, or anamnesis. Education, then, is an inner search for true knowledge, not just information transfer. This principle reinforces the idea that education should not be a mere transfer of information, but an inner journey in search of authentic knowledge. The Quadrivium supported this by placing math at the heart of learning and viewing knowledge as a unified whole—a concept echoed today in STEM/STEAM, which blends disciplines to foster critical thinking and creativity (Sternberg, 1988).

STEM/STEAM is an acronym that represents a multidisciplinary educational framework emphasizing the integration of the disciplines and enabling students to recognize the relationships among these disciplines and their practical applications in addressing real-world challenges. It extends beyond merely acquiring new knowledge, but also of developing skills such as analytical reasoning (Dewey, 1938), (Bloom, 1956), divergent thinking (Guilford, 1967), experiential learning, learning by doing (Lewin, 1951), skills that are fundamental to face a future in which technology and science will play a leading role. The presence of art in enhances the framework by transcending mere technical and scientific reasoning. Art, in fact, is about the ability to think creatively (Rochon, 2024), to look at problems from different angles, making solutions more fascinating and often more efficient. In "The Seven Knowledges Necessary for Future Education" (Morin, 2001), Morin emphasizes the importance of replacing thinking that separates and reduces with thinking that distinguishes and connects. This shift does not entail abandoning knowledge of parts for knowledge of totality, nor replacing analysis with synthesis; rather, it requires an integration of both approaches.

Imagine projecting the Quadrivium disciplines into STEM/STEAM disciplines. From arithmetic to mathematics: studying numbers and their properties develops the basis for algebra, cryptography and data analysis, all key skills for programming and AI; from geometry to engineering: proportions and geometric shapes (geometry) are fundamental in structural engineering, design and digital graphics (Elam, 2001); from music to technology: music is not

only art, but also music software, sound physics, wave theory (Camurri, 1990), (Boschi, 1991), (Ozzola, 2018); from cosmology to science: the study of celestial movements and cosmic proportions is the basis of astronomy and space exploration (James, 1993).

Certainly, Quadrivium has a more theoretical and philosophical focus, while STEM is more application and technology-oriented, but both promote a holistic approach to learning, in which knowledge is not fragmented but part of a unified, interdisciplinary system. The importance of this approach in education is based precisely on the intersection of theory and practice and on interdisciplinarity, which helps students to grasp the connections between different subjects, provides tangible experiences, increases motivation and enables problem solving, an essential skill for modern careers that increasingly demand mixed skills.

2. The Mathematical High School Project

The educational initiative presented in this document is strategically crafted as a component of the Mathematical High School Project (MHS, in Italian "Liceo Matematico") and is intended for implementation in 12th and 13th-grade classrooms. The MHS project involves a collaboration among 30 universities and more than 160 educational institutions across Italy.

This forward-thinking educational program seeks to reintegrate the interdisciplinary essence of mathematics into the Italian school curriculum. It is designed through hands-on laboratory experiences and cross-disciplinary courses led by skilled educators and university researchers specializing in pedagogy and educational development, conducted during extracurricular hours.

The objective of this initiative is to enhance the connections between scientific and humanistic disciplines, fostering a variety of interdisciplinary approaches. By leveraging emerging technologies, the project seeks to explore and reinterpret subjects such as history, art and economics through a mathematical perspective (Bologna et al., 2020), (Rogora &Tortoriello, 2021), (Tortoriello & Veronesi, 2021), (Bimonte et al., 2023), (Musmarra et al., 2023). Within the framework of this initiative, music serves as a significant unifying cultural force, harmonizing with mathematics to enhance cognitive development. The objective of this project is to develop a prospective interdisciplinary educational framework, initiating with the interplay between mathematics and music.

The methodological framework underpinning the activities within the MHS is founded on constructivist principles (Vygotsky, 1934). Constructivism is a theoretical framework that highlights the proactive engagement of learners in shaping their own comprehension of the world around them. According to this perspective, knowledge is not simply absorbed; instead, it is actively developed through social interactions and influenced by one's surroundings. The constructivist framework offers a versatile and inclusive methodology that facilitates the examination of various perspectives and the recognition of fundamental patterns and themes. In

conclusion, employing a constructivist approach within this laboratory fosters a thorough comprehension of interdisciplinary subjects.

3. The Interdisciplinary Laboratory

3.1. Maths and Music with technology

Software plays a fundamental role in modern education, as it offers tools that enrich the learning experience, making it more dynamic, interactive and personalized. Thanks to educational software, applications and online platforms, teachers can integrate content by presenting it in an engaging way, stimulating students' curiosity, and facilitating the understanding of complex concepts. Moreover, they facilitate adaptive teaching (Sweller, 1988), capable of responding to students' individual rhythms and needs, promoting a more inclusive approach.

GeoGebra has long been an essential tool in mathematics education, as it allows mathematical concepts to be visualized and manipulated in a concrete way. Teachers can design hands-on activities that facilitate understanding of the relationships between different areas of mathematics and encourage the development of critical thinking. Interactivity and the ability to explore without fear of making mistakes make teaching more engaging and less abstract. GeoGebra also encourages collaboration between students, who can solve problems together, improving their mathematical and digital skills and offers a practical example of the multimedia learning theory (Mayer, 2001).

Music software also enhances learning, making it more interactive, practical and accessible. Muse Score, Finale, Sibelius are examples of software that are extremely useful both for teaching music theory and writing, and for developing listening and composition skills. Teachers can create spares that students can edit in real-time, and the sound playback feature helps connect the writing of notes with their actual sound.

3.2. The development of the learning path

In the proposed experimental activity, the software GeoGebra has been introduced as a semiotic mediator of mathematical meanings. In particular, the isoperimetric problem is a classic optimization problem: "Among all plane figures that have a specified perimeter, which configuration yields the maximum area?". The quest to identify the figure with the largest area, while maintaining a constant perimeter, offers an ideal interdisciplinary approach integrates concepts from Quadrivium and STEM.

The objective was to design an educational activity to explore the link between mathematics, music, arithmetic, astronomy and the STEM disciplines. This initiative aims to link the geometric optimization of the isoperimetric problem to harmonic optimization in music, as well as to arithmetic principles, cosmic proportions and technological applications. Demonstrating

how all these fields share structures and proportions, the laboratory invites to reflect on mathematics influences both in the sciences and arts. The parallelisms in art, music, geometry, cosmology and engineering, offer students an interesting and creative interdisciplinary vision.

The aim of the activity is to engage students in the analysis of the harmonic ratios that define musical intervals (e.g., 2:1 for the octave, 3:2 for the right fifth, 5:4 for the major third) (Corona, 2015). Furthermore, it aims to establish connections between these ratios and the geometric proportions of the isoperimetric problem, using mathematical, technological and practical tools. Additionally, it investigates the relationship between these ratios and the fundamental numerical proportions in arithmetic, the way in which they are highlighted in the organization of planetary orbits in astronomy and their applications in modern technology.

The prerequisites required are a basic knowledge of plane geometry (familiarity with the concepts of proportion and ratio), of dynamic geometry software (such as GeoGebra) and music software (such as Muse Score), of introductory notions of music theory (such as scale structure and intervals). A basic understanding of rational and irrational numbers in arithmetic and the structure of the solar system in astronomy is also useful.

The activity begins by introducing the classical isoperimetric problem and comparing the idea that the circle represents the maximum contained area for a given perimeter with the search for perfection in musical ratios and astronomical proportions, highlighting how all these areas seek to maximize a certain characteristic (area, harmony or cosmic order).

Students construct regular isoperimetric polygons with an increasing number of sides and compare their areas using the dynamic geometry software GeoGebra. They observe that as the number of sides increases, the area increases and recognize that the circle (polygon with an infinite number of sides) has a maximum area, as seen in the figure.

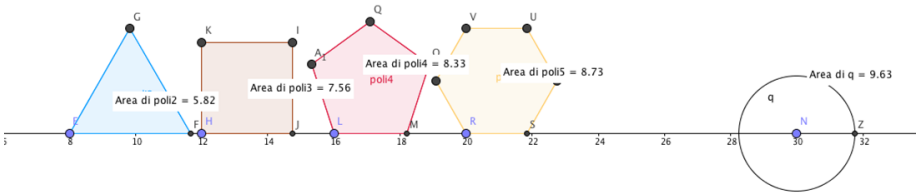


Figure 1 - Classical isoperimetric problem and polygon comparison

It is emphasized to the students that the graphical experimental verification does not constitute a mathematical demonstration, the heuristic approach to the problem is effective in fostering didactic reflection. Then, students use GeoGebra to represent a circle and divide it into arcs proportional to harmonic ratios.

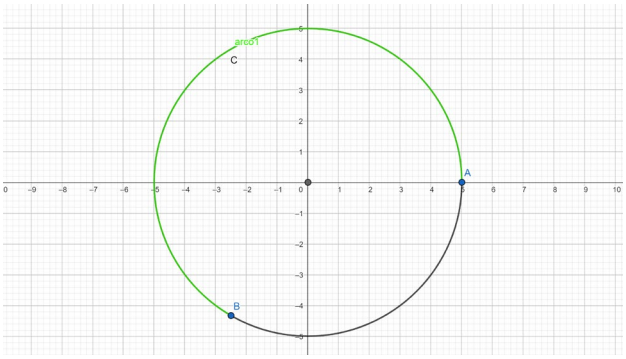


Figure 2 – Example of an arc of 2/3 of the length of the perimeter representing the perfect fifth

Following, students are asked to construct regular polygons inscribed in the circle, where each side represents a note.

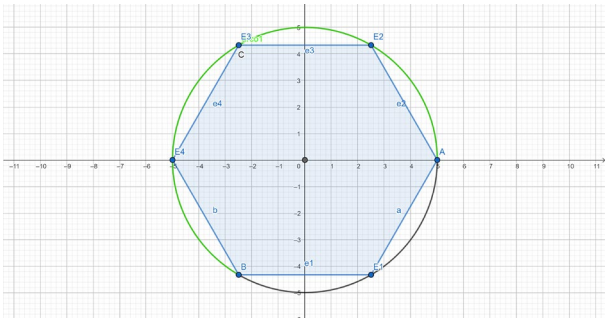


Figure 3 – The example of the regular hexagon (n=6)

Simultaneously, they examine the fundamental numerical series underlying these relationships in arithmetic and their correlation with the movements of astronomical objects and modern satellite navigation technologies, where the determination of optimal satellite trajectories and synchronization exploit advanced geometric concepts.

The activity proceeds with students calculating the ratios between the sides and verifying whether they correspond to known harmonic intervals. To gain a comprehensive understanding of the ratios and connections with musical intervals, software tools can be used to dynamically change the length of the arcs. Additionally, the analysis of proportions in planetary orbits is noteworthy, such as the Titius-Bode law, and how they reflect universal harmony.

Finally, with the Muse Score software, students can reproduce the frequencies corresponding to the harmonic ratios. This practice facilitates a deeper understanding of the auditory effects associated with mathematical proportions. Students may be encouraged to listen to the generated chords and verify how mathematical ratios influence the perception of harmony.

The activity encourages a thoughtful examination of the classical isoperimetric problem as an example of geometric optimization drawing a parallel to harmonic optimization in music, the numerical structure of arithmetic, the harmonic arrangement of the universe in astronomy and modern STEAM applications.

4. Conclusions

This paper advocates for a reinstatement of a cognitive approach reminiscent of the Quadrivium, which emphasizes the harmony between the mind, the senses, and the universe. It proposes an educational model centered on the significance of constructing enduring meanings that are collectively understood across various dimensions of knowledge.

The educational path presented in this article is part of a constructivist learning model that uses mathematics to foster integration between disciplines. The objective is to build upon the Quadrivium tradition while integrating contemporary STEM/STEAM methodologies to create a teaching experience in which students actively engage in their own learning process (Vygotsky, 1934).

The proposed laboratory activity is centered on the well-known isoperimetric problem enhanced through its integration with music and goes beyond a mere fusion of disciplines. It is rooted in the concept of "connection with a purpose." (Bauman, 2003). Unlike the superficial and temporary connections typical of liquid modernity, a connection with a purpose is oriented towards the construction of meaning and lasting relationships. In this laboratory, in fact, students do not limit themselves to relating mathematical and musical concepts, but build a stable bridge between languages, recognizing in the harmonic structure of music the same principles of proportion and order that govern geometry. The laboratory thus becomes a place of deep relationships: between disciplines, between logical thinking and aesthetic sensitivity, between students and teachers, between theory and practice. This didactic approach promotes knowledge that is not aimed at immediate consumption, but at critical elaboration and reflection, dialogue between intelligences, and the shared construction of meanings. It is not just a method, but a form of thinking that breaks down the barriers between subjects.

The Quadrivium-STEM/STEAM combination succeeds in creating an innovative learning environment that enhances both ancient knowledge and the possibilities offered by new technologies. In fact, through the combined use of software such as GeoGebra and Muse Score, students can gain insight into the fundamental role that mathematical proportions play in both geometric optimization and musical harmony. Additionally, they will learn how these concepts are interconnected with astronomy, particularly in the organization of planetary orbits and the advancements in modern navigation technology.

The objectives can be categorized into several domains of learning, which encompass the comprehension of mathematical concepts, the cultivation of interdisciplinary skills, the enhancement of technological proficiency, the attainment of critical and reflective thinking abilities, the development of problem-solving skills, and the encouragement of collaborative learning.

The classroom experimentation with students will begin in May 2025, and will be accompanied by a phase of data collection and analysis for further critical reflection. At the same time, the workshop will be proposed as a training course in refresher courses for teachers, with the aim of disseminating interdisciplinary teaching practices that respond to contemporary educational challenges.

References

Bauman Z., (2003). *Liquid love: On the frailty of human bonds.* Cambridge: Polity Press.

Bimonte G.; Tortoriello F.S.; Veronesi I. (2023). An interdisciplinary educational path to understand the economic phenomena of a fluid and complex world with mathematics, *Soft Computing*.

Bloom, B. S. (1956). *Taxonomy of Educational Objectives: the classification of educational goals.* New York: Logmans, Green.

Bologna F.; Perrotta A.; Rogora E.; Veronesi I. (2020). Using graphing calculators at University, *APLIMAT 2020 Proceedings*.

Boschi, C. (a cura di) (1991). *Musica e scienza. Il margine sottile*. Roma: ISMEZ.

Camurri, A. (ed.) (1990). *Artificial intelligence and Music*. Special issue of Interface, Journal of New Music Research.

Corona, A. (2015). *Teoria musicale e matematica Vol.1. Prospettiva dell'altezza.* Vicenza: Tgbook.

De Maria, G. (2018). *Matematica e musica: due linguaggi universali.* Roma: Stamen.

Dewey, J. (1938). *Experience and education*. New York: Macmillan.

Elam, K. (2001). *Geometry of Design: sudies in proportion and composition*. New York: Princeton Architectural Pr.

Ferguson, K. G. (2008). *The Music of Pythagoras. How an ancient brotherhood cracked the code of the universe and lit the path from antiquity to outer space.* New York: Walker & Company.

Guilford, J. P. (1967). *The Nature of Human Intelligence*. New York: McGraw-Hil.

James, J. (1993). *The Music of the Spheres: Music, Science, and the Natural Order of the Universe.* New York: Copernicus.

Lewin, K. (1951). *Field theory in social science.* London: Dorwin Cartwright.

Mayer, R.E. (2020). *Multimedia Learning*. Cambridge: Cambridge University Press.

Morin, E. (2001). *The Seven-Knowledge Necessary for Future Education*. Brasilia: United Nations Educational, Scientific, and Cultural Organization.

Musmarra P.; Tortoriello F.S.; Veronesi I. (2023). Technology-enhanced learning: Cloud computing to implement cooperation among schools, *Proceedings HEAd'23*, Editorial Universitat Politècnica de València.

Ozzola, V. (2018). *Numero + suono = musica. Capire la musica con la matematica.* Milano: Delos Digital.

Rochon, M. (2024). *Il cervello e la musica. Un'odissea fantastica tra arte e scienza.* Torino: LINDAU.

Rogora, E.; Tortoriello, F. S. (2021). *Interdisciplinarity for learning/teaching mathematics*. Bolema Boletim de Educacao Matematica.

Sternberg, R. (1988). *The Triarchic Mind: A New Theory of Human Intelligence*. New York: Viking Adult.

Sweller, J., (1988.) Cognitive Load During Problem Solving: *Effects on Learning, Cognitive Science, a multidisciplinary Journal*, pp. 257-285.

Tortoriello, F.S.; Veronesi, I. (2021). Internet of things to protect the environment: a technological transdisciplinary project to develop mathematics with ethical effects, *Soft Computing.*

Tortoriello F.S.; Veronesi I. (2021). Historical path in mathematical games: a didactic laboratory activity dedicated to upper secondary school students, *Proceedings The 25th World Multi-Conference on Systemics, Cybernetics and Informatics: WMSCI 2021.*

Vygotsky, L.S., (1934). *Pensiero e Linguaggio*, Moscow: State Socioeconomic Publishing House.

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Introducing co-creation and generative coaching into learning environments: the effects on students' self-regulation skills, self-efficacy and academic efficacy

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Abstract

In this action research study, we investigate the impact of co-creation and generative coaching on students' self-regulation, self-efficacy and academic efficacy in the context of three course units in higher mathematics education at university. Using questionnaire data, we measure (1) to what extent students perceive a difference between the learning environments of the three experimental courses - with co-creation and generative coaching - and those of the three control courses - without co-creation and generative coaching - and (2) to what extent there is a difference in self-regulation, self-efficacy and academic efficacy in the experimental learning environments vs. in the control learning environments. Descriptive statistics and paired t-tests show statistically and practically significant impacts of co-creation and generative coaching on self-regulation skills, self-efficacy and academic efficacy. The results suggest that in order to boost students' learning, it might be worthwhile to invest in co-creation and generative coaching in learning environments.

Keywords: *Innovative teaching and learning experiences.*

1. Introduction

According to MIT-researchers Scharmer (2018) and Kaufer (Scharmer & Kaufer 2013, 2025), the main challenge for education is to now move from Education 2.0 which is testing-centric, to Education 3.0 and 4.0. Education 3.0 is learner or student centric with the lecturer as a facilitator of learning processes. Education 4.0 is co-creation or innovation centric with generative coaching as a major role of the lecturer. In Education 4.0 learners and educators co-create and co-shape the future, acting from an eco-system awareness with respect for the well-being of all. The concept of generative coaching refers to the lecturer acting as a coach who

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initiates, enables and facilitates generative dialogue, an open and meaningful type of communication that captures the interests of participants by focusing on what excites them and what frustrates them (Shaw 2002, 2005).

Evidence on the effects of co-creation and generative coaching in the context of (higher) education is still very sparse and anecdotal, most of it is based on document analysis (e.g. individual student logs, student portfolios, notes and observations), interviews and evaluation/reflection meetings (e.g. Iversen et al. (2015), Aarup and Krogh (2017)). No quantitative analysis has yet been done to measure the effects of co-creation and generative coaching. Research on the effects of co-creative learning revealed an increase in student engagement, student involvement, and high-level learning outcomes (Iversen et al., 2015). Aarup and Krogh (2017) showed that most students wish to be part of the co-creation processes regarding teaching activities and that those who are involved in some of the decision-making processes express much more contentment. Based on research in positive psychology, this contentment (cf. positive affect) may in turn increase self-regulation, self-efficacy and academic efficacy amongst others (Lyubomirsky, 2005). Iversen and Stavnskær Pedersen (2017) studied the effects of co-creative generative dialogue between students and teachers (which is strongly related to generative coaching) and argued that this enhances the societal relevance of education and at the same time prepares students for becoming 21st-century knowledge workers.

Over the last years, we set up a pilot study in the bachelor program of Computer Sciences at a Belgian university to introduce co-creative learning and generative coaching in the context of mathematics education. We applied the main principles of action research and developed appropriate questionnaires. In this paper, we present the results of our quantitative analysis based on descriptive statistics and paired t-tests. In this way, we like to contribute to the understanding of the effects of co-creation and generative coaching on students' learning. This study shows a statistically significant impact of co-creative learning and generative coaching on students' self-regulation skills, self-efficacy and academic efficacy.

2. Research design, instruments and methods for data analysis

2.1. Research context

In this action research study, we selected six bachelor mathematics courses at university that are curriculum embedded and compulsory and have lecturers with excellent teacher evaluations. In the three experimental courses – denoted E1, E2 and E3 - we introduced co-creation and generative coaching. The other three courses are control courses, denoted C1, C2 and C3. The mathematics courses C1 and E1 are attended by the same student group in the first semester of their study. The same holds for C2-E2 in the second semester and for C3-E3 in the third semester. That way we selected for each experimental course a control course as similar as

possible with regard to characteristics of study context: class size, level of expertise of the students, time and place. This yields an experimental design in which the experimental and control group are the same: in three successive semesters, participants attended both an experimental and a control mathematics course and filled out a questionnaire for each at the corresponding final exams.

2.2. Research questions

With the first research question (Q1) we verify whether students actually perceive differences between learning environments with and without co-creation and generative coaching. Q1: To what extent do students perceive a difference between a traditional learning environment (i.e. without co-creation and generative coaching) versus a learning environment with co-creation and generative coaching?

With the second research question (Q2) we look at the impact of co-creation and generative coaching on various learning approach aspects. Q2: To what extent is there a difference in (1) regulation strategies of learning (self-regulation, external regulation, lack of regulation), (2) self-efficacy (self-confidence, self-image, self-appraisal) and (3) academic efficacy (confidence in academic competence) in the experimental learning environments with co-creation and generative coaching vs. in the control learning environments without co-creation and generative coaching?

2.3. Participants and instruments

Bachelor in Computer Science students participated anonymously and voluntary by attending the courses involved and completing four times a questionnaire for a pair of courses: E1pre-C1pre, E1post-C1-post, E2-C2, E3-C3. The questionnaire combines nine validated scales of the instruments LEMO (Donche et al., 2010), Modified WIHIC (Afari et al., 2013) and MJSES (Jinks & Morgan, 1999), that are relevant for the research questions. These scales and their meaning are presented in Table 1.

The items on social aspects of learning, regulation strategies, and academic efficacy are scored on a five-point Likert scale ranging from 1=almost never, over 2=rarely, 3=sometimes, 4=often to 5=almost always. The items on self-efficacy are scored on a five-point Likert scale ranging from 1=disagree, over 2=rather disagree, 3=neither agree nor disagree, 4=rather agree to 5=agree.

Acceptable Cronbach's alpha values were found for the following scales: Self-regulation (Cronbach's $\alpha = 0.81$), Lack of regulation (Cronbach's $\alpha = 0.77$), Self-efficacy (Cronbach's $\alpha = 0.93$), Student cohesiveness (Cronbach's $\alpha = 0.87$), Teacher support (Cronbach's $\alpha = 0.95$), Student involvement (Cronbach's $\alpha = 0.92$), Student cooperation (Cronbach's $\alpha = 0.94$), and

Academic efficacy (Cronbach's α = 0.90). Only the External regulation scale turned out to be unreliable (Cronbach's α = 0.59) and could therefore not be used for further analysis.

Table 1. Scales used in this study and their meaning

	Scales	Meaning
Social aspects of learning	Student cohesiveness	The extent to which students are supportive of one another.
	Teacher support	The extent to which the teacher helps, trusts, and shows interest in students.
	Student involvement	The extent to which students have attentive interest, participate in discussions, perform additional work.
	Student cooperation	The extent to which students cooperate rather than compete with one another on learning tasks.
Regulation strategies	Self-regulation	The extent to which students actively steer their own learning process.
	External regulation	The extent to which students rely on teaching staff or the learning material to steer their learning process.
	Lack of regulation	The extent to which students experience a lack of clarity on how to steer their learning process.
Efficacy	Self-efficacy	The extent to which students have confidence in their learning approach and believe in their own ability.
	Academic efficacy	The extent to which students have confidence in their academic competence.

2.4. Data analysis

First, we applied descriptive statistics and paired t-tests on the data for the scales regarding social aspects of learning - Student Cohesiveness, Teacher support, Student involvement and Student cooperation - to verify whether, and to what extent, students perceive differences between a traditional versus an experimental learning environment with co-creation and generative coaching (Q1).

Next we used descriptive statistics and paired t-tests to examine to what extent students' self-regulation, self-efficacy and academic efficacy differ in a learning environment that they perceived as experimental versus in a learning environment that they perceived as traditional (Q2).

3. Research results

To answer research question **Q1**, we consider paired t-tests for the following 3 combinations:

- C1pre-E1pre (Table 2) to verify if there is a difference in students' perceptions of the learning environments of the courses E1 and C1 at the midterm before which both courses applied a traditional learning environment.
- C1post-E1post (Table 3) to verify if there is a difference in students' perceptions of the learning environment with co-creation and generative coaching in the experimental course E1 after midterm versus the traditional learning environment of the control course C1.
- E1pre-E1post (Table 4) to verify if there is a difference in students' perceptions of the learning environment with co-creation and generative coaching in the second half of the experimental course E1 versus the traditional learning environment (without co-creation and generative coaching) of the first half of E1.

Table 2. C1pre-E1pre (cohort 1, N = 39)

Scale	C1pre		E1pre		paired t-tests			
	M	SD	M	SD	t	df	p-value	Cohen's d
Student cohesiveness	2.86	0.76	3.06	0.84	1.34	37		**0.22 (S)**
Teacher support	3.72	0.60	3.76	0.59	0.29	30		0.05
Student involvement	3.06	0.62	3.02	0.73	**-0.23**	34		- 0.04
Student cooperation	2.64	0.84	3.06	0.79	**2.69**	31	*	**0.48 (S)**

Table 3. C1post-E1post (cohort 1, N = 31)

Scale	C1post		E1post		paired t-tests			
	M	SD	M	SD	t	df	p-value	Cohen's d
Student cohesiveness	2.93	0.63	3.72	0.62	5.67	28	***	1.05 (L)
Teacher support	3.65	0.49	4.01	0.47	3.58	25	***	0.70 (M)
Student involvement	2.96	0.57	3.67	0.38	5.84	28	***	1.08 (L)
Student cooperation	2.59	0.77	4.04	0.46	8.02	25	***	1.57 (L)

Table 4. E1pre-E1post (cohort 1, N = 35)

Scale	E1pre		E1post		paired t-tests			
	M	SD	M	SD	t	df	p-value	Cohen's d
Student cohesiveness	3.02	0.79	3.70	0.60	4.04	33	***	0.69 (M)
Teacher support	3.77	0.51	3.95	0.49	1.40	28		0.26 (S)
Student involvement	3.09	0.68	3.60	0.36	3.82	31	***	0.68 (M)
Student cooperation	3.11	0.74	3.95	0.50	4.97	29	***	0.91 (L)

We find statistically significant differences with large effects in favour of the experimental setting for all scales considered: Student Cohesiveness, Teacher support, Student involvement and Student cooperation.

To answer research question **Q2**, we consider paired t-tests for the combinations C1post-E1post, C2-E2 and C3-E3 for the scales self-regulation, self-efficacy and academic efficacy. The results are shown in Tables 5-7.

Table 5. C1post-E1post (N = 58)

Scale	C1post		E1post		paired t-tests			
	M	SD	M	SD	t	df	p-value	Cohen's d
Self-regulation	3.01	0.84	3.30	0.76	2.26	55	*	0.30 (S)
Lack of regulation	2.70	0.81	2.32	0.66	-3.34	53	**	-0.45 (S)
Self-efficacy	2.94	1.00	3.62	0.61	5.89	56	***	0.78 (M)
Academic efficacy	2.43	0.82	3.10	0.70	5.48	53	***	0.75 (M)

Table 6. C2-E2 (N = 46)

Scale	C2		E2		paired t-tests			
	M	SD	M	SD	t	df	p-value	Cohen's d
Self-regulation	3.08	0.92	3.22	0.90	1.3	45		0.19
Lack of regulation	2.53	0.78	2.47	0.74	-0.54	45		-0.08
Self-efficacy	2.98	1.11	3.26	0.91	2.27	45	*	0.33 (S)
Academic efficacy	2.58	0.98	2.76	0.70	1.58	45		0.23 (S)

Table 7. C3-E3 (N = 38)

Scale	C3		E3		paired t-tests			
	M	SD	M	SD	t	df	p-value	Cohen's d
Self-regulation	3.16	0.86	3.43	0.84	2.33	37	*	0.38 (S)
Lack of regulation	2.68	0.68	2.22	0.70	-3.52	37	**	-0.57 (M)
Self-efficacy	3.40	0.88	3.59	0.95	1.29	36		0.21 (S)
Academic efficacy	2.75	0.79	3.05	0.81	1.86	36		0.31 (S)

All of the significant differences are in favour of the experimental courses. In table 5 (semester 1), we notice a statistically significant difference for the scales self-regulation, lack of regulation, self-efficacy and academic efficacy. For the regulation scales, the effects are small practically significant. For self-efficacy and academic efficacy, the effects are medium

practically significant. In table 6 (semester 2), the scale self-efficacy differs with small statistical significance and small practical significance. For the scale academic efficacy, the difference that can be observed is not statistically significant. In table 7 (semester 3), we notice a statistically significant difference for the scales lack of regulation and self-regulation, the effects are medium respectively small practically significant. For the scales self-efficacy and academic efficacy, the effects are small practically significant.

4. Main conclusions

The results show that between the two types of learning environments – traditional versus experimental with co-creation and generative coaching – students perceive significant differences in their relationships towards their peers, in learning together, in working together and also in teacher support.

Moreover, this study illustrates positive effects of co-creation and generative coaching on students' self-regulation, lack of regulation, self-efficacy and academic efficacy. The largest effects can be observed in semester 1. While in semesters 2 and 3, the learning environments of the experimental courses are the same, the significant impact in the latter is far larger. A possible explanation could be that the extent to which students steer their own learning process and to which they have confidence in their academic competence is challenged by the comprehensive assignment to co-create and realize their own project proposal, which is new to students in the second experimental course and pushes them beyond their comfort zone. In semester 3 they can build on their experience gained in semester 2.

In the context of this action research we co-created examples of Education 3.0 and 4.0 learning environments in the experimental courses. These courses are currently being spotlighted as good practices in several European universities, thus improving educational practice. We see this action research as a stepping stone towards Education 4.0 in which students become fully fledged learning partners and co-creators/innovators.

Moreover, this study suggests that it might be worthwhile to invest in co-creation and generative coaching in learning environments, in order to boost students' self-regulation, self-efficacy and academic efficacy, essential qualities for 21st-century skills such as lifelong learning.

References

Aarup Jensen, A., & Krogh, L. (2017) Re-Thinking curriculum for 21st-century learners: examining the advantages and disadvantages of adding co-creative aspects to problem-based learning. In *Co-creation in Higher Education,* 1-14. ISBN: 9789463511186.

Afari, E., Aldridge, J., Fraser, B., & Khine, M. (2013). Students' perceptions of the learning environment and attitudes in game-based mathematics classrooms. *Learning Environments Research*, 16, 131-150. doi:10.1007/s10984-012-9122-6.

Donche, V., Van Petegem, P., Van de Mosselaer, H., & Vermunt, J. (2010). *Een instrument voor feedback over leren en motivatie [An instrument for feedback on learning and motivation]*. Plantyn: Mechelen. ISBN: 978-90-301-0834-4.

Iversen, A., Pedersen, A., Krogh, L., & Jensen, A. (2015). Learning, leading, and letting go of control: Learner-led approaches in education. *Sage Open*, 5(4), 1–11. doi: 10.1177/2158244015608423.

Iversen, A., & Stavnskær Pedersen, A. (2017). Co-creating knowledge: students and teachers together in a field of emergence. In *Co-creation in Higher Education*, 15-30. ISBN: 9789463511186.

Jinks, J., & Morgan, V. (1999). Children's perceived academic self-efficacy: an inventory scale. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *72*(4), 224–230. doi: 10.1080/00098659909599398

Lyubomirsky, S., King, L., & Diener, E. (2005). The benefits of frequent positive affect: does happiness lead to success? *Psychological Bulletin, 131*(6), 803-855. doi: 10.1037/0033-2909.131.6.80.

Scharmer, O. (2017). edX-MITx U.Lab 2x Live Webcast The future of learning & creativity. (accessed on February 7, 2025). http://webcast.mit.edu/u.lab2x/live/6/ .

Scharmer, O. (2018). *The Essentials of Theory U*. Berrett-Koehler Publishers. ISBN: 978-1-60509-926-2.

Scharmer, O., & Kaufer, K. (2013). *Leading from the emerging future.* Berrett-Koehler Publishers. ISBN: 978-1-60509-926-2.

Scharmer, O., & Kaufer, K. (2025). *Presencing: 7 Practices for Transforming Self, Society, and Business*. Berrett-Koehler Publishers, ISBN: 979-8890570284.

Shaw, P. (2002). *Changing conversations in organizations: A complexity approach to change*. Routledge: London, ISBN: 978-0415249157.

Shaw, P. (2005). Conversational inquiry as an approach to organisation development. *Journal of Innovative Management, Fall 2005,* 19–22.

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Designing the Sixth Sense: Wearable Technology and the Role of Prototyping in Fashion Tech Higher Education

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Abstract

The study investigates the design of smart jewelry, focusing on the materialization of the so-called "sixth sense" through a university workshop. The aim was to examine how in higher education designers can develop new interactions between body, object and environment by exploiting speculative tools and advanced design methods. The results show a prevalence of solutions oriented toward health and interpersonal connection, with movement and color as the main modes of output. Methodologically, storyboards, physical models, digital renderings and videos proved to be key tools to compensate for the lack of technological prototyping. The conclusions emphasize the potential of wearable technologies to broaden the sensory experience and open up new design perspectives in fashion tech.

Keywords: *Fashion-tech, jewelry design, speculative prototyping, digital technology, wearable interaction, human-centered design.*

1. From body to behavior

In recent years, academic research in the field of Fashion Tech has placed increasing emphasis on training professionals who can manage design complexity by developing creative skills capable of integrating and enhancing technological innovation (EDU4FashionTech Benchmarking Report (Colombi & Tenuta, 2020) and "FTAlliance. Weaving Universities and Companies to Co-create Fashion-Tech Future Talents," a three-year (2020-2022) Knowledge Alliance Project co-founded by the Erasmus+ Program of the European Union (GA 612662-EPP-1-2019-1-IT-EPPKA2-KA). Designing products with integrated technology is an interdisciplinary field, characterized by the convergence of physical, symbolic, emotional, experiential and interactive dimensions. This complexity requires a critical review of the design processes and tools used in design so that they can adequately support the creation of hybrid and innovative solutions. The present study examines a university workshop focused on the concept of jewelry behavior, defined as the capacity of jewelry to exhibit dynamic responsive

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actions through the integration of technology. The study thematically addressed the materialization of an intangible human sensory experience, exploring how technological enhancement enables jewelry to embody perceptual and affective dimensions. The scholarly literature highlights the growing interest in integrating the physical and digital dimensions of experience, particularly in contexts where interaction with the body plays a central role (Rossato, 2024; Tenuta & Rossato, 2023; Cappellieri et al, 2022; Testa, 2019; Mistry et al, 2009). This approach brings design thinking back to corporeality and the tangible transposition of intangible stimuli. In this perspective, the interaction between subject and object gains relevance as a reciprocal and meaning-making process. As described in the fourth category of embodiment by Van Rompay and Ludden (2015), the object actively shapes the user experience, fostering engagement through its affordances and responses. The main objective of the workshop was to test, within the academic realm of higher education, the possibility for designers to design the behavior of jewelry by exploiting digital technologies to generate new modes of interaction between object and user. The centrality of the materialization of experience emerged as a key element of the design process, with digital technology used not only as a technical tool, but as a means to activate new forms of relationship between body and object. The case study focuses on the concept of the sixth sense and how wearable digital technologies can amplify human sensory perception (Baker and Boddington, 2022), transforming intangible inputs into tangible signals and, as a result, fostering new modes of interaction between users, their bodies and their surroundings.

2. Case Study: “Sixth Sense (SS)” Workshop

2.1. Significance and Objectives

The Sixth Sense (SS) workshop was conducted with jewelry design students in the three-year degree program at Politecnico di Milano. The structure and method will be explained below, but it is important to first mention the meaning and objectives of the brief and related analysis. As the title itself suggests, the brief was to explore the concept of sixth sense through the integration of technology within the fashion product, in this case a piece of jewelry made in collaboration with an Italian fashion company. The case study thus refers to the context of wearable technologies and, in particular, smart jewelry. The intention to investigate this topic stems from some recent considerations in the literature. In particular, the EDU4FashionTech Benchmarking Report (Larsson et al, 2018) highlighted 5 possible future developments in the Fashion-Tech sector: (a) body protection and enhancement through an artificial second skin; (b) culture-based wearables: art, technology and innovation; (c) hyper-body: connection between senses and materials; (d) fashion that takes care of the person; (e) mixed real/virtual environments. The (c) scenario proposed an exploration of human senses and materiality, particularly for sight, hearing and touch, where technology was configured as a support for

exploring, controlling and empowering the human body. Crossing the boundary of bodily sensory perception, the decision to introduce the sixth sense as the first investigative boundary in the project brief was intended to suggest future considerations on the Hyper-body and Extra-Humans scenarios proposed in the report (Colombi & Tenuta, 2020). In this perspective, digital technology embedded in fashion objects becomes the means to materialize additional intangible information. What if a smart piece of jewelry worn on the body acts as an extension of our sensory perception and becomes, materially, our sixth sense? The sixth sense is defined here as "a power of perception similar to, but not belonging to, the five senses: a distinct intuitive ability". There is no scientific evidence for the existence of this phenomenon, apart from alleged anecdotal evidence that by its nature has no scientific credibility or statistical significance, nor a proven physical correspondence between the sixth sense and the human body. Rather, it can be defined as a supposed, intangible intuition involving the body itself. Far from trying to prove its existence, the sixth sense is here regarded as an intangible subject related to the body to be materialized. Between empowering the body and reconnecting with our embodied experience, the sixth sense is used as a narrative concept to define the design limits of the brief (Rossato, 2024). The analysis pursued two main objectives: thematic and methodological. The first aimed to explore how students interpreted the concept of the sixth sense and its materialization through body-related smart jewelry. This also included examining the emerging meanings related to the designed objects, with particular attention to the perceived level of embodiment. The second, the methodological objective, aimed to evaluate the effectiveness of the design activity within an academic context, highlighting the pedagogical opportunities and limitations encountered throughout the process.

2.2. Structure and method

The workshop took place over 13 days in October 2021. The activity involved: 40 students (including 4 international students) enrolled in the third year of the three-year degree program in Fashion Design at Politecnico di Milano; 1 Italian fashion company; 1 professor of jewelry design; 1 tutor (PhD student in design supporting the activity). The design activity was carried out individually by all participants. Figure 1 shows the overview of the structure of the design and review process initially set up.

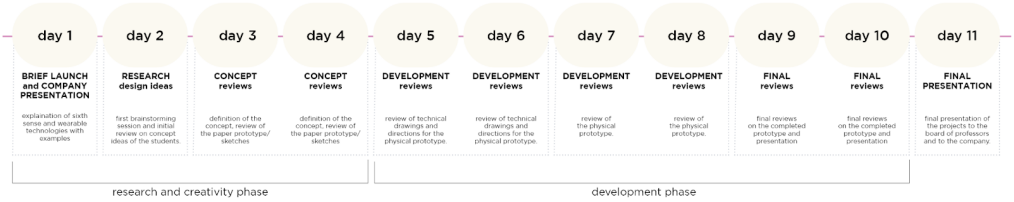


Figure 1. Overview of the workshop structure and the design process followed for the creation of the smart jewel (created by the authors).

The workshop was conducted mainly through a learning-by-doing approach, with constant monitoring and revisions by the professor and the course tutor. The analysis was conducted through this continuous observation of the design process, enriched by informal exchanges within the course and subsequent analysis of the projects developed. The initial brief was presented along with the company's presentation. In this case, it was important to associate experimentation on the theme described with a product created for the company, to give more credibility and feasibility to the design outputs. More time was spent on the development phase to create a physical prototype to show how the technology works. Integration of the actual technology was not required, as the workshop was mainly devoted to the design idea, i.e., concept development. However, the design had to be feasible and not refer to a non-industrial or purely artistic approach. The brief request and the proposed experimentation are schematized in the framework in Figure 2, used to analyze the project outputs. Starting from an intangible input, internal or external to the body, the jewelry was to act as a perceptual translator (i.e., the sixth sense) to materialize the signal (output).

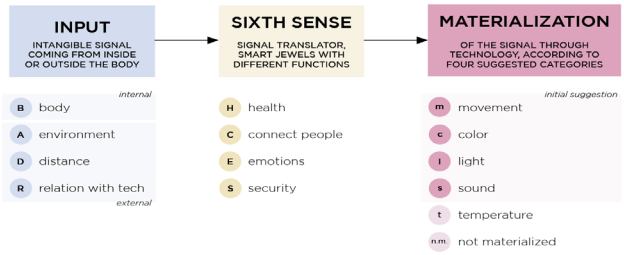


Figure 2. Input-sixth sense-materialization system, with related interpretation of the design outputs. (created by the authors).

The output would relate to the user's own body, the surrounding environment, or other bodies. The initial constraints were related to the perceptual translator value of the sixth sense, i.e., the possibility of the jewelry detecting an input before the user's body or in relation to information of which the body itself was unaware. There were no initial constraints with respect to the type of input or sixth sense, and certain types of materialization were suggested to facilitate brainstorming on the output of the technology, i.e. light, motion, color, and sound. The types of interaction that wearable technologies can introduce were suggested through existing examples in the clothing and accessory industry. To facilitate understanding of the topic beyond the field of design, we briefly present some examples that were shown to the students: the *Spider Dress* by Anouk Wipprecht moves according to respiratory and motion data collected from the wearer's body; *Neclumi*, a necklace that projects customizable light graphics onto the neck of the wearer; *Bodyscape* by Behnaz Farahi, an interactive fashion object that lights up by analyzing and mirroring the body's movements; *ShiftWear*, which integrates a digital display into fabric to create sneakers that can change appearance and be customizable via smartphone;

Caress of the Gaze, a 3D-printed interactive garment capable of detecting another person's gaze and reacting through movement.

3. Results and analysis

3.1. Thematic considerations

The design workshop resulted in 40 smart jewelry design outputs on the theme of the sixth sense. The analysis focused on three key dimensions: the relationship between input, sixth sense, and materialization; the degree of embodiment in the design outputs; the modes of interaction among the body, other people, and the environment.

3.1.1. Analysis of the relationship between input, sixth sense, and materialization

The input–sixth sense–materialization system was analyzed using macro-categories to highlight the main interpretative patterns. Inputs were classified into four types: Body (B), Environment (A), Distance (D), and Relation to technology (R), further grouped into internal (B; 24 outputs) and external stimuli (A, D, R; 16 outputs). Four primary interpretations of the sixth sense were identified: Health (H), Connecting People (C), Emotions (E), and Safety (S). Materialization modes included movement (m), color (c), light (l), and sound (s), with an additional category, temperature (t), emerging from the analysis. Three projects did not involve physical materialization (Digitized). Figure 3 provides a schematic synthesis of these findings.

	category	description	n° of outputs
INPUT	B body *internal*	stimulus comes directly from the body.	24
	A environment *external*	stimulus comes from the surroundings.	7
	D distance *external*	stimulus tracks the position of objects relative to each other.	8
	R relation with tech *external*	stimulus comes from interaction with technology.	1
SIXTH SENSE	H health	protecting the body (e.g., detecting harmful environmental agents, monitoring a physical condition, rebalancing well-being)	18
	C connect people	connecting individuals through community, identity, and relationships.	9
	E emotions	expressing or experiencing emotions through technology to interact with others or to experience a personal feeling in a tangible way.	9
	S security	protection and signaling, such as to warn of surrounding dangers or facilitate a call for help.	4
MATERIAL-IZATION	m movement	physical movement of the object in response to input.	18
	c color	change in color to express emotions or physical states.	10
	l light	use of light to convey sensory information.	6
	s sound	sound responses to stimuli (e.g., psychological discomfort).	2
	t temperature	change in temperature as materialization.	1
	n.m. not materialized	the sixth sense is not materialized physically, but digitized (e.g.,design of an AI digital assistant).	3

initial suggestion

Figure 3. Findings of the input–sixth sense–materialization system's analysis (created by the authors).

3.1.2. Analysis of the degree of embodiment

Although embodiment was not explicitly required in the brief, the body-centered nature of the topic naturally led to embodied outputs. Based on definitions from Van Rompay and Ludden (2015) and Merriam-Webster, embodiment was interpreted in two ways: Embody (Incorporate) → when the design becomes part of the body or acts as an extension of it; Personify (Personify) → when the design represents human or animal forms. The analysis further identified two main categories of jewelry behavior: "Technology to Human" (18 designs) where technology is humanized, taking on anthropomorphic or behavioral characteristics similar to humans or animals; and "Human to Technology" (9 designs) where human interaction mimics digital behaviors (e.g., light notifications or materialization of social media feedback). Thirteen projects showed no clear embodiment, focusing instead on environmental stimuli, without behavioral references (e.g., perception of ultrasound or reaction to environmental sounds).

3.1.3. Interaction between body, environment and other people

The analysis of interaction considered four main modes. "Body-to-body" (14 designs): the jewel interacts solely with the wearer's body, through either conscious (5) or unconscious (9) input, encouraging self-awareness. "From body to others" (8): internal bodily signal are externalized, promoting connection and interpersonal communication. "Environment to Body" (12): the jewelry informs the body about intangible events (e.g., air pollution or harmful UV rays) or supports community-based awareness (e.g., locating people in space or signaling their presence or absence). "From environment to others" (4): the jewel activates only in response to external signals, functioning within a community without direct bodily interaction.

3.2. Pedagogical and Methodological considerations

Beyond the thematic outcomes, the workshop revealed key insights into the pedagogical potential of prototyping without technology. Participants had to imagine scenarios, products, and experiences through alternative tools that would allow for a plausible representation of their ideas. In line with Ferraris' (2023) framework on the functions of the prototype in design education, students explored speculative scenarios using a combination of analog and digital tools. The storyboard, understood as a sequential graphical representation, played a key role in outlining the user experience at the design stage. This tool was employed to visualize the flow of interaction with the product, map the user journey, and identify potential critical issues, thus facilitating an informed, experience-centered approach. Specifically, the storyboard supported three main phases: Envision and speculate, i.e. defining the initial idea and interaction possibilities; Create and design, i.e. structuring the design through visual sequences; Comprehend, i.e. identification of user needs and potential improvements to the experience. The storyboard was a valuable tool, especially in the initial phase of the design process, transforming participants from students into narrative creators. Integrated technology needs the management

of both the aesthetic dimensions of design and the user experience, positioning participants as hybrid figures. Furthermore, the creation of physical models was critical in translating design ideas from the conceptual to the concrete stage. It allowed: to evaluate the development of the idea and first iterations of the design; to represent the form and wearability simulation; to evaluate the aesthetic and tactile qualities; to explore and understand the experimentation with design variations; to communicate through a visual presentation of the product. The design process included the use of 3D modeling software such as Rhinoceros, SolidWorks, and KeyShot to create detailed visualizations of the product. Digital rendering played a key role in two main areas: first, it helped to develop the design by refining and defining the formal details, and second, it was used to communicate the concept by generating realistic images that encouraged critical discussion and feedback. Additionally, video became an important communication tool, although not explicitly requested. Several students chose to produce videos to show the jewelry behavior. Video proved to be an effective medium for showcasing the behavior of the product, clarifying the dynamics of interaction, and illustrating how the object responded to external stimuli. Furthermore, the use of video facilitated feedback from others, enabling a better understanding and critical evaluation of the design. These strategies enabled students to simulate, visualize, and evaluate their ideas despite the absence of working integrated technology, providing concrete tools to explore the relationship between the body, technology, and sensory interaction.

3. Conclusions

Thematically, the investigation into the materialization of the sixth sense through smart jewelry design showed a tendency for students to focus on four main areas: health, connection between individuals, expression of emotions, and safety. The dominance of the categories health (45%) and emotions (22.5%) highlights a design orientation to interpret the sixth sense as a tool for personal protection and well-being, rather than as a means of extended interaction with the environment. In addition, the preference for movement (45%) and color (25%) as output modes suggests a strong connection with the visual and kinetic dimensions of sensory perception. On the pedagogical and methodological level, the workshop confirmed the effectiveness of the combined use of representational and prototyping tools in supporting the creative process in the absence of functioning technologies. The storyboard proved to be a useful tool in the initial stages of design, while physical models played a key role in verifying the wearability and aesthetic rendering of concepts. 40% of students also used video media as a communication tool, demonstrating a growing trend toward visual storytelling to illustrate the behavior of designed objects. The experience highlighted some limitations, most notably the lack of technical expertise, which prevented an in-depth analysis of the technological feasibility of the developed concepts. Additionally, students faced challenges in translating abstract ideas, such as the concept of the sixth sense, into tangible and practically feasible design solutions. This

limitation addresses the need to refine pedagogical tools to enhance strategies for the definition and validation of the ideas. Moreover, the study confirms the need and importance of training interdisciplinary and hybrid professional development (Larsson et al, 2018 and Colombi & Tenuta, 2020). Designers need to manage both creative and technical competencies, suggesting that future development of the research could investigates better how to seamlessly integrate creative speculative conceptualization with technological requirements.

References

Baker, C & Boddington, G. (2022) Editorial. Extended senses: embodying technology. *Intellect - Virtual Creativity, Issue Extended Senses: Embodying Technology*, 12 (1). pp. 3-8. ISSN 2397-9704 (Print), 2397-9712 doi:https://doi.org/10.1386/vcr_00057_2

Cappellieri, A., Rossato, B., Tenuta, L., & Testa, S., (2022). Digital Filters: A New Way to E-Wear Jewellery. In Ahram, T., & Taiar, R., (Eds.), *Human Interaction, Emerging Technologies and Future Systems V* (pp. 837-843). Springer https://doi.org/10.1007/978-3-030-85540-6_106

Colombi, C., & Tenuta, L. (2020). *Education for fashion-tech. Design and technology for future fashion creatives*. Nielsen Book. ISBN 978-1-906908-64-5.

Ferraris, S. D. (Ed.). (2023). *The Role of Prototypes in Design Research: Overview and Case Studies*. SpringerBriefs in Applied Sciences and Technology, PoliMI SpringerBriefs. Springer

Larsson, J., Vellesalu, A., Cappellieri, A., Colombi, C., Tenuta, L., Teunissen, J., Kapsali, V., Miller, G., Berge, C., Freundorfer, B., Henchoz, N., van Dongen, P., & Walter, L. (s.d.). (2018) *Fashion Tech. Education and research. Benchmarking Report. Education4Fashion-Tech.*

Mistry, P., Maes, P., & Chang, L. (2009). WUW - wear Ur world: A wearable gestural interface. *CHI '09 Extended Abstracts on Human Factors in Computing Systems*, 4111–4116. https://doi.org/10.1145/1520340.1520626

Rossato, B. (2024). *Embodied Digital Fashion. Supporting the Design Practice of Future Creatives in Dematerialization* (Doctoral dissertation). Available from May 2027 from Politecnico di Milano Politesi.

Tenuta, L. & Rossato, B., (2023). Digital Jewelry and Virtual Exhibition: Interaction in the Metaverse. *Proceedings of EDULEARN23 Conference.* 3rd-5th July 2023, Palma, Mallorca, Spain. ISBN: 978-84-09-52151-7, DOI: 10.21125/edulearn.2023

Testa, S. (2019). *FashionTech. Body Equipment, Digital Technologies and Interaction*. Mantua (MN), Italy: Universitas Studiorum. ISBN 978-88-3369-057-5.

Van Rompay, T. J. L., & Ludden, G. D. S. (2015). Types of embodiment in design: The embodied foundations of meaning and affect in product design. *International Journal of Design*, 9(1), 1-11. https://www.ijdesign.org/index.php/IJDesign/article/view/1670/673

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From Theory to Practice: A Study on Integrating Makerspaces into Undergraduate Curriculum

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Abstract

This study investigates whether integrating makerspace activities into a formal, credit-bearing course enhances undergraduate students' ability to innovate and engage in a project-based learning (PBL) engineering curriculum. Using a modified Student Assessment of Learning Gains (SALG) instrument that captures key student-relevant competencies, we compared 42 students enrolled in a three-credit Makerspace-based Engineering Design course (treatment group) with 38 students who used the makerspace for other PBL courses (control group). Rigorous statistical analyses reveal that the treatment group achieved moderate to high gains across all measured competencies, with significant differences observed between groups ($p < 0.01$, effect sizes ranging from moderate to high). Preliminary qualitative feedback further supports these findings. We conclude that formal curricular integration of makerspace activities significantly enhances students' innovation and engagement outcomes in project-based learning.

Keywords: *Makerspace Integration; Project-Based Learning; Undergraduate Innovation; Engineering Education; Iterative Design; Entrepreneurial Mindset*

1. Introduction

The rapid evolution of technology and the growing emphasis on experiential learning have challenged traditional higher education pedagogies. Academic makerspaces, collaborative, technology-rich environments, have emerged as transformative platforms that bridge the gap between theoretical instruction and real-world application (Galaleldin et al., 2017; Wilczynski & Stark, 2015; Hoople et al., 2020). These spaces often incorporate maker technologies such as 3D printing and laser cutting, which develop design skills, problem solving, and teamwork in engineering education (Galaleldin et al., 2019). Beyond engineering, makerspaces have also been integrated into courses spanning the arts, business, and the social sciences, thereby

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supporting multidisciplinary learning experiences (Wilczynski et al., 2017; Berg et al., 2020) and fostering inclusivity (Heintzman, 2018).

Research indicates that effective curricular integration can positively impact student engagement, teamwork, and innovation skills (Nilsson, 2012; Berg et al., 2020). Additionally, structured makerspace experiences help address organizational and didactic challenges, ensuring that students not only gain hands-on skills but also develop an entrepreneurial mindset (Stephanie Gillespie et al., n.d.; Bonnie H. Ferri et al., 2017). Despite the benefits of extracurricular makerspace activities, few studies have systematically integrated these experiences into formal, for-credit curricula. Research suggests that structured integration can boost student engagement, teamwork, and innovation skills (Nilsson, 2012; Sandtrø et al., 2020), while also cultivating an entrepreneurial mindset (Gillespie et al., n.d.; Ferri et al., 2017).

This study examines an Engineering Design course called Innovation Through Making, an eight-week, three-credit offering that integrates makerspace activities within a PBL framework at Worcester Polytechnic Institute (WPI). The course uses a blended learning approach that includes flipped classroom lectures, active learning sessions, and dedicated makerspace workshops, culminating in a Prototype Showcase that emphasizes innovation, sustainability, and real-world impact. By comparing learning gains between course participants and a control group with unstructured makerspace access, we seek to determine how formal curricular integration improves undergraduate innovation and engagement outcomes.

2. Research Methods

2.1. Course Description:

Innovation Through Making is an engineering design sciences elective offered as a new experimental course at WPI. Learning outcomes target five competencies: tool proficiency, iterative design, creative problem solving, collaboration, and entrepreneurial mindset. Table 1 summarizes the core makerspace activities.

Approximately 50 % of class time occurs in the makerspace; the remainder uses flipped-classroom discussions and design reviews to link theory to practice.

2.2. Group Selection

A total of 42 undergraduate students enrolled in the Makerspace course served as the treatment group. This was collected over three course offerings stretching a three-year period. Demographic data (including major, academic year, and gender) were collected to study any dependent descriptive factors. To isolate the impact of formal curricular integration, a control group of 38 students was selected from those concurrently enrolled in two other project-based

Table 1. Weekly Makerspace Activities and Alignment to Competencies

Week	Activity	Competency Alignment*
1	"Maker Passport" safety & intro workshop; simple laser-cut key-tag	TP
2	Low-fidelity cardboard prototype of a kinetic toy	ID, CPS
3	CAD & 3-D-print challenge	TP, ID
4	Mid-term peer critique & design-iteration log	CE, CPS
5	Electronics integration: Circuits	TP, CPS
6	Failure-reflection journal & redesign	EM, ID
7	High-fidelity prototype using mixed media	TP, ID, CE
8	Prototype Showcase with industry judges	EM, CE

*TP = Tool Proficiency; ID = Iterative Design; CPS = Creative Problem Solving; CE = Collaborative Engagement; EM = Entrepreneurial Mindset.

undergraduate courses at the same institution. Although these students had access to the same makerspace facilities for their projects, they did not receive, nor were they required, to use a dedicated makerspace curriculum.

2.3. Data Collection Instruments and Procedure

Data were collected using a modified version of the Student Assessment of Learning Gains (SALG) instrument, administered to both groups at the beginning (pre-course) and the end (post-course) of the term. The SALG is a validated survey that asks students how much specific aspects of a course helped their learning (Vogt et al., 2005). We adapted item stems to target makerspace competencies; each sub-scale exhibited high internal consistency (Cronbach's $\alpha = 0.86–0.91$). The SALG was tailored to capture several student-relevant competencies, which are defined as follows:

- **Tool Proficiency:** The student's self-assessed ability to effectively operate makerspace technologies (e.g., 3D printers, laser cutters) and other technical equipment.
- **Iterative Design & Prototyping:** The capacity to apply design thinking and engage in successive cycles of prototyping, evaluation, and refinement to develop functional and innovative solutions.
- **Creative Problem Solving:** The ability to generate and implement innovative solutions for complex, real-world challenges by thinking outside conventional frameworks.
- **Collaborative Engagement:** The effectiveness with which students work in teams, share ideas, and leverage diverse perspectives to improve project outcomes.

- **Entrepreneurial Mindset (Risk-Taking):** The willingness to embrace uncertainty and learn from failure, reflecting a proactive approach to exploring novel ideas and opportunities.

All control-group students completed the same pre-course and post-course SALG surveys (administered at the start and conclusion of their respective courses), enabling a direct comparison of learning gains. Background checks ensured that no control-group participant was simultaneously enrolled in the course, thus maintaining a clear separation of experiences.

2.4. Data Analysis

For data analysis, paired t-tests were used to assess within-group changes in SALG scores from pre- to post-course. An analysis of covariance (ANCOVA) was then performed to compare post-course outcomes between the treatment and control groups while controlling for baseline differences. Reliability analyses (e.g., Cronbach's alpha) were conducted to confirm the internal consistency of the modified SALG subscales. Subgroup analyses were also performed to explore potential differences in gains based on major, academic year, or gender. This approach enabled a rigorous evaluation of the impact of formal makerspace curricular integration on undergraduate innovation and engagement within a project-based learning framework. Demographic comparisons were also conducted to confirm that observed differences were not attributable to variations in gender, major, or academic year.

3. Results

3.1. Participant Demographics

Table 2 summarizes the demographic profile of both groups. No statistically significant differences in major distribution, academic year, or gender were observed, ensuring that differences in learning gains are attributable to the course design rather than demographic variation.

Table 2. Demographic Overview of Treatment and Control Groups

	n	% Engineering	% Non-Engineering	Avg. Academic Year	% Female
Treatment (Course)	42	60%	40%	2.8 (soph–senior)	40.5%
Control (2 PBL Courses)	38	62%	38%	2.9 (soph–senior)	42.1%

3.2. SALG Results

Table 3 summarizes the pre-course and post-course SALG scores (M ± SD) for the five domains. Each item was rated on a 5-point Likert scale (1 = "Very Low" to 5 = "Very High"). Within-group paired t-tests showed significant improvements in all domains for both groups; however,

ANCOVA, controlling for pre-course scores, revealed that the treatment group's post-course scores were significantly higher than those of the control group ($p < 0.01$).

Table 3. Pre-Post SALG Mean Scores and Statistical Analyses (n=42 Treatment, n=38 Control)

Domain	Group	Pre (M ± SD)	Post (M ± SD)	Paired t-test (p)	ANCOVA (Post Scores, Treatment vs. Control)
Tool Proficiency	Treatment	2.75 ± 0.75	4.10 ± 0.60	< 0.001	< 0.001
	Control	2.76 ± 0.80	3.30 ± 0.70	0.012	-
Iterative Design & Prototyping	Treatment	2.80 ± 0.70	4.05 ± 0.65	< 0.001	< 0.001
	Control	2.69 ± 0.65	3.35 ± 0.68	0.018	-
Creative Problem Solving	Treatment	2.90 ± 0.66	4.20 ± 0.55	< 0.001	< 0.001
	Control	3.00 ± 0.60	3.50 ± 0.60	0.011	-
Collaborative Engagement	Treatment	3.10 ± 0.72	4.30 ± 0.50	< 0.001	0.002
	Control	3.15 ± 0.70	3.65 ± 0.68	0.015	-
Entrepreneurial Mindset	Treatment	2.70 ± 0.80	3.95 ± 0.68	< 0.001	0.003
	Control	2.65 ± 0.75	3.20 ± 0.72	0.027	-

Both the treatment and control groups exhibited statistically significant improvements from pre- to post-course across all domains ($p < 0.05$). Post-course scores in the treatment group were significantly higher than those in the control group for all domains ($p < 0.01$ for most comparisons). Effect sizes ranged from moderate to high (Cohen's $d \approx 0.6$ to 0.9), indicating that formal, credit-bearing makerspace integration provided a substantive advantage.

Tool Proficiency, Iterative Design & Prototyping, and Creative Problem Solving showed the most pronounced gains in the treatment group. Entrepreneurial Mindset (risk-taking) also demonstrated a notable jump, suggesting that students became more comfortable experimenting with novel ideas and learning from failures.

The bar graph in Figure 1 visually compares mean pre-to-post gain scores for each competency, clearly illustrating the larger improvements achieved by students in the structured makerspace course (treatment) versus those with unstructured makerspace access (control).

3.3. Interpretation of Findings

The SALG results strongly indicate that a structured, for-credit makerspace course yields moderate to high gains in key innovation-related competencies. Notably, while the control group also showed improvements, likely due to the inherent value of PBL tasks, these gains were smaller, implying that unstructured makerspace access alone may be insufficient to maximize students' creative and entrepreneurial potential.

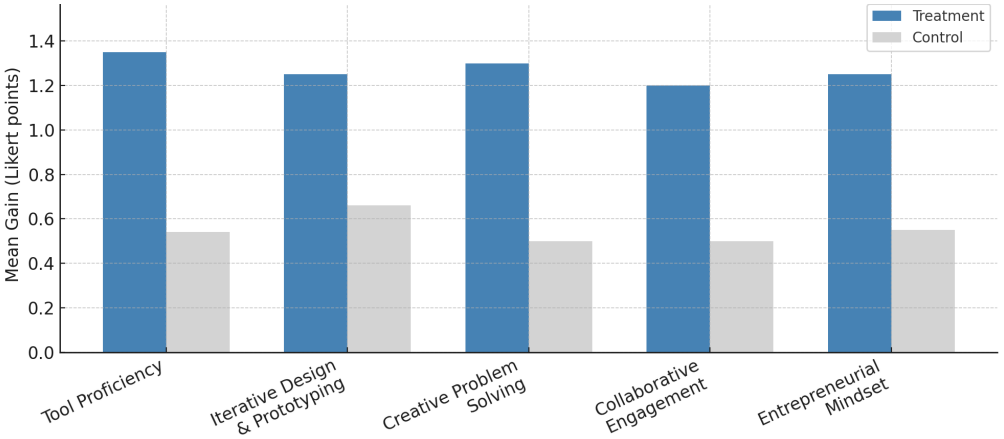


Figure 1. Mean SALG Gain Scores (± SE) by Competency

Tool Proficiency and Iterative Design improvements suggest that repeated, guided exposure to emerging technologies within an academic context fosters deeper mastery. This outcome is consistent with prior research emphasizing the importance of structured didactic approaches in maker education (Kaar & Stary, 2019). Meanwhile, the jump in Creative Problem Solving aligns with the notion that makerspaces can act as catalysts for design thinking and real-world experimentation (Wilczynski et al., 2016; Mohamed Galaleldin et al., 2019). These results also extend findings (Sakkal & Harlan,2024) by demonstrating that credit weighting and explicit alignment to course outcomes magnify learning gains.

The robust increases in Collaborative Engagement and Entrepreneurial Mindset reflect students' evolving attitudes toward teamwork, iterative risk-taking, and embracing failure as a learning opportunity (B. Robinson et al., 2020; Sakkal & Harlan, 2024). This shift is particularly relevant in engineering contexts where cross-functional collaboration and innovation drive project success (Nilsson, 2012; Sandtrø et al., 2020).

Limitations include modest sample sizes, which may limit the generalizability of these findings, and self-selection bias, as students opting to enroll in a makerspace-focused course may already possess higher interest in hands-on learning. Additionally, external factors, such as teaching styles in the control-group courses, can variably influence outcomes. Nonetheless, the large effect sizes and consistency across multiple domains lend strong support to the efficacy of the course design.

4. Conclusion

In summary, our study demonstrates that embedding makerspace activities into a formal, for-credit course significantly improves undergraduate students' innovation and engagement within

a project-based learning curriculum. The treatment group showed moderate to high gains in competencies such as tool proficiency, iterative design, creative problem solving, collaborative engagement, and an entrepreneurial mindset, gains that were statistically and practically significant compared to the control group. These findings suggest that structured curricular integration of makerspace resources empowers students with the skills and confidence needed to address complex, real-world challenges. Although sample sizes were modest and self-selection bias may be present, the consistency of the results and the robust effect sizes indicate that this approach holds substantial promise. Future research should build on these findings with larger samples and deeper qualitative investigations to further elucidate the transformative impact of makerspaces on project-based learning.

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We gratefully acknowledge that initial findings from an earlier phase of this research were presented at a previous conference (Anand et. al, 2024). The present manuscript extends that work by adding a third course offering, doubling the sample size, introducing a matched control group, employing a revised SALG instrument with makerspace-specific subscales ($\alpha = .86–.91$), and providing full effect-size analyses. No text, tables, or figures are reused verbatim; all overlapping data are re-analyzed in aggregate. We also thank VentureWell for their financial support, which contributed to the development of the course.

References

Anand, M. V., Abel, C., & Sabuncu, A. C. (2024, June). *Cultivating innovators—Unveiling the hidden potential of "Innovation Through Making" in engineering education* [Conference paper]. 2024 ASEE Annual Conference & Exposition, Portland, OR, United States. https://doi.org/10.18260/1-2--47097

Berg, A., Sandtrø, T. A., Güler, E.., Carella, A. ., Norvalls, M. ., Thor, J. H. H. ., & Lysebo, M. (2020). Designing an Interdisciplinary Course in a Makerspace: Towards collaborative creativity for a sustainable society . *FormAkademisk*, *13*(6). https://doi.org/10.7577/formakademisk.4015

Blikstein, P. (2013). Digital fabrication and "making" in education: The democratization of invention. In *Proceedings of the 2nd International Conference on Creativity and Innovation in Engineering Education* (pp. 1–10).

Carbonell, R., Boklage, A., Clayton, P., & Borrego, M. (2020). Making improvements: Pedagogical iterations of designing a class project in a maker space. https://doi.org/10.18260/1-2--34942

Ferri, B. H., Pham, K., Steinberg, J., Williams, W., & Ferri, K. (2017). Practical skills and design: A maker course for ECE students. In *Proceedings of the Frontiers in Education Conference*. https://doi.org/10.1109/FIE.2017.8190477

Galaleldin, M., Bouchard, F., & Anis, H. (2017). A systematic review of makerspaces in higher education. *International Journal of Engineering Education, 33*(5), 1458–1468.

Heintzman, J. (2018). Fostering inclusivity in STEM through makerspaces. *Journal of STEM Education, 19*(2), 34–40.

Hoople, G., Mejia, J., Hoffoss, D., & Devadoss, S. (2020). Makerspaces on the Continuum: Examining Undergraduate Student Learning in Formal and Informal Settings. *IJEE International Journal of Engineering Education*, *36*(4).

Martinez, S. L., & Stager, G. (2013). *Invent to learn: Making, tinkering, and engineering in the classroom*. Constructing Modern Knowledge Press.

Nilsson, M. (2012). Integrating makerspaces into engineering education: Challenges and opportunities. *Journal of Engineering Education, 101*(3), 539–555.

Sakkal, A., & Harlan, E. (2024). Connecting hand and mind: Fostering student creativity and confidence through makerspace projects. In *Proceedings of the 10th International Conference on Higher Education Advances (HEAd'24)*. https://doi.org/10.4995/head24.2024.17359

Taheri, P., Robbins, P., & Maalej, S. (2019). Makerspaces in first-year engineering education. *Education Sciences, 10*(1), 8. https://doi.org/10.3390/educsci10010008

Vogt, G., Atwong, C., & Fuller, J. (2005). Student assessment of learning gains (SALGains): An online instrument. *Business Communication Quarterly, 68*(1), 36–43. https://doi.org/10.1177/1080569904273332

Wigner, A., Lande, M., & Jordan, S. S. (2016). How can maker skills fit in with accreditation demands for undergraduate engineering programs? https://doi.org/10.18260/p.25468

Wilczynski, V., & Stark, C. (2015). Makerspaces for students: The future of engineering education. In *Proceedings of the ASEE Annual Conference and Exposition*.

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Designing the Curriculum for Proactive Resilience in Higher Education: Students' Experience of a University Student Success Coaching (SSC) Programme

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Abstract

Higher education has experienced a concerning rise in attrition and non-progression rates and increasing and complex well-being issues among students. One strategy employed to address these challenges is providing coaching services that support and promote student resilience. This paper reports on the University of Galway's experience developing the Student Success Coaching (SSC) programme dedicated to its undergraduate students. Rooted in the principles of Design Thinking, SSC encourages students to reflect on their strengths, challenges, and personal development pathways within their academic journey, and beyond. Feedback was gathered from students who participated in SSC through focus groups as part of an ongoing evaluation strategy. This paper highlights how SSC exemplifies how resilience can be framed as a dynamic, forward-moving process about overcoming adversity and cultivating the skills to face current and future challenges. Coaching can support this proactive form of resilience, enabling students to reclaim their agency and approach their academic and personal lives more confidently.

Keywords: *Resilience; coaching; agency; design thinking.*

1. Introduction

This paper reports on the design of a co-curricular university coaching programme, SSC, and explores whether participating in academic activities such as coaching would similarly give higher education students the capacity to face challenges and difficulties and reframe them, not only to recover from hardships but also as a starting place and learning opportunity to design their lives meaningfully. Furthermore, the SSC aimed to put coaching at the heart of students'

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learning, as an enhancement to the formal university curriculum, and potentially augment its impact in terms of positive outcomes in developing students' holistic learning and growth in higher education. This paper examines how the SSC programme supports undergraduate students in cultivating resilience across their educational, professional, and personal lives at the University of Galway. The focus is on the dimensions of holistic change, proactive resilience, and agency through self-reflection that the SSC underscores, making it an impactful and transformative approach.

Academic coaching has been linked to fostering student resilience by providing proactive support for mental health challenges and managing stress, burnout, and crises (Bellman et al., 2015). Coaching enhances students' ability to navigate challenges effectively by integrating strategies such as stress management and promoting academic and personal resilience (McFarlane, 2023). However, academic coaching has theoretical and empirical limits despite its benefits. Studies show coaching is perceived as a formal self-development framework lacking personal connection. Passmore (2010) suggests that students often regard coaching as a commercialized approach, overly centred on self-promotion and generic narratives of success. Another critical challenge in coaching lies in reimagining its purpose; instead of framing coaching narrowly on problem-solving as a static approach that treats issues as obstacles to be fixed—toward embracing it as a dynamic process that unlocks students' potential and nurtures meaningful growth (Grant, 2013). Resilience aligns with this broader vision of coaching when it is not framed as the missing factor leading students to struggle with university demands but is recognized as a holistic preparation for navigating the challenges of academic, personal, and professional life. Furthermore, within this coaching programme, resilience is framed as proactive, rather than reactive, the central idea being to embed coaching as an integral, formal part of students' curriculum, where they develop resilience (skills and tools) through the SSC programme and a related, for-credit module called Design Your Life (DYL), based on and linked to the Stanford University Life Design model (Hall et al., 2024).

Universities are asked to take more innovative approaches to coaching practices and their understanding of resilience for a more caring and inclusive university experience, which engages with and ameliorates the worrying numbers of mental health challenges and non-progression rates within higher education institutions. At the University of Galway, the SSC programme exemplifies an alternative vision of academic coaching for resilience. Grounded in design thinking principles, it aligns with engagement theories to foster resilience and "academic buoyancy," (Martin and Marsh. 2009). Which emphasizes constructive re-engagement after setbacks through interpersonal resources like peer engagement and intrapersonal resources like self-efficacy and autonomy. Drawing on Skinner and Pitzer's (2012) concept of "families of coping," SSC integrates strategies like problem-solving and support-seeking to underpin students' well-being and manage stress, contributing to their progressive development, acknowledging that challenges and failures are an inevitable and important part of life.

2. Methods

2.1 Context and goals of SSC

The University of Galway has established SSC as a cornerstone of its innovative educational initiative, Designing Futures (DF). This large educational programme, funded by the Irish Government through the Human Capital Initiative (€7.57m, 2020-2025) prepares students to deal with today's complexity and uncertainty and the future world of work. The wider DF programme in which the SSC is situated focuses predominantly on developing student entrepreneurship, through student engagement with an innovation hub, the IdeasLab, and by introducing students to innovative learning in research-based modules and transdisciplinary curriculum where they get to work with faculty and peers from across academic disciplines. Acknowledging that higher education is about the full, rounded education of the person, the SSC programme and related DYL module form the core personal development of DF, where students are afforded reflective space, time and supports to identify their interests and talents. SSC is an innovative programme that encourages students to learn more about themselves, gain clarity on their goals, and decide on actions to achieve them through fostering a supportive space for students. Students can participate in coaching through one-on-one or small group sessions tailored to their unique needs. SSC encourages and supports students to take an active, intentional role in 'designing their lives' to achieve their unique academic, personal, and life goals. The coaching process involves techniques and strategies with a proven impact on an individual's resilience. Three coaches work with students to identify and develop key resilience-building skills, such as problem-solving, emotional regulation, optimism, gratitude, and effective coping mechanisms. Techniques like reframing, goal setting, energy mapping and stress management are integral to the process.

Coaching offers nonjudgmental support for students to determine their professional and life goals and encourages new perspectives and mindsets to achieve them. This creates a space where students can have honest conversations, identify barriers to success, and develop a personal action plan. SSC supports students in taking an active, intentional role in 'designing their lives' to achieve their unique academic, personal, and life goals. Students can collaborate with a coach 1:1 or in a group session to work on several goals such as the following:

- Recognise strengths and natural talents and gain insight about what they innately do best. Assessments can be used to support this.
- Navigate successful transition into university life and community.
- Increase confidence and motivation to maximise their goals, talents, interests, and curiosities.
- Make decisions about educational and professional goals to make the most of their potential.

- Build their network and explore co-curricular and extra-curricular opportunities e.g. societies, clubs, peer learning, which can complement and support their degree.
- Connect more closely with fellow students and their university community.

2.2 Key Activities and Workshops

SSC is not an isolated activity, and is offered alongside an interactive, workshop-based module utilizing the Stanford University DYL framework, aimed at enhancing student engagement and personal development. In practice, the SSC activities encourage students to approach their academic and life challenges creatively and collaboratively through various activity tools and a community of peers and mentors where students work on issues through assigned readings, reflections, and in-class exercises. The project reflects the principles of design thinking not only in its one-to-one coaching sessions but also in its different workshops;

Odyssey Planning: In this workshop, students imagine the narratives of three possible futures (odyssey plans) that might be upheld over three years, considering elements of work, relationships, health, and play. The participant students unpacked the future career and life they would like to lead by designing three alternative life scenarios: (1) the one they believe they currently live; (2) what if Life 1 was not possible and a Plan B was needed; and (3) what if there were no constraints

Mapping your energy—how to Design more energy into our Lives: This workshop helps students recognize their energy levels over a typical day or week and identify strategies to create more balance and to make the most of their time.

Design Your University Journey: In this workshop, students explore what university means for them and what they want to get out of their time at University. It includes a discussion with fellow students and a chance to recognize what personal success means.

Understand your Strengths and Make them Work for you: This workshop helps students recognize and appreciate their natural strengths and talents. Students are supported in applying their strengths in their academic and personal lives.

E-learning modules: SSC offers two self-directed e-learning resources: Coach Yourself to Success and DYL. Students can access both resources online.

2.3 The difference between SSC and traditional coaching approaches

The main difference between SSC and traditional coaching is that SSC is embedded within the university curriculum as part of the DF programme and is not extracurricular like traditional coaching. In other words, it is not a separate support service but complements academic learning by being an intentional part of the student's educational journey. Additionally, traditional coaching may focus on goal setting or time management, but SSC emphasizes iterative,

reflective processes encouraging students to creatively and flexibly engage with uncertainty. SSC proactively supports personal growth, resilience, and self-awareness and is not a corrective reaction to student difficulties after they arise. Unlike traditional coaching, which may narrowly target performance issues or career guidance, it nurtures the whole student—emotionally, socially, and academically. SSC fosters a learning community through group sessions, workshops, and reflective exercises with peers. Traditional coaching often centres on individual sessions and does not necessarily integrate peer learning or collective reflection.

3. Results

Student feedback showed that unlike traditional coaching, which often focuses on recuperative resilience and problem-solving, SSC coaching promotes a more profound and transformative shift that engages with students' personalities and prepares them for future adversities. Students frequently reported that the coaching did not only address their day-to-day issues but encouraged proactive resilience through a proactive approach. The findings are supplemented by a description of some of the workshops from the coaching activities, which equipped students with tools to face future challenges with confidence and agency. Their experiences are summarized under three thematic areas below, with supporting quotes provided. Pseudonyms are used to maintain anonymity.

3.1 Coaching as a holistic change

From the feedback of the participating students, we can see that the coaching had a holistic approach to resilience, which was focused on three levels: the first in dealing with their problems and difficulties at the university, the second in offering tools for their professional and academic development and the third is future-oriented with a focus on looking at the lessons learned from their present challenges as instrumental to future achievements. Specifically, SSC aimed to help students deal proactively with the challenges of their lives and the difficulties that they face as undergraduate students at the university, as Bronagh says:

> "Because it is really helpful and, in a day, and age where counselling and other mental health services aren't available as easily. SSC is great to manage like smaller issues before they become too big." (Bronagh)

Additionally, as the SSC is within the framework of DF, the goal is to support students in designing their possible futures through a personalized skills development pathway. Hence, the coaches organized one-to-one coaching sessions but also workshops where they actively observed the students' struggles and gave them corresponding tools to develop solutions. The practical benefits of SSC, such as goal setting and time management, were accompanied by a more profound transformative change and a focus on solutions rather than problems and offered a sense of empowerment and clarity As Lucy explains, the coaching relationship supported her

to have a positive view of challenges as well as develop practical professional and academic skills:

> "So, it's kind of like counselling, but not really, it's just more you go in and you can talk about your problems and there's somebody always there to listen and help you manage your tasks and go about it in a more productive way rather than trying to solve the mental health issue at hand. So, it's more what you can do now, a solution … they will help you organize whatever you need, assignments, do you need help breaking them down. So, it's just more helps you breathe for a bit. I feel like just a bit of like a chill session to sort out what you can do." (Lucy).

3.2 Conceptualizing Proactive Resilience

SSC participants underlined how the programme's tools fostered their sense of resilience in a proactive way. The Clifton Strengths assessment enabled them to identify and leverage their inherent talents as mechanisms for success. It enabled them to learn how to apply their strengths in their personal, academic, and future professional lives and to connect with colleagues who share their interests. For example, Bronagh described how the coaching process helped her recognize the importance of setting boundaries and prioritizing, key skills that contributed to her evolving sense of resilience:

> It's not like counselling. That's how I described it to people. I was like, if you were struggling, but you don't feel comfortable, and I know the counselling waiting list can be really long. And even if you just need, like, help organizing your days, if you're just struggling, doing success coaching is a great option … you learn so much about yourself, even the Clifton strength test that was the example I would always use." (Bronagh)

The coaching also promoted the ability to proactively identify challenges and implement a structured plan to tackle them through skills of taking initiative and self-organization. As Adnan says:

> Like right now I only have one exam, but I have like six assignments big ones, so we have to get them on track and they're all due like yesterday, today, two weeks, one week. So, like you know it takes planning and organization and everything." (Adnan)

In this proactive way of looking at problems, the participating students are encouraged to focus on immediate, actionable solutions as a resilience method. As Lucy expressed:

> It’s not like therapy, it's like counselling, but a more chill environment. It's not to focus on your problems but how to solve the task at hand." (Lucy)

Students noted that the coaching revealed latent strengths and encouraged them to reframe challenges as opportunities for growth rather than obstacles to overcome. This perspective shift is a core component of SSC, which focuses on cultivating the skills necessary for students to face uncertainty and complexity confidently. This holistic approach empowers students to discover and recognise their resources and potential. In this way, resilience becomes a tool for forward movement that promotes personal and academic development.

This resonates with theoretical perspectives on agency and resilience as dynamic and relational processes rather than fixed traits (Ungar, 2011). Through the coaching relationship, students were encouraged to reclaim their sense of agency to confront challenges with renewed confidence and a clearer vision for the future. This aligns with a broader understanding of resilience as the ability to endure adversity and reimagine and expand one's possibilities in response to it (Luthar et al., 2000).

3.3 Cultivating Agency through Self-Reflection

The participating students appreciated how SSC's tools and structured exercises fostered their sense of agency. These exercises allowed them to identify their strengths and goals and to design their life academically and professionally in an active way. This process reflects the principles of reflective practice (Schön, 1983), which emphasize the importance of structured reflection in fostering self-awareness and intentional decision-making. For Bronagh, coaching helped her recognize her ability to set boundaries and prioritize effectively:

> "It's good to let you know more about yourself and how to put boundaries in place and how to just understand more about yourself as well." (Bronagh)

This realization aligns with Kahu and Nelson's (2018) conceptual framework for student engagement, which identifies a sense of control and autonomy as crucial factors in enhancing students' capacity to navigate complex educational demands. Similarly, Adnan noted how the sessions facilitated a clearer perspective on his daily routines and responsibilities, enhancing his confidence in taking control of his workload:

> "This because I know I was in a place where I was bad until like actually came to the Coach and we started talking and organizing and planning how to move forward because last semester was different from this semester. Last semester, I was behind on assignments but this semester, just coming, talking to the Coach and just figuring out day by day, like today, I'm going

> to get this done and fully done. And you can also then if I got overwhelmed, I came and sat down with the Coach just had a chat and it made it 10 times better for myself to go then and get all my work done." (Adnan)

4. Discussion

The findings from the evaluation of the SSC programme show a shift in how students conceptualize and experience resilience due to an alternative view of coaching. The coaching program, inspired by the Design Thinking approach, focuses on using empathy, problem-solving, brainstorming, prototyping concepts, and testing. This holistic approach potentially empowers students to discover and recognise their own resources and potential. This is advocated by Trowler et al. (2022), who suggest promoting a student's awareness of their individual coping strategies (problem solving/support seeking/escape) for the development of a sense of resilience. These findings align with the primary and general conceptual framework of Student Engagement, which grounds the project (O'Regan et al., 2023). SSC, as well as the other initiatives of DF, frame student engagement along multiple pathways and a dynamic, and active conceptualization of efforts to promote student outcomes. Hence, the adopted vision of coaching and resilience fits well with the project philosophy. Moreover, rather than viewing coaching to foster resilience to recover from adversity, participants framed resilience as a proactive, forward-looking quality facilitated by the personalized and reflective nature of the coaching sessions. This aligns with the multidimensional approach to resilience proposed by Luthar and Cicchetti (2000), which emphasizes resilience as an evolving process influenced by context and the support systems in place. Similarly, Holdsworth et al. (2017) identify resilience, as a capability underpinned by well-being, as key to students managing academic demands. One of the most notable aspects of the SSC programme was its ability to help students focus on solutions rather than problems and fostered their sense of agency. This affirmative shift is coherent with resilience as both the endurance and the ability to reimagine one's possibilities in the face of challenges. As Tomlinson (2017) argues we need more proactive approaches to enable students to identify and leverage their personal strengths. This helped students to set boundaries and prioritize their time effectively and gain a clearer understanding of how to manage their life commitments and workloads. Through these reflective exercises, students felt empowered to act with greater agency, resulting in both personal and academic growth. While resilience is often framed as a positive individual trait, we recognise the importance of a more critical stance. Encouraging students to become more resilient should not overshadow the need to question and address the structural and systemic challenges they face. The SSC programme considers that resilience understood only in individual psychological terms might not be a sufficient response — for example, in contexts where institutional barriers, discrimination, or systemic inequities are at play. The SSC aims to balance personal empowerment with a broader awareness of the social conditions that shape students' experiences.

5. Conclusion

There exists an unfortunate paradox in coaching services: the students participating in coaching sessions have already overcome their initial hesitation and insecurity about sharing their difficulties with a coach. While the very students who most need the coaching possibly avoid it, with a common misperception that coaching consists of repetitive motivational speeches or generalized advice, which can feel unhelpful. This hesitancy is usually due to a perception of coaching as "not meant for them." Contrary to this misconception is an image of coaching designed to support every student through personalized, tailored approaches. To address these challenges, the SSC reframed coaching as a flexible, student-centred process that adapts to everyone's unique needs. Coaching designed this way potentially enhances its relevance, reduces intimidation, and makes it more accessible and attractive to those who might otherwise hesitate to seek help. By fostering a more inclusive and personalized approach, the SSC experience suggests that we can ensure that coaching fulfils its potential to support every student effectively, promoting their proactive resilience. The SSC is a transformative approach to resilience-building in higher education. It supports students in managing their academic and personal challenges and developing a proactive mindset toward their futures. The programme encourages holistic growth through reflective practices, practical skill development, and a supportive environment that empowers students to take ownership of their journeys. Student feedback demonstrates that SSC goes beyond traditional problem-solving methods, fostering meaningful self-awareness, agency, and sustained resilience. Initiatives like SSC highlight the value of integrating personal development into university life, offering a caring and future-oriented model for student support in contemporary higher education.

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References

Bellman, S., Burgstahler, S., & Hinke, P. (2015). Academic coaching: Outcomes from a pilot group of postsecondary STEM students with disabilities. *Journal of Postsecondary Education and Disability*, 28(1), 103–108.

Grant, A. M. (2013). The efficacy of executive coaching in times of organisational change. *Journal of Change Management*, 13(2), 258–280.

Hall, T., Millar, M., & O'Regan, C. (2024). "(Re-)Discovering the treasure within – The contribution of a Design Your Life Module to Undergraduate Education". *HEAd'24: 10th International Conference on Higher Education Advances, Universitat Politècnica de València (Spain),* 18th – 21st June 2024. https://doi.org/10.4995/HEAd24.2024.17139.

Holdsworth, S., Turner, M., & Scott-Young, C. M. (2017). …Not drowning, waving. Resilience and university: A student perspective. *Studies in Higher Education*, 42(6), 1057–1073.

Luthar, S. S., Cicchetti, D., & Becker, B. (2000). The construct of resilience: A critical evaluation and guidelines for future work. *Child Development*, 71(3), 543–562.

Martin, A. J., & Marsh, H. W. (2009). Academic resilience and academic buoyancy: Multidimensional and hierarchical conceptual framing of causes, correlates and cognate constructs. *Oxford Review of Education*, 35(3), 353–370.

McFarlane, J. (2023). The impact of a coach training intervention on undergraduate students. *International Journal of Mentoring and Coaching in Education*, 12(3), 284–299.

O'Regan, C., Walsh, N., Hall, T., Mannion, G., & Millar, M. (2023). Conceptualising student engagement as a theoretical framework for innovative higher education practices: A literature review. *All Ireland Journal of Higher Education*, 15(2).

Passmore, J. (2010). A grounded theory study of the coaching experience: The implications for training and practice in coaching psychology. *International Coaching Psychology Review*, 5(1), 48–62.

Schön, D. A. (1983). The reflective practitioner: How professionals think in action. *Basic Books*.

Skinner, E. A., & Pitzer, J. R. (2012). Developmental dynamics of student engagement, coping, and everyday resilience. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 21–44). Springer US.

Trowler, V., Allan, R. L., Bryk, J., & Din, R. R. (2022). Pathways to student engagement: Beyond triggers and mechanisms at the engagement interface. *Higher Education*, 84(4), 761–777.

Ungar, M. (2011). The social ecology of resilience: Addressing contextual and cultural ambiguity of a nascent construct. *American Journal of Orthopsychiatry*, 81(1), 1–17.

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Circular Pedagogy, Assessment and Cultural Capital: What a student journal can do for graduates, current students and tutors

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Abstract

This paper explores a third-year sociology module assessment where students critically analyze contemporary social phenomena using theoretical frameworks from the module. By incorporating their generational perspectives and zeitgeist, students produce insightful commentaries that contribute to a shared learning experience among peers and tutors. This exercise fosters a community of practice, emphasizing mutual learning and engagement. Furthermore, the assessment follows a circular pedagogy, as the most outstanding student work is published annually in an open-access online journal by a student-staff editorial board. This initiative not only enhances academic discourse but also provides students with their first publication, strengthening their CVs and employability. The paper reflects on the impact of this pedagogical approach, highlighting its role in promoting research skills, critical thinking, and collaborative knowledge production.

Keywords: *Undergraduate student journal; cultural capital; assessment; circular pedagogy.*

1. Introduction

In this paper our aim is to reflect on and unpack our experiences of producing, in collaboration with sociology students at Leeds Beckett University, an online journal of student 'Critical Reflections' over the past 12 years. Our paper is organized into four parts: in the following section we provide some history and background to the development of our online student journal whilst in section 3 we highlight the pedagogic strategy and principles that informed the construction of the critical reflection assessment from which the student journal publication is developed. In the final section we present two strands of reflections: Firstly, tutors' reflections on 12 years of doing the assessment and working with students who have achieved a first-class grade in the original assignment as an editorial committee to prepare the pieces for online publication with the help of technical assistance from our librarians (Bower et al., 2017). We

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also present some findings from an ongoing small-scale research project that uses an online survey to explore if and how being involved in the project and having an online publication has been useful to the student authors since leaving us.

We make several claims on the basis of our joint experiences: firstly, that through careful assessment design and support, students can be facilitated to generate meaningful, valid and authentic academic knowledge of the social world that resonates and has value far beyond the boundaries of the university in the broader online 'public sphere' (see also Bruff, 2019). Secondly, that this process can contribute to developing students' creativity and voice – in our case their 'sociological imagination' - and inspire them to produce work that has meaning and value to them, beyond simply completing an assessment. Finally, we suggest that in collaborating with students on the production of the online journal over the past 12 years we have developed a stock of student knowledge that functions as a 'circular economy of learning and teaching', whereby each year we use the student journal to showcase the previous work done on the module and invite students to aspire to make their own contribution to the journal.

We suggest that this form of peer-learning can be a source of inspiration and motivation for students in the attempt to move away from the traditional model that constructs students as the object of educational processes and knowledge production and instead emboldens them to be its subject. As Bruff (2019) argues, this means moving beyond understanding students as passive consumers of information and instead enabling them to take an active role in shaping their learning experiences and in producing meaningful academic knowledge in collaboration with their academic facilitators.

2. Background of the online student journal

Started in 2013 as a paper publication, the online version of Critical Reflections: A Student Journal on Contemporary Sociological Issues was launched in 2016 by the University librarian team as its first open-access student journal (Bower et al., 2017; https://ojs.leedsbeckett.ac.uk/index.php/SOC/index). As the first of its kind at the university, the journal showcases student reflections on contemporary social phenomena through a theoretical sociological lens. In so doing, a recognition was made that the research culture could be grown and developed to include and recognise the contribution of undergraduate research and knowledge production (see also Neary and Win, 2009; Hynes, 2018). Furthermore, the experience of writing for publication allowed students to capitalise on their time and experience at university, creating a consequent effect upon both employability and their career development skills and increasing motivation for the task (Bruff, 2019).

For the library, the idea for the journal emerged from key developments in 2014 when the university's library repository support team sought to expand awareness of open-access

initiatives. Recognizing the potential to engage both academics and students, the library team explored alternatives to traditional repository systems to promote open-access publishing.

At the same time, the rise of independent university publishing platforms was seen as a way to address the escalating costs of academic journal subscriptions, known as the "serials pricing crisis." The Open Journal Systems (OJS) platform, developed by the Public Knowledge Project, was identified as an ideal solution due to its open-source nature, requiring no licensing fees. By adopting OJS, the university aimed to create a sustainable, accessible publishing model that encourages student engagement in research while contributing to the broader academic community (Bower et al., 2017).

The journal, which remains the only one at the university, has developed organically from a third-year module assessment (discussed below) whereby students are tasked with applying their sociological toolkit of theories and concepts to an everyday social phenomenon of their choice, thereby making an original contribution to the wider pool of knowledge. Upon introducing this assessment some of the students' work was of such high quality that the module tutors thought it a shame that the knowledge produced would be merely archived, so they started to publish the best pieces in order to distribute it to a wider audience. In its second year, the tutors decided that, rather than editing the contributions themselves, the student authors could benefit from being involved in the editorial process, and they have been ever since. In 2016 the move to OJS was made, and future issues will use the platform for the whole editorial process. In the 12 years of publication, the journal has published 131 student contributions (15% of the total 902 students) (Table 1).

Stone, Jensen & Beech (2016) outline the benefits for undergraduates in terms of improving the quality of student writing, and the consequent opportunity to increase employability by including publication details in prospective job applications. This was reflected in the feedback received from some of the students participating in the research who added the journal to their LinkedIn page and commented on how the creation of the journal had improved their academic writing skills (see section 4). The pedagogical advantages of publication and peer review as a means of authentic assessment and for developing higher order learning by encouraging students to develop a more reflective, evaluative attitude rather than a 'passive, spoon fed approach' have been demonstrated (Garde-Hansen and Calvert, 2007; Holford et al., 2024). Garde-Hansen and Calvert (2007) also identified the importance of creating a 'research-culture' amongst undergraduate students. This is a particularly current consideration given the importance in the UK of the Research Excellence Framework (REF), which recognizes the importance of cultivating a research ethos, and the Teaching Excellence Framework (TEF), which emphasizes the importance of delivering high-quality teaching and student engagement with their learning.

Table 1. Number of yearly publications compared to overall student number on module; includes percentage of students published and indication of year of publication/graduation.

No publications	Students on module	% students published	Year
6	61	9%	2024
9	52	17%	2023
12	81	14%	2022
9	78	11%	2021
9	39	23%	2020
12	64	18%	2019
11	75	14%	2018
13	63	20%	2017
9	48	18%	2016
11	72	15%	2015
15	148	10%	2014
15	121	12%	2013
131	902	15%	Total

3. Pedagogic and Theoretical Framework

Several key ideas underpinned the design of the critical reflection assessment that gives the final year student work produced through it particular kinds of value. The critical reflection assignment asks students to mobilize several sociological theories and concepts covered on the module (titled Contemporary Society and Social Futures) in order to explore a social phenomenon of their choice. Within that framework the assessment is deliberately designed to be interpreted flexibly so that students are effectively designing their own assessment by exploring a topic of their choice through mobilizing theories and concepts they have learnt on the module. Students are thus challenged not simply to passively regurgitate theory they have learnt through answering a question designed by an 'expert other' (us) but are instead challenged to apply the content they have learned to a social phenomenon *they* find pertinent.

Our experience working on the module tells us that facilitating this kind of assessment task is challenging for both educators and students, not least because designing open-ended, student-centered assessments that facilitate high levels of student autonomy 'compels teachers to focus more on the needs of students and less on what is easy, comfortable and familiar' (Hynes, 2017: 3; see also Bruff, 2019). Yet, these kinds of assessments may be highly productive in terms of stimulating particularly meaningful and authentic knowledge production by students because it enables students to articulate *their* voice and to explore *their* interests through dipping into their sociological toolkit of theories and concepts and stretching their sociological imagination in

terms of how they apply that knowledge to real-world examples and in the process bring together or align sociological theory with their own interests. As Bruff (2019: 9) argues, 'when we give students some choices in what work they do or in how they go about that work, we help them embrace the work as their own and engage more deeply in it', generating greater authenticity and motivation in the process and a deeper, more meaningful learning experience amongst students, and indeed, academics. From the instructor point of view, putting assessment construction in the hands of students, and tasking students with theorizing their own areas of interest, shines a light on how students perceive the world around them, and genuinely and authentically validates student's epistemic vantage point as a source of academic knowledge production. We also place this paper in current debates of pedagogy as a circular process where learners grow and develop by taking different roles and identities as they navigate a research-informed learning continuum defined by growing levels of complexity and uncertainty (Morales et al., 2022). Students find inspiration from their predecessors' topics as well as the resulting publications thereby contributing to what Morales et al. (2022) have called a "circular pedagogy" where the role of the teacher, student and researcher endure thus helping to develop a community of practice.

Furthermore, in working with students collaboratively on the design of our teaching, assessment and learning strategy and on the construction of games and learning tools to be used on the sociology degree at Leeds Beckett University over the last 2 decades, we have been strongly influenced by some of the key principles of the 'students as producers' critical pedagogy (see Neary and Winn, 2009; Gerodetti and Nixon 2014; Strudwick, 2017; Hynes, 2017; Bruff, 2019). We share a strong belief with that discourse that through careful curriculum and assessment design, and through working alongside academics as collaborators or partners in the construction of academic knowledge, students can be facilitated to produce meaningful and authentic knowledge that is valuable both inside and outside of academia (Matthews, 2016). This has been brought home to us through the years as our student journal gains more and more views online from people all around the world and the student authors gain more and more citations on their individual papers (Table 2). An outcome that was far beyond our initial expectations for the journal.

Taking students' epistemic vantage point seriously, as the starting point for the generation and production of useful and valid academic knowledge alongside academic facilitators or collaborators, is a foundational plank of the 'student as producer' discourse. As Strudwick contends (2017:75) "through embedding students in higher education, not as recipients, or consumers, or customers, but as collaborators, Student as Producer embraces the importance of ensuring meaningful participation between academics and students.... such reshaping effectively demonstrates to students the benefits skills, knowledge and engagement within a culture of partnerships in teaching and learning".

Table 2. Contributions with highest number of views and number of citations. Source: James Fisher, LBU library technician.

Critical Reflections article	No views	No citations
That's Problematic': Tracing the Birth of Call-Out Culture	2,620	23
SHEIN: The Perfectionists of Manipulation and Exploitation	2,563	3
Veganism in a Post Modern Society	1,555	3
TikTok: The Darkside of Surveillance	979	5
Is the 'Girl Boss' Really Just an Anti-Feminist Commodification	633	2

The 131 student papers that we have now published across the 12 editions of our student journal aptly demonstrate the creative benefits that can also accrue from this kind of approach to student learning and knowledge production. We believe that the process outlined here has assisted in developing our student's sociological imagination and academic identity (McGregor, 2022) by providing them with an exercise and opportunity to develop and articulate their academic voice. Over time the knowledge generated and consolidated in the student journal has become an important resource and a source of both inspiration and aspiration for current students who appear very eager and motivated to contribute to the journal and in the process develop their first academic publication. In the last section we reflect on some of our key observations regarding the benefits of the project to us as educators and also include feedback data from student authors, harvested from an online survey conducted in January 2025.

4. Reflections & Conclusions

For current students seeing previous students' work published serves as a motivational driver to do well themselves and get published in the next issue. Furthermore, it also contributes to the idea of students and tutors as a community of practice and helps the development of a circular pedagogy whereby skills and ideas are fed back into the loop of learning and teaching. For graduates, the publications are yet another form of 'cultural capital' (Bourdieu, 1986) and many clearly deploy their publications in their further endeavors where it frequently is a topic of conversation at interviews:

> "Having a publication has helped elevate my CV and provide confidence in the areas where I lack experience. It has also helped me showcase some of my skills that would otherwise not be demonstrable...I have cited my publication during a number of job interviews and higher studies applications - the topic of my reflection has been directly relevant to some of the roles I applied for". Graduate A

> "It has certainly been a benefit it terms of getting jobs (and interviews) - a good conversation starter in terms of why sociology is relevant outside of the classroom. I am also an EPQ

> mentor at work, so having publications like this is useful in supporting students with their writing.... ". Graduate B
>
> "I'm so proud of it! I talk about it all the time, and if anything when i read it back now I find it so interesting that even though ive changed so much my writing is still very similar, so I feel like having the process and being supported through it I felt like I found my voice" Graduate C.
>
> "For me the main benefit was being involved in the editorial process (I also wrote the introduction to the issue that year). This was really helpful experience for applying for postgraduate study and also when I started peer reviewing research papers". Graduate D

Reading and editing other students' work has intrinsic value to final year students. For us as tutors we also have a track record and pool of students' publications that we use at university Open and Applicant Days where we can proudly demonstrate what some of our students are achieving by their third year of study.

This paper has highlighted the value of a third-year Sociology module assessment that encourages students to critically engage with contemporary social issues through theoretical frameworks. By incorporating their generational perspectives, students contribute to a shared learning environment that we use to foster a community of practice and circular pedagogy within our teaching. For the graduate, the annual publication of outstanding work in an open-access journal not only enhances student academic discourse but also provides students with tangible cultural capital (Bourdieu, 1986), benefiting their career and academic aspirations.

References:

Bourdieu, P. [1985] (1986). *The Forms of Capital. in Handbook of Theory of Research for the Sociology of Education*. London: Bloomsbury. Pp. 46–58

Bower, K., Fisher, J. and Gerodetti, N. (2017). Open journal systems and undergraduate research: How an open journal system can facilitate digital literacy and a research culture. *Sconul Focus*, 66-69.

Bruff, D. (2019). 'Students as Producers: collaborating toward Deeper Learning' In: Jackson, A. S., Pierard, C., & Schadl, S. M. (eds.). Scholarship in the Sandbox: Academic Libraries As Laboratories, Forums, and Archives for Student Work. Chicago, IL: ACRL.

Critical reflections: a student journal on contemporary sociological issues [online] [accessed 27 January 2025]. Available from: https://ojs.leedsbeckett.ac.uk/index. php/SOC/index

Garde-Hansen, J., & Calvert, B. (2007). Developing a research culture in the undergraduate curriculum. *Active Learning in Higher Education*, 8(2), 105-116.

Gerodetti, N. and Nixon, D. (2014). Students as producers: Designing games to teach social science research methods and ethics. In: *Proceedings of the 8th European Conference on Games Based Learning*. 143 - 150. ISBN 9781910309551

Holford, D., McLean, J., Holcombe, A. O., Puebla, I., and Kempe, V. (2024). Engaging undergraduate students in preprint peer review. *Active Learning in Higher Education*, 0(0). https://doi.org/10.1177/14697874241264495

Hynes, M (2018). Students-as-Producers: Developing valuable student-centered research and learning opportunities. *International Journal of Research Studies in Education*, 7 (4): 1-13.

Matthews (2016) 'Students as partners as the future of student engagement'. *Student Engagement in Higher Education Journal* 1(1): 1-5.

McGregor, S. (2022). Undergraduate students' research identity and research culture: Professional commentary. *Kappa Omicron Nu.* https://kon.org/publications/student-research-identity-and-culture.pdf.

Morales, L., Coetzer, J.H., Barkoczi, N., Pop, L., Marian, C. Flynn, P. (2022). A Circular Pedagogy for Higher Education. *EUt Working paper No. 2022/01*. ELaRA_Paper01_WorkingPaperSeries (1)_0.pdf.

Neary, M. & Winn, J. (2009). The Student as Producer: reinventing the student experience in higher education. *The future of higher education: policy, pedagogy and the student experience.* London: Continuum.

Stone, G., Jensen, K. & Beech, M. (2016). Publishing undergraduate research: linking teaching and research through a dedicated peer reviewed open access journal. *Journal of scholarly publishing,* 47 (2), 147–70

Strudwick, K. (2017). Debating Student as Producer: relationships, Contexts and Challenges for Higher Education. *Prism: Casting New Light on Learning, Theory and Practice*. Vol.1,73-96.

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Fragile Foundations: Indonesian Architecture Students' Struggles in Experiential Learning and Community-Based Pedagogy

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Abstract

Experiential learning in architecture education has gained momentum globally, often framed as a transformative bridge between theory and practice. It takes various forms—live projects, design-build programs, service learning, or community-based design—however the existing scholarship overlooks the systemic challenges students face, particularly in non- Western contexts where institutional instability frequently shape the operational reality of such programs.

Drawing on ethnographic research across three university–community collaborations in rural Indonesia, this paper exposes the fragile foundations underpinning community-based pedagogy: blurry institutional support, resource constraints, and unpredictable social dynamics that disrupt students' expectations of meaningful, structured learning. Rather than empowering students, these programs often burden them with logistical uncertainties, unstructured roles, and financial precarity, forcing them to navigate a structurally flawed system with minimal support.

By critiquing the romanticization of experiential learning, this study argues that 'learning by doing' in Indonesia often becomes 'learning by enduring.' It calls for pedagogical models that acknowledge instability as a systemic issue, rather than an individual challenge for students to overcome. The findings advocate for clear institutional guidelines and supports, financial accountability, active engagement collaborations, towards insightfully experiential learning in Indonesian architectural education and potentially other Global South contexts.

Keywords: *Fragile Foundations, Experiential Learning, Community-Based Education, Architectural Pedagogy, Student Struggles.*

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1. Introduction

Globally, architecture education is undergoing a transformative shift toward more practice-based, collaborative, experiential, and service-learning models, moving beyond the traditional master-apprentice and studio-based approaches (Salama 2002; Harriss 2014). These initiatives—variously termed live projects, design-build, or community-based design—are celebrated for bridging theory and practice while addressing real-world societal needs (Pak and De Smet 2022). However, implementing such approaches in Indonesia requires navigating a complex set of socio-economic and institutional contradictions, revealing fragile foundations that shape student experiences in these projects.

Indonesia's long-established higher education framework, the Tri Dharma of Higher Education (UU 1961; Suwignyo 2024), has emphasized community service as a means of decolonizing and reforming the higher education sector since the post-colonial era. However, despite this longstanding history, scholarship on these initiatives in Indonesia remains limited especially in architecture field. Recent reforms, such as the 2020 Kampus Merdeka (Freedom Campus) policy, which encourage students to spend up to two semesters participating in and off campus activities (Purwanti 2021; Kusumo et al. 2022), have further intensified tensions between institutional agenda and on-the-ground realities. While experiential learning initiatives in Indonesia aim to equip students with real-world experience, they also expose students to unpredictable institutional and socio-economic challenges that force them to develop adaptive resilience and renegotiate their roles as architects and designers.

Despite expanding opportunities for experiential learning widely, related research remains limited on how structural barriers reshape student experiences in Indonesia—a gap magnified by the often Western-centric discourse dominating existing community-based pedagogy literature (Smith, Dupre, and Crough 2023), which frequently fails to adequately address the profound impact of resource scarcity, bureaucratic ambiguity, and institutional unpredictability prevalent in contexts like Indonesia.

Given the expanding role of community-based initiatives in Indonesian architectural education, this paper addresses a central question: What challenges do Indonesian architecture students face in these projects, and how do these 'fragile foundations' reshape their learning? Drawing on ethnographic engagement with three university–community collaborations, this paper exposes how blurry institutional support, resource constraints, and unanticipated social dynamics complicate idealized narratives of experiential learning. By centring student struggles, this paper reframes these challenges as systemic conditions rather than individual failures, urging a critical rethinking of architectural pedagogy and curricula in Indonesia and similarly characterized in other Global South contexts.

2. Experiential Learning and Community-Based Education in Indonesia

Experiential learning is grounded in the concept of learning by doing, emphasizing that learning cannot happen without direct experience. Extending on Deweyan 'learning by doing' philosophy (Dewey 1963), Kolb's (Kolb 1983, 2014) later expanded on this concept by introducing a four-stage cycle involving, comprising Concrete Experience (CE), reflective observation (RO), abstract conceptualisation (AC), and active experimentation (AE). Over the year, Kolbs's model has become a cornerstone in educational practice. Nevertheless, critiques of Kolb's framework have emerged, pointing to its potential overemphasis on individual cognition and insufficient attention to structural and contextual factors (Mughal and Zafar 2011; Seaman 2008; Morris 2020). These critiques are particularly relevant in Indonesia, where institutional instability and socio-economic constraints complicate the application of experiential learning. For instance, pervasive resource limitations can directly impede the 'Active Experimentation' phase, while unclear institutional guidance and lack of structured mentorship may undermine meaningful 'Reflective Observation' and 'Abstract Conceptualisation,' disrupting the idealized cycle.

Community-based education in Indonesia traces back to the Tri Dharma Higher Education framework initiated in the 1960s to reform and decolonize the country's higher education (Suwignyo 2024). Alongside teaching and research, community service constitutes a core pillar of this framework. In practice, the framework's application varies across institutions—some have developed dedicated service modules or programs, while others integrate community-based assignments within existing courses.

Recently, the development of Kampus Merdeka (Freedom Campus) Policy, under Minister of Education and Culture Regulation No. 3/2020, further redefined the role of Indonesian higher education in community engagement by promoting flexible learning activities (Purwanti 2021). A central component of this policy grants students up to two semesters off-campus activities (Vhalery, Setyastanto, and Leksono 2022), effectively shifting community-based pedagogy from peripheral to integral parts of academic programs (Persov et al. 2020; Smith, Dupre, and Crough 2023) by aligning them with the academic credits.

However, while this policy expands opportunities for experiential learning, it also exposes the fragility of university–community collaborations. Institutions often lack adequate funding, administrative support, and consistent engagement, leading to unpredictable project outcomes. Rather than ensuring deeper student engagement, the structural weaknesses of Kampus Merdeka often place students in precarious learning environments.

While students are expected to engage meaningfully with communities, the lack of preparation, cultural-social training, and long-term institutional partnerships frequently leaves them navigating challenges alone. Given these constraints, Indonesian architecture education must constantly adapt, renegotiate their roles, and navigate this uncertainty.

3. Methodology

This essay reflects on the ethnographic observation conducted in three rural areas in East Java, Indonesia, where architecture students from a university engaged in collaborative programs with local village communities. The selected case studies have at least one semester of collaboration, allowing an examination of long-term dynamics between students, communities, and institutional structures. Ethnography was chosen for its capacity to capture an in-depth exploration of cultural and social dynamics, within specific contexts (Gullion 2015; Fetterman 2009). Over three months, observations of student–community meetings, design workshops, and site visits were recorded to document the learning process and structural challenges encountered.

Additionally, the study involved 20 semi-structured interviews with students from three different institutions, supplemented by additional interviews with lecturers and community representatives. Participants were selected through purposive sampling to capture diverse perspectives across different locations and roles. Throughout fieldwork, care was taken to critically reflect on the researcher's positionality. As an observer associated with the university, there was a risk that participants might moderate their critiques or concerns. Strategies such as informal conversations, repeated visits, and the use of trusted local intermediaries helped in mitigating power asymmetries. The data collected through observation and interviews were analysed using qualitative coding methods. Qualitative coding is the process of systematically categorising and interpreting textual data to identify themes and patterns (Saldana 2009).

4. Findings

4.1. Blurry Institutional Support

All three case studies revealed a critical flaw in institutional support: the absence of clear guidance, leaving students struggling to define their roles. This was particularly evident in Kampus Merdeka (KKN-T), where structural inconsistencies created confusion and inefficiencies, exemplifying the fragile foundations of community-based education in Indonesia. As student GV remarked, "*We were confused because there were no technical guidelines. We wanted to do a direct survey, but for the first two weeks we just ate and slept, waiting for instructions*." Similarly, student UM noted, "*Coordination is lacking; we want to ask about this and that, but if we do it on our own, we're afraid of miscommunication and doing wrong things*." These responses reflect a lack of institutional structure and mentorship, leaving students to navigate uncertainty alone, particularly in rural areas far from the university.

Students were often expected to "figure things out" independently, assuming they would adapt. However, not all students possess the necessary skills to engage effectively with communities.

At a minimum, pre-project orientation should include guidance on community engagement, expected outcomes, and available university support.

A similar issue emerged with faculty disengagement. Lecturers were often absent, creating gaps in supervision and mentorship. One student noted that some of the lecturers failed to grasp the local context as they are rarely engaging on the field work progress. Thus, it is difficult to bridge communication between universities and communities when there is a problem happening.

Furthermore, the university's limited resources and expertise highlight the need for external professionals in community-based design projects. As student MB suggested, "*There should be a dedicated experienced mentor, like in our bamboo project. We discussed ideas with residents, but we were still confused because, in campus, we only learned a brief theoretical overview*." This suggests that inviting external experts could provide practical guidance on specific and practical topic, ensuring students receive the support necessary for project execution.

4.2. Resource Constrains

Alongside institutional ambiguities, students faced significant constraints related to funding, materials, and time. A recurring challenge across all case studies was the uncertainty over financial responsibility—whether costs were covered by the university, local government, or students themselves. Although these programs were university-led, this did not guarantee sufficient funding. Budgets were typically allocated for transportation and accommodation, leaving implementation costs unclear.

Architecture students generally approach community-based projects by analysing the site, proposing ideas, and seeking implementation opportunities. However, funding inconsistencies determined whether projects moved beyond the design phase. If adequate funding—either from the university or external grants—was available, some proposals could be realized. But often, students encountered situations like that of MR, who recalled: "*We wanted to build a café and a greenhouse, but the funding was unclear. In the end, we could only design it, with no certainty on when it would be executed.*" She added, "*We made a budget plan, but when the residents asked, 'Where is the funding coming from?' we didn't know, and neither did the lecturers.*"

Given these constraints, some students managed expectations by shifting focus away from physical construction. However, this often-left 'unfinished businesses' for community partners, who expected tangible outcomes. The tension between idealized classroom design principles and limited on-site resources further exacerbated this issue. Students, inspired by theoretical learning, were sometimes drawn into 'unrealistic imaginations,' proposing ideas that were unachievable within tight budgets and time constraints.

Time limitations compounded financial uncertainty. Determining how much time to allocate to community-based work was difficult, particularly when projects overlapped with other

academic requirements. In one case study, students participated in a service-learning module that only allowed three site visits within a semester—one at the start to assess conditions, one mid-semester to present ideas, and one for a closing event. This rigid structure restricted deeper engagement, hands-on experimentation, or the completion of designs.

However, longer on-site presence did not always guarantee better conditions. In two case studies, students were able to stay longer with the community due to government-funded accommodation. Yet, this funding was insufficient to cover all participants, forcing some students to finance their own participation. This underscores a deeper issue: involving students in community-based projects is not equivalent to having free labour. Universities must recognize that community-based learning requires careful planning, clear funding provisions, and sustainable engagement strategies. Without these, students bear the financial and logistical burden, reinforcing the fragile foundations of institutional support in community-based architectural education.

4.3. Unanticipated Social Dynamics

Although most students entered these programs eager to learn directly from the community—given that their universities are in urban centres—the reality of community engagement proved far more complex. In practice, only a handful of recognized local gatekeepers—such as the village head or a few prominent locals—regularly attended planning sessions and workshops. As student MP explained, "*The dialogue with the residents only involved a few people, and during the public hearing, it was the same people who attended. As a result, the feedback was sometimes lacking*." Similarly, in one recurring program, student UN noted, "*We conducted a socialization session, but their response was: 'Do whatever you want, we believe in you.' It seems like they were already exhausted*." These observations underscore the complexity of the village's social dynamics, where, as Indonesia's smallest governmental unit, a variety of actors, personalities, and agendas converge in one setting.

Given these challenges, it is essential for the university to ensure that its local village partner is not only willing to collaborate but is also committed to actively contributing—especially during discussions with the students. The local gatekeeper should serve as the primary champion who helps align community expectations with the initiative's objectives. Beyond this, the university must create an inclusive environment that invites broader community involvement so that additional local champions can emerge to support the project. In this context, the role of the faculty in structuring community-based learning and fully grasping the local situation becomes especially important. It is also important to have pre-training on cultural-social humility for the students that could make them aware on the situation on the ground, and how they could adapt, mingled, and interact with community effectively so then they could have better co-production knowledge outputs on field.

Taken together, the overlapping issues of institutional opacity, insufficient resources, and inconsistent participation have created a fragile foundation for experiential architectural learning in Indonesia. Students struggled to align their conceptual designs and curiosity spirit with the realities of budget shortfalls and potential local scepticism. It is a big challenge if we are expecting insightful experiential learning experience that can be beneficial for both students and community.

5. Conclusion: Learning by Doing or Learning by Enduring

Experiential learning is lauded as a vital bridge between architectural theory and practice. Yet, this study reveals that within the context of Indonesian community-based architectural education, the reality for students is often less about empowered learning and more a test of endurance against systemic fragilities. Institutional opacity, resource uncertainty, and unpredictable social dynamics converge, often with minimal institutional buffering.

Instead of being equipped as adaptive designers, students are frequently burdened with logistical and financial challenges stemming from unclear guidelines, faculty limitations, inadequate funding, and misaligned expectations. Universities may frame these struggles as 'learning opportunities,' but these narrative risks masking systemic failures for which students must compensate, sometimes personally and financially. In a context where institutional instability frequently shapes program delivery, the line between 'learning by doing' and 'learning by enduring' becomes blurred.

This study contributes by empirically documenting these student struggles within the specific Indonesian higher education landscape, thereby challenging universalist assumptions often embedded in experiential learning discourse and highlighting systemic barriers frequently under-acknowledged in Global South contexts.

If community-based pedagogy is to genuinely benefit students and communities, it must move beyond idealized portrayals. Universities gain reputational benefits from 'engaged learning,' yet the practical burdens disproportionately fall on students and communities. Fundamental reforms are needed: clear institutional guidelines, transparent and adequate funding mechanisms, robust faculty support and training, and strategies for fostering genuinely active and equitable community collaboration. Without addressing these fragile foundations, such programs risk perpetuating inequity, benefiting institutions more than those they ostensibly serve. If Indonesian students must navigate these systemic challenges largely alone, they are not just learning by doing—they are learning by enduring.

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References

Dewey, John. 1963. Experience and Education. Kappa Delta Pi Lecture S. London, England: Macmillan.

Fetterman, David M. 2009. Ethnography: Step-by-Step. 3rd ed. Applied Social Research Methods. Thousand Oaks, CA: SAGE Publications.

Gullion, Jessica Smartt. 2015. Writing Ethnography. PDF. 1st ed. Teaching Writing. Rotterdam, Netherlands: Sense. https://doi.org/10.1007/978-94-6300-381-0.

Harriss, Harriet. 2014. Architecture Live Projects: Pedagogy into Practice. Edited by Harriet Harriss and Lynnette Widder. Routledge.

Kolb, David A. 1983. Experiential Learning: Experience as the Source of Learning and Development. Upper Saddle River, NJ: Financial TImes Prentice Hall.

———. 2014. Experiential Learning. 2nd ed. Upper Saddle River, NJ: Pearson FT Press. Kusumo, Haryo, Achmad Solechan, Manuel E. Caingcoy, Dian Marlina, and Mega Novita.

2022. "Kampus Merdeka: College Educational Breakthrough to Address the Wide Gap between Industry and Academia." KnE Social Sciences, December, 499–508.

Morris, Thomas Howard. 2020. "Experiential Learning – a Systematic Review and Revision of Kolb's Model." Interactive Learning Environments 28 (8): 1064–77.

Mughal, Farooq, and Aneesa Zafar. 2011. "Experiential Learning from a Constructivist Perspective: Reconceptualizing the Kolbian Cycle." International Journal of Learning and Development 1 (2). https://doi.org/10.5296/ijld.v1i2.1179.

Pak, Burak, and Aurelie De Smet, eds. 2022. Experiential Learning in Architectural Education: Design-Build and Live Projects. Routledge Focus on Design Pedagogy. London, England: Routledge.

Persov, E., R. Udyavar Yehuda, R. Kantor, E. Blit-Cohen, and E. Sadan. 2020. "Design Pedagogy for Learning Sustainability with Communities." IOP Conference Series. Earth and Environmental Science 588 (3): 032085.

Purwanti, Eko. 2021. "Preparing the Implementation of Merdeka Belajar – Kampus Merdeka Policy in Higher Education Institutions." In Proceedings of the 4th International Conference on Sustainable Innovation 2020–Social, Humanity, and Education (ICoSIHESS 2020). Paris, France: Atlantis Press. https://doi.org/10.2991/assehr.k.210120.149.

Salama, Ashraf M. A., ed. 2002. Architectural Education Today: Cross-Cultural Perspectives. Lausanne: ARTI-ARCH.

Saldana, Johnny. 2009. The Coding Manual for Qualitative Researchers. London, England: SAGE Publications.

Seaman, Jayson. 2008. "Experience, Reflect, Critique: The End of the 'Learning Cycles' Era."Journal of Experiential Education 31 (1): 3–18.

Smith, Sebastian G., Karine Dupre, and Julie Crough. 2023. "Live Projects: A Mixed-Methods Exploration of Existing Scholarship." Int. Journal of Architectural Research Archnet-IJAR 17 (4): 793–811.

Suwignyo, Agus. 2024. "Higher Education as an Instrument of Decolonisation: The Community Service Programme in Indonesia, 1950–1969." Asian Studies Review 48 (3): 447–66.

UU. 1961. "Undang-Undang Republik Indonesia Nomor 22 Tahun 1961 Tentang Pendidikan Tinggi (National Regulation of the Republic of Indonesia Number 2 Year 1961 on the Higher Education)." Indonesian Government.

Vhalery, Rendika, Albertus Maria Setyastanto, and Ari Wahyu Leksono. 2022. "Kurikulum Merdeka Belajar Kampus Merdeka: Sebuah Kajian Literatur" Research and Development Journal of Education 8 (1): 185

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Detection of territorial challenges and co-creation of knowledge

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Abstract

This paper describes the process of capturing challenges and the co-creation of knowledge at the Universitat Autònoma de Barcelona (UAB) through Challenge-Based Learning (CBL). In collaboration with the quadruple helix – citizens, public administration, universities and companies – real problems in the territory are identified and innovative and sustainable solutions are developed.

The objectives of the research are: to examine the process of detecting challenges and their definition adapted to university teaching; to analyse the potential of CBL as a methodology for the co-creation of knowledge between the university and the territory; and to evaluate the impact of the solutions developed on local communities and students.

The process includes meetings with the stakeholders involved to identify needs and the co-creation of solutions in collaboration with the students, guided by the teaching staff.

The results show the feasibility of the model to solve real problems and improve student engagement.

Keywords: *quadruple helix; Challenges; Learning; innovation; sustainability.*

1. Introduction

Challenge-Based Learning *(CBL*) is a learning methodology based on a real experience: participants face a specific problem in the territory and, together with the stakeholders involved, explore possible options for improvement, coming up with a possible solution proposal, which ends up being implemented and evaluated (Kohn Rådberg, Lundquvist, Malmqvist , & Hagvall Svensson, 2020; Tecnológico de Monterey, 2015).

This methodology consists of 3 different phases: engagement, research and action, all of which include the reflection of the participants, as can be seen in Figure 1.

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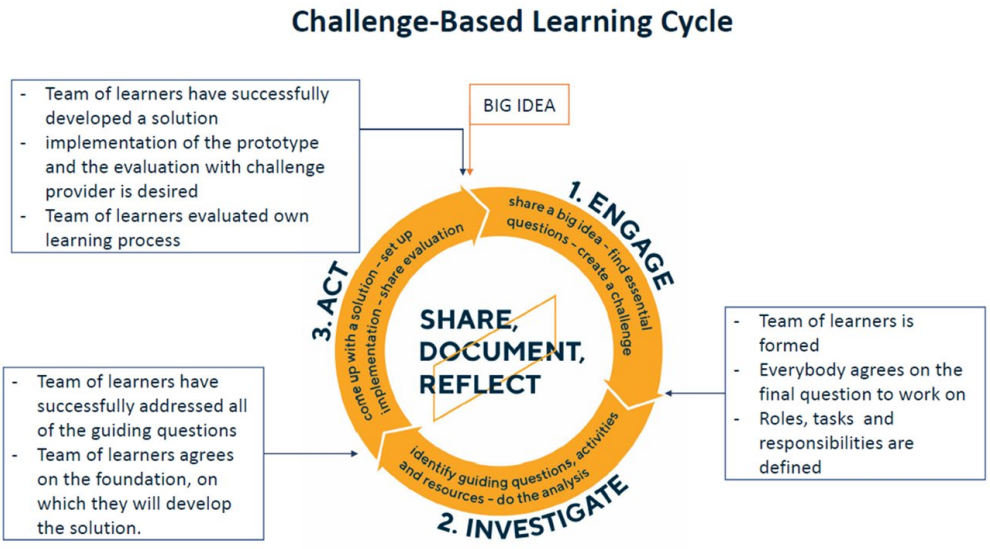


Figure 1: Challenge-Based Learning Cycle. Source: Ellinger, Simon (2020).

The person in charge of coordinating a training challenge experience is a facilitator or *teamcher* (a term coined by the ECIU University): a person who is an expert in the subject to be dealt with, who coordinates and energizes the group of participants and is the connecting element between them and the entity that provides the challenge. The working groups are multidisciplinary, and each member contributes with their knowledge and experience to the analysis of the challenge and the formulation of the final proposal. In this sense, this methodology opens the possibility of bringing together students and teachers different subjects from different backgrounds in order to solve a challenge in the territory.

As for the stakeholder that provides the challenge to be solved, this can be a private company, a public institution, an NGO... in general, any stakeholder that has a strong connection with the territory.

In this way, the main objective of the implementation of this methodology is to move towards a university that is much more open to society, and with a real impact on its natural territories (what can be defined as its ecosystem), seeking integrated approaches for the socio-economic development of the territories, creating regions of knowledge in which universities play a leading role as dynamic elements.[1] This approach seeks the active participation of the different social agents (quadruple helix: governments, academia, companies and civil society) in the

[1] Higher Education for Smart Specialisation https://s3platform.jrc.ec.europa.eu/higher-education

development and application of strategies for social and economic dynamization and innovation, always in accordance with the needs and potential of this territory.

In this sense, the process of detecting and capturing challenges so that they can be worked on in the classroom is crucial. Multi-stakeholder collaboration, the definition of the challenge and its adaptation to the teaching guides are tasks that require a long and well-defined process.

The Universitat Autònoma de Barcelona (UAB) is a member of a European Alliance, the ECIU University. This alliance has allowed the UAB to act as a testing ground for the implementation of Challenge-Based Learning (CBL) in a protected environment. Over time, this has paved the way for parallel curricular integration of CBL across the university, ensuring a smoother adoption process and a broader impact.

The challenges of the ECIU University are mostly aligned with the United Nations Sustainable Development Goal (SDG) number 11 – Sustainable Cities and Communities and have been offered across the consortium as extracurricular activities with credit recognition.

Currently, however, with this initial stage closed, there is already a definitive process for designing challenges, as well as a guide for the implementation of Challenge-Based Learning in the University's subjects (Blanch, Franco, Redondo, Ronzoni, 2024), which contains the key elements for implementing CBL in a subject and resources linked to the definition and support tools for each phase, as you can see in Figure 2:

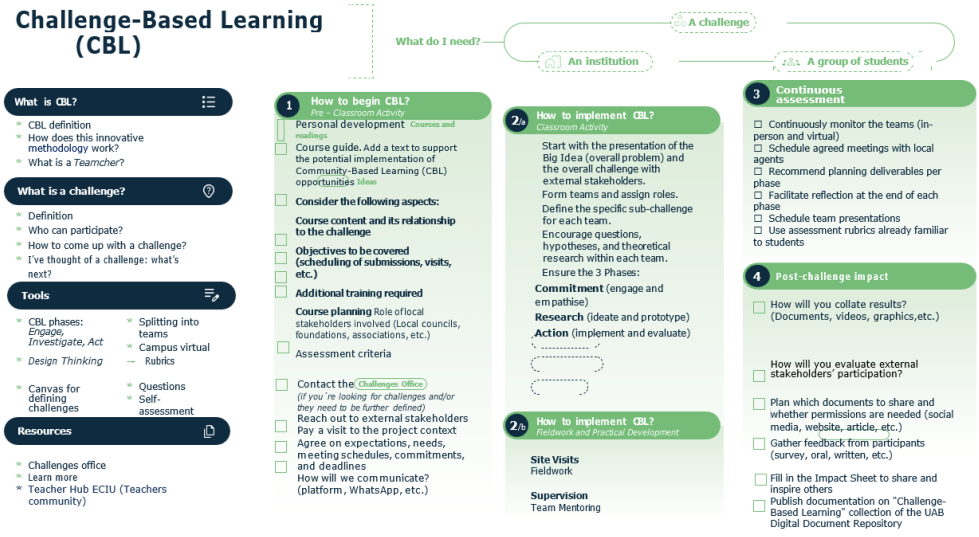


Figure 2: Guide for teachers to implement Challenge-Based Learning. Source: Blanch, Franco, Redondo, Ronzoni (2024).

2. Process of defining challenges

For the past two years, the Universitat Autònoma de Barcelona has had a Challenges Office that has different tasks, both in terms of research and education. With regard to the latter, the teaching innovation methodologies that require connection with institutions in the university ecosystem (Service Learning (SL) and Challenge-Based Learning (CBL)) have unified the processes of contact with the stakeholders in order to centralise communications for the University as a whole.

In this sense, the Universitat Autònoma de Barcelona itself is becoming a benchmark in the ecosystem when it comes to responding to local problems through the co-creation of knowledge.

2.1. Contact with the stakeholder

Institutions, organised citizens and private companies contact the Challenges Office in order to raise challenges and needs that they have detected. The person responsible for defining the challenges meets with the stakeholder in order to have more information about it and decide how the University should respond.

Depending on the complexity, as well as the characteristics of the agents involved and the groups of citizens affected, the challenge is faced by different research groups, by involving students from different subjects or within the framework of the ECIU University, always in a multidisciplinary way.

One of the main obstacles that has been encountered is the stakeholder's sense of belonging to an ecosystem. It is often difficult for stakeholders to perceive the Universitat Autònoma de Barcelona not as a consultancy, but as another territorial actor with whom to establish a collaborative relationship to address a shared challenge.

For instance, some small companies have declined collaboration, despite their interest in participating, because they are unsure whether the potential impact of the collaboration will sufficiently justify the effort and resources they are required to invest.

2.2. Definition of the challenge

During this process, the Teaching and Research Staff expert in the subject, the representatives of the stakeholder and a person from the Challenges Office, define in an appropriate way according to the academic credits that the subject has, and agreed in terms of the point of view when addressing the problem.

This first step makes it possible to identify and understand relevant aspects of the identified problem, such as the degree of incidence, the main actors affected, the associated social and cultural factors or the sense of urgency to solve it. In addition, it helps to reflect and visualize the desired change that is to be achieved in the territory.

For example, during the first semester of the 2023–2024 academic year, teachers from three different degree programs (Faculty of Education Sciences and Faculty of Psychology) collaborated with the directors of the schools in the Rural Schools Zone (ZER) of Moianès to define the challenge using the template shown below.

The main obstacle encountered during this process was the formulation of a challenge that was specific enough to be addressed within a single semester, while also being broad enough to allow for exploration from multiple disciplinary perspectives and to promote student innovation.

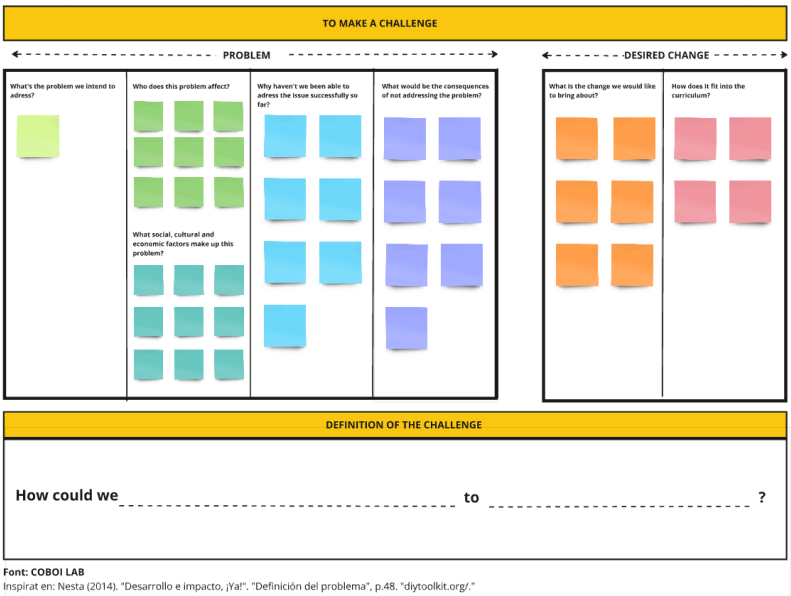


Figure 3: guide to defining a challenge. Source: COBOILAB (2016)

2.3. Challenge work based on Challenge-Based Learning (CBL)

It is at this point that the three phases of Challenge-Based Learning begin, always based on the *Design Thinking methodology*:

• **Engage:** the basis of motivation is to work on a "big idea". It can be anything within a social, economic or environmental issue, such as health or public transport. All participants, teachers, students and external partners make sure to agree on the final challenge to be worked on and to define initial indicators that allow the impact achieved at the end of the action to be evaluated

• **Investigate:** the whole team must make sure that everyone understands the challenge and can contribute to solving it with their knowledge and skills. Teams can use micromodules to fill knowledge gaps or acquire new skills that can help them solve the challenge.

• **Act:** local stakeholders can use their shared knowledge to design, evaluate and prototype new solutions. The teams can also offer the proposed solutions, which can include services, products, research questions, start-ups and spin-offs.

3. Results

During the academic years from 2020 to 2024, the ECIU University has offered 95 challenges for students across all member universities, involving faculty and administrative staff who act as *teamchers* (usually two experts in the subject area).

At the UAB, 7 challenges have been proposed: 4 standard challenges (lasting 6 months) and 3 mini challenges (lasting between 1 and 3 months), integrated into 4 courses and 3 Bachelor's Final Projects. Up to 70 students have participated in teams to address these different opportunities. The challenges represent between 1 and 6 ECTS for students, depending on the challenge's duration.

Additionally, 150 micromodules have been offered, covering topics such as language learning, gender, interculturality, etc. These micromodules are recognized with between 1 and 6 ECTS.

In the last years, the number of Pilot Faculties that implement Challenge-Based Learning (CBL) has been increasing year after year. Currently, all faculties have subjects that work with this methodology and there is no longer talk of a pilot test, but of a teaching innovation methodology that is present in a generalized way throughout the university. In addition, a Challenge-Based Learning Day is held annually, where stakeholders, teachers and students participate, in order to reflect on the implementation of this methodology.

During the 2023-2024 academic year, more than 30 subjects and 20 Bachelor's Thesis were carried out with this methodology, thus involving more than 500 students from the University. Below in Table 1 you can see different information from the last year:

Table 1. Data on the implementation of the CBL at the UAB for the 2023-2024 academic year. Source: own elaboration.

Data for the 2023-2024 academic year	
Areas involved	18
Teachers	70
Students	525
ECTS	174

At the curricular level, an example to highlight is the challenge that was carried out jointly between the Faculties of Education Sciences and Psychology, with the collaboration of the ZER-Moianès Llevant (a network of rural schools in Catalonia), consisting of finding ways to transform the teaching of the written language and thus improve the writing of students. About

200 students from different subjects participated, coordinated by 5 teachers from the University, over the course of a semester.

To date, there is already a network of more than 800 agents in the territory who have adapted to the UAB's academic calendar when it comes to proposing challenges and collaborating in the design of the University's own teaching guides.

4. Conclusions

The experience of offering and implementing challenges has been highly valued by both the university, the students, and the stakeholders involved. The students have especially highlighted participation in real challenges and teamwork, underlining how this methodology has allowed them to learn in a more meaningful way, especially when they have had the opportunity to travel and get to know first-hand the communities where the challenges are located.

The initial barriers related to time and the integration of challenges in curricular subjects have been overcome thanks to the accumulated experience, facilitating the sustainability of implementation and the use of support tools for better planning.

In relation to the stakeholders, there are some barriers that still need to be overcome, such as the weight of each member of the driving team when it comes to agreeing on the same point of view in tackling the challenge. The stakeholder still does not conceive of the definition of the challenge as a process where everyone has the same representation, where knowledge is generated in equal parts, understanding that the important thing is to respond to the Sustainable Development Goals (SDGs) together, involving the different actors and groups affected.

In this sense, the conception according to which the University is the only institution that generates and transfers knowledge to the outside world continues to prevail within the ecosystem. Although the first changes that are moving towards the co-creation of knowledge can already be observed, especially by City Councils and NGOs.

On the other hand, stakeholders positively value the implementation of Challenge-Based Learning, as well as its greater involvement in university education. To date, there is already a network of more than 800 stakeholders who have adapted to the UAB's academic calendar when it comes to proposing challenges and collaborating in the design of the University's own teaching guides.

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References

Blanch, S., Franco, D., Redondo, O. & Ronzoni, M. (2024). Guide to implementing ABR at the UAB. DDD. https://ddd.uab.cat/record/291917/

ECIU University (sf). https://www.eciu.eu/

Ellinger D., Simon, S. (2020). Workshop Basic Principles in Challenged-Based Learning.

Higher Education for Smart Specialisation https://s3platform.jrc.ec.europa.eu/higher-education

Höffken, J., & Lazendic-Galloway, J. (2024). Engaging for the future: challenge-based learning and stakeholder partnerships in sustainability education. *Sustain Earth Reviews 7*(20). https://doi.org/10.1186/s42055-024-00087-6

Kohn Rådberg, K., Lundquvist, U., Malmqvist M, & Hagvall Svensson O. (2020). From CDIO to challenge-based learning experiences – expanding student learning as well as societal impact?, European Journal of Engineering Education, *45*(1), 22-37. https://10.1080/03043797.2018.1441265

Service Learning Network of the Catalan Universities (2019). *Guide 0. Doing Service Learning at the university.* Service Learning Network of Catalan Universities and Catalan Association of Public Universities. https://www.apsucat.cat/wp-content/uploads/2024/03/GUIA-0_Fer-aprenentatge-servei-a-la-universitat_DEF-1.pdf

Sukackė, V., Guerra, A. O. P. D. C., Ellinger, D., Carlos, V., Petronienė, S., Gaižiūnienė, L., Blanch, S., Marbà-Tallada, A., & Brose, A. (2022). Towards Active Evidence-Based Learning in Engineering Education: A Systematic Literature Review of PBL, PjBL, and CBL. *Sustainability*, *14*(21), 13955. https://doi.org/10.3390/su142113955

Tecnológico de Monterey (2015). Observatory of Educational Innovation of the Tecnológico de Monterrey. https://eduteka.icesi.edu.co/pdfdir/edutrends-aprendizaje-basado-en-retos.pdf

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Empowering the Role of Supervisors in Academic Environment

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Abstract

Capacity Building in Higher Education EU projects continue to serve as critical platforms for experimenting innovative teaching methods and producing open-access resources that benefit the entire academic community. Against this backdrop, this paper discusses three key resources designed to support the supervision of PhD students in Africa: a Compendium of Resources, a Toolkit, and Online Training Modules. These resources were developed based on an assessment of supervisors' needs through targeted surveys. The training materials were produced within the framework of the DigiGrad Africa Project with the aim of Strengthening Research Capacity and Postgraduate Training. The role of PhD supervisors, once assumed to be an intrinsic competency of every academic, has increasingly become a focal point for dedicated training and professional development. This need is particularly urgent in Africa, where universities face significant challenges in research and postgraduate training due to sector expansion, rising enrolments, funding shortages, and quality concerns.

Keywords: *PhD supervisors; training; skills; digital tools; toolkit; compendium of resources.*

1. Introduction

Training early-career researchers is becoming increasingly complex due to the diversity of doctoral degrees, rapid knowledge evolution, internationalisation, and the expectations of funders and employers (Lee, 2007). African universities face significant challenges in research and postgraduate training, including sector expansion, rising student numbers, funding constraints, and quality concerns. Despite their crucial role in addressing Africa's challenges, research productivity remains low due to limited research capacity (Lakati & Masibo, 2023; Sawyerr, 2004). The supervision process is a multifaceted teaching responsibility that requires a significant investment of time and energy from both supervisors and students. Supervisors play a key role in ensuring the quality of research, guiding candidates through the complexities of academic inquiry, and fostering an environment that supports intellectual growth and professional development (Almusaed & Almssad, 2020; Odularu & Akande, 2024). In this

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context, the use of digital tools by both students and supervisors is essential for enhancing engagement in supervisory tasks, improving communication, increasing overall efficiency (Kigwilu & Nyonje, 2024), fostering collaboration, providing flexible learning opportunities, and ensuring the quality of postgraduate training (Díaz-García et al., 2022). International initiatives and structured training programmes are strategic in equipping supervisors with the necessary skills to adapt to evolving academic and professional landscapes.

DigiGrad Africa, an EU-funded project, aims to enhance the quality and relevance of postgraduate training and research by harnessing the opportunities provided by digitalisation and internationalisation in Africa. It also seeks to contribute to regional and Sustainable Development Goals, particularly Goal 4: Quality Education. Coordinated by ANIE and OBREAL Global, the project brings together 12 higher education institutions (HEIs), four from Europe and eight from Africa, promoting South-South-North cooperation. It aims to build HEI staff capacity in African universities to manage internationalisation, strengthening the integration of digital tools, and equipping young African researchers and PhD supervisors with the skills to effectively use these tools throughout research process (DigiGrad Africa, 2025).

Sapienza University of Rome and the University of Extremadura (UEx) lead a Work Package (WP) focused on building staff capacity, aligning their skills with institutional internationalisation strategies and equipping them with digital tools to enhance graduate and postgraduate training. They also contribute to the development of an online platform, Moodle, hosted by ANIE, which offers up-to-date resources and open-access training materials to ensure continuous support and knowledge sharing. Within this framework, Sapienza and UEx lead a dedicated task aimed at training PhD supervisors. As part of this effort, this paper discusses the methodology employed in the development of three closely interconnected resources, the *Compendium of Resources*, the *Toolkit for Supervisors*, and the *Online Training*, which are designed to support supervisor training and strengthen their skills and competencies.

2. Collecting needs of PhD supervisors

To assess the training needs and digital skills of PhD supervisors at African partner institutions, the Sapienza team designed a survey with 29 closed-ended questions, divided into three sections. The first section, *Use of Digital Skills* (17 questions), examines supervisors' confidence, critical thinking, and responsible use of digital technologies such Teams, Google Meet, Zoom, and Google Drive. The second section, *Moodle* (4 questions), focuses on the use of Moodle as a Learning Management System (LMS) for managing and supporting online and blended supervision activities and exchanging materials. The Final section, *PhD Supervisor Role and Activities* (8 questions), explores different supervisory approaches and practices.
The survey, created using Google Forms, was distributed in March 2024 to researchers and professors at DigiGrad partner universities, resulting in 46 responses. Among the respondents,

37 identified as PhD supervisors, and the data analysed above were drawn from this group. Of these 37, only 35 were considered valid for the sample, as two responses, one from Burundi and one from South Sudan, were not representative.

As a result, the analysis focuses on universities in Kenya and Ghana, which are relatively young institutions in terms of their foundation. These include Moi University in Kenya, founded in 1984 as a public university; Africa Nazarene University in Kenya, a private university founded in 1994; the University of Cape Coast in Ghana, founded in 1962 as a public institution; and Laweh Open University College in Ghana, a private institution established in 2015.

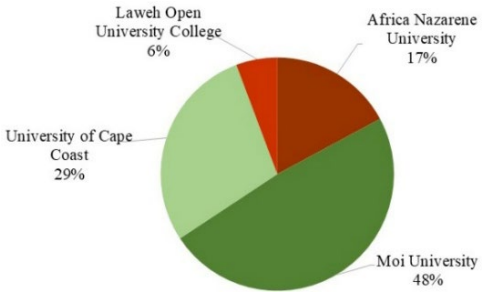


Figure 1. Breakdown of the results: Participation.

The highest participation came from Moi University, Kenya (48%), followed by the University of Cape Coast, Ghana (29%), and Africa Nazarene University, Kenya (17%) (Figure 1). All respondents were over 35 years old, with the majority (48%) aged 51 and above, followed by those aged 46–50 (23%). Respondents affiliated with Kenyan universities tended to belong to older age groups compared to their Ghanaian counterparts (Figure 2). As expected, all participants involved in supervisory roles held a PhD.

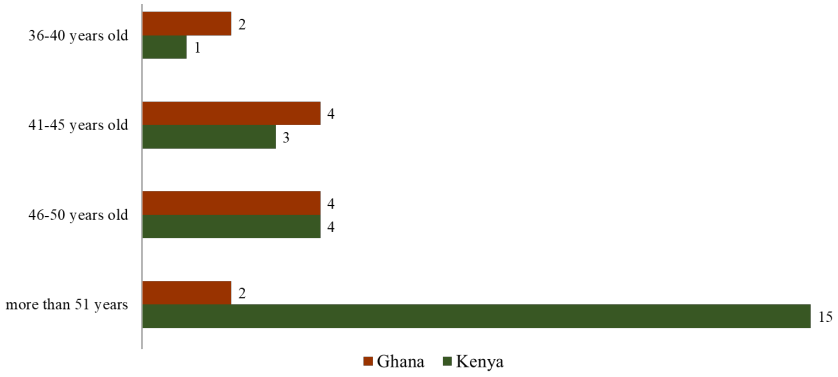


Figure 2. Breakdown of the results: Age Range participants from Ghana and Kenya.

In the first section of the survey, *Use of Digital Skills*, only the most relevant responses are reported here. The majority of respondents (88%) reported confidence in using basic digital

tools (e.g. word processing, search engines, video tutorials) and operations such as copy-paste functions. Many also demonstrated competences in more advanced tools like cloud storage platforms (e.g. Dropbox). However, 34% of respondents indicated they either do not know how to, or require help with, creating new content that integrates different formats (e.g. text, images, video, and audio). In terms of video conferencing platforms, a significant minority (31%) reported difficulty using them independently or lacked familiarity altogether. The most commonly used platforms were Zoom, Google Meet, and Microsoft Teams, in that order. With regard to remote collaboration, 20% of respondents reported not fully understanding its potential benefits.

As highlighted in the second section of the survey, *Moodle*, we observed that more than half of respondents either do not know Moodle (11%) or have only a limited understanding of it (37%), a majority (57%) do not use Moodle at all, and 46% reported being unable to use it without assistance. Furthermore, 63% of participants were unfamiliar with the distinction between Moodle's "resource" and "activity" functionalities. Although Moodle is an open-source platform designed to foster collaborative learning, its adoption across African universities remains limited comparing to other regions globally. South Africa leads the continent, with 1,966 registered Moodle sites (Figure 3).

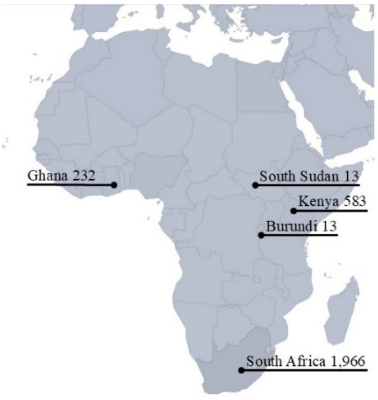


Figure 3. Moodle: Number of registered sites among DigiGrad African partners as of 17/01/2025. Source: https://stats.moodle.org/

In the final section of the survey, *PhD Supervision: Role and Activities,* responses from both Kenya and Ghana highlight a strong institutional orientation towards academic career preparation, with 80% of supervisors reporting that their PhD programmes are primarily geared towards academia. This academic focus suggests a traditional approach to doctoral training, potentially overlooking the need to diversify career pathways beyond academia, particularly within the private sector or applied research fields. This may limit the broader relevance and adaptability of doctoral education in today's rapidly evolving knowledge economies. More than half of supervisors (66%) are responsible for supervising more than one PhD student per year,

typically two to three students. Most supervisors (80%) reported interacting with PhD students through both online and face-to-face meetings. The frequency of supervision meetings was generally one to two times per month (69%). While all participants reported following university administrative guidelines for supervision, fewer than half (48%) used a common evaluation grid for assessing PhD theses. Finally, the demanding nature of the supervisory role was widely acknowledged, with 86% of respondents describing it as highly challenging.

3. Compendium of Resources, Toolkit for Supervisors and Training.

The findings from the survey highlighted specific gaps in digital competencies, supervision practices, and the use of learning platforms among PhD supervisors in African partner universities. These insights provided a foundational understanding of the practical challenges faced by academic staff in their supervisory roles.

In response to the identified needs, the following methodology was adopted in designing the three resources. The *Compendium of Resources* is a curated collection of openly accessible tools and materials, bringing together resources from various institutions with a strong focus on digitalisation and innovation in PhD supervision, training, and research. Organised for ease of use, it serves as a reference for supporting training sessions, seminars, and other initiatives. Designed as a flexible and evolving "living document," the compendium is intended to remain open to additions and updates throughout the DigiGrad Africa project and beyond, allowing for continuous refinement and the incorporation of new insights and practices. The resources are categorised by document title, type, keywords, key lessons learned, author, and the corresponding training module, ensuring accessibility and contextual relevance (Figure 4).

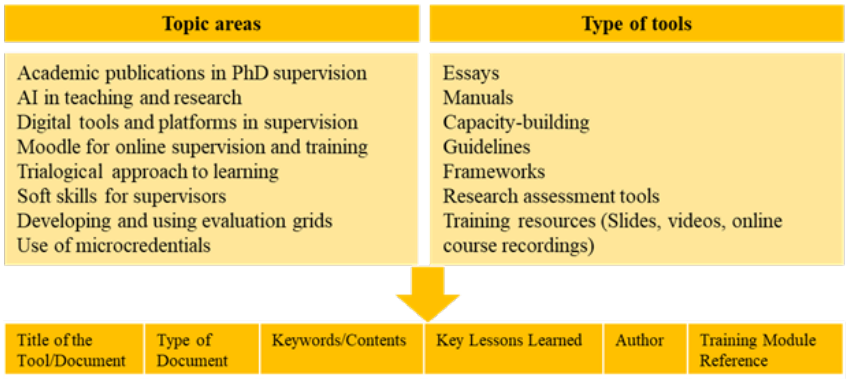


Figure 4. Compendium of Resources: Topic Areas, Type of Tools and Structure.

The *Toolkit for Supervisors* provides practical guidance for effectively managing PhD students throughout the entire research process, both in person and within digital environments. It provides a wide range of resources, tools, and templates for each stage of supervision, from

setting expectations and developing research plans to addressing challenges and preparing for thesis submission. The toolkit also includes guidance on essential software for reference and data management, collaborative platforms, data analysis tools, and cutting-edge AI resources (Wright, 2024). Drawing on extensive bibliographic research and a diverse collection of institutional resources, the team has synthesised and organised the most relevant references and recommendations, ensuring the Toolkit is both comprehensive and user-friendly. This effort brought together a mix of supervisory guidelines, training models, and evaluation frameworks drawn from a broad range of universities and research institutes around the world, including HES-SO, IES, Université de Montréal, TU Delft, Utrecht University, University of Reading, University of Edinburgh, UCL, USTO, IMT, Sapienza University, the University of Extremadura, Institut Polytechnique de Paris, and members of the PRIDE Network. It also incorporated key documents from institutions such as the European Commission, the EU, NPF, and Formez PA. In addition, the Toolkit integrates relevant contributions from leading scholars and research labs working on doctoral education, supervision, and academic development globally.

The document is structured into seven sections. *Getting Started* assists supervisors in laying a solid foundation with PhD students by clarifying expectations, defining research goals, and aligning with institutional policies, emphasising personalised approaches and long-term planning. *Ongoing Supervision* offers advice on maintaining regular, structured meetings, tracking progress, and fostering collaboration through constructive feedback and writing support. *Managing Challenges* focuses on common issues such as time management and motivation, proposing strategies for communication, conflict resolution, and wellbeing support to ensure academic continuity. *Thesis Writing and Completion* guides supervisors in helping students through final thesis stages, including structure, formatting, submission, and defence preparation. *Helping Researchers Make the Best of their Research* highlights the supervisor's role in facilitating publication, career planning, and networking, thereby enhancing academic visibility. *Continuous Professional Development (CPD)* underscores the need for supervisors to stay current with research and student needs through training and reflective practice. Finally, *Golden Rules* outlines the core supervision principles, offering a concise guide to best practices throughout the PhD journey

Each section of the Toolkit offers targeted resources, such as charts, assessments, and digital tools, to support doctoral supervision and enhance both soft and technical skills. Particular emphasis is placed on essential digital tools that can be integrated across the entire research process. Practical sessions and Digital Tools are designed to assist both supervisors and PhD candidates in effectively navigating the thesis journey while maximising the use of available technologies. One example of Practical Session is *"Breaking Down Research Activities into Work Packages"*, which helps PhD supervisors in guiding students structure their research. Another example of digital tool is "*Using Artificial Intelligence to Support Writing"*, which

showcase AI platforms that aid academic research through literature access, writing enhancement, and research streamlining. It stresses the ethical use of generative AI, guided by ERA Living Guidelines principles like transparency, privacy, confidentiality, and intellectual property rights (European Commission, 2024).

Additionally, these two documents serve as a foundational reference for the final phase of the project task, the *Training for PhD Supervisors*. To maximise impact and foster a culture of shared learning and capacity building, the training sessions were opened to a broader audience beyond supervisors, including researchers, academic staff involved in supervision, and institutional representatives engaged in research management and development. Building directly on the identified needs and competency gaps identified through the survey, the training materials and support tools were carefully tailored to enhance supervisors' effectiveness across the research lifecycle. The training was conducted in two phases. The first phase comprised the online training programme comprising three sessions in January 2025, attended by approximately 50 academic staff members. Feedback collected through post-session surveys indicated high levels of satisfaction with both the quality and relevance of the training content.

The second phase, managed by UEx, involved an in-person workshop in Badajoz, Spain, in February 2025, with two supervisors from each African partner university. The training addressed the specific needs of PhD supervisors, focusing on improving research supervision through digital skills integration and effective tool usage, as well as developing transversal competencies for guiding doctoral candidates. Participants gained hands-on experience in structuring supervision services, designing supervisor training, and managing research processes. They also collaborated on creating supervision plans and common guidelines for PhD supervision, drawing from both their experience and the project’s materials.

4. Conclusion

African universities, which are particularly young institutions, face significant challenges in research and postgraduate training. For this reason, postgraduate training is recognised as essential for improving research output and institutional relevance. Strong international collaboration and South-South-North knowledge exchange play a vital role in enhancing postgraduate training, foster PhD student success, and achieve high-quality research outcomes. By embracing digitalisation and fostering global partnerships, African universities can enhance the quality and relevance of postgraduate training, ultimately driving higher research productivity and innovation. Digitalisation is a transformative opportunity worldwide to support internationalisation and capacity building, encouraging more efficient, scalable, and inclusive supervisory practices. By integrating digital tools, all universities across the globe can strengthen research supervision, enhance student engagement, and streamline administrative processes. The DigiGrad Africa project has contributed to this effort by providing open-access

resources, which are described in this paper. These resources are considered living documents that should be updated by African institutions both during and after the project, in response to evolving local needs and in alignment with global developments. Moreover, sustained institutional commitment, continuous professional development, and cooperation will be essential to ensuring long-term impact.

Acknowledgement

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References

Almusaed, A., & Almssad, A. (2020). The Role of the Supervisor on Developing PhD Students' Skills. *International Conference on Humanities, Social and Education Sciences*, 25–36.

Díaz-García, V., Montero-Navarro, A., Rodríguez-Sánchez, J. L., & Gallego-Losada, R. (2022). Digitalization and digital transformation in higher education: A bibliometric analysis. *Frontiers in Psychology*, *13*(December). https://doi.org/10.3389/fpsyg.2022.1081595

DigiGrad Africa. (2025). *Strengthening Research Capacity and Postgraduate Training in Africa*. https://digigradafrica.anienetwork.org/

European Commission. (2024). *Living guidelines on the Responsible Use of Generative AI in Research* (Issue March 2024). https://research-and-innovation.ec.europa.eu/document/2b6cf7e5-36ac-41cb-aab5-0d32050143dc_en

Kigwilu, P. C., & Nyonje, R. (2024). Utilization of Digital Technologies in Doctoral Thesis Supervision at the University of Nairobi: Implications for Quality Assurance. *East African Journal of Education Studies*, *7*(1), 552–561. https://doi.org/10.37284/eajes.7.1.1844

Lakati, A. S., & Masibo, P. K. (2023). A call for African universities to define their research priorities. *The Lancet Global Health*, *11*(10), e1505–e1506. https://doi.org/10.1016/S2214-109X(23)00366-2

Lee, A. M. (2007). Developing effective supervisors: Concepts of research. *South African Journal of Higher Education*, *21*(4), 680–693. https://doi.org/10.4314/sajhe.v21i4.25690

Odularu, O. I., & Akande, J. . (2024). Reflection of experiences with academic supervisors, supervisees and issues of power. *South African Journal of Higher Education*, *38*(2), 254–273. https://doi.org/10.20853/38-2-5706

Sawyerr, A. (2004). Challenges Facing African Universities: Selected Issues. *African Studies Review*, *47*(1), 1–59. https://doi.org/10.1017/S0002020600026986

Wright, A. (2024). Postgraduate Supervision in a ChatGPT World: What's Next? *10th International Conference on Higher Education Advances (HEAd'24)*. https://doi.org/10.4995/HEAd24.2024.17244

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Navigating the Future of STEM Higher Education: Technological Innovations, Gender Dynamics, and Remote Assessment in Southern Europe

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Abstract

This study investigates the evolving landscape of remote assessment in STEM higher education, with a specific focus on Southern European institutions. The objective is to examine the impact of emerging technologies on online education, particularly in Spain, Italy, and Portugal. Employing qualitative methodologies, including expert interviews, the research explores the challenges inherent in STEM learning, necessary adaptations, and the long-term implications for educational practices. The method involves semi-structured interviews with experts, recorded and transcribed for thorough analysis. The results highlight the integration of new technologies in educational settings, addressing gender bias, and advocating for diversity and equitable participation. The findings contribute to the development of more inclusive, flexible, and personalized learning environments, emphasizing the importance of competency-based learning and critical thinking in preparing students for a technologically advanced future.

Keywords: *Remote assessment; Technology; future of Higher Education Institutions (HEIs); STEM; gender bias.*

1. Introduction

In the rapidly evolving landscape of higher education, the integration of remote learning in STEM fields has become increasingly important. This study examines the challenges faced by Higher Education Institutions (HEIs) in online education, with a particular focus on the impact of emerging technologies such as Generative Artificial Intelligence. Utilizing a qualitative methodology, the research involves semi-structured interviews with experts from Spain, Italy, and Portugal to explore regional variations in remote STEM learning. The study

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comprehensively addresses the challenges and necessary adaptations in STEM education, while also anticipating long-term impacts on the educational landscape. Additionally, the research tackles gender bias in STEM degrees, promoting diversity and equal participation. By addressing these issues, the study aims to provide valuable insights for the evolution of educational practices, ensuring inclusivity and equity in the evaluation of student performance.

2. Literature Review

Online assessment tools in Higher Education Institutions offer numerous benefits, including instant feedback and enhanced learning outcomes (Jordan, 2023). Various forms of online assessments, from computer-marked evaluations to peer assessments, have shown potential in facilitating online learning experiences (Skliarova et al., 2022). The COVID-19 pandemic has further highlighted both the advantages and complexities of online education and assessment methodologies. Recent studies have explored the challenges and adaptations in STEM education within remote settings. MacDonald et al. (2020) emphasized the need for effective approaches across various educational levels. Gender bias remains a significant issue in STEM fields, affecting various aspects of academia and hiring practices. Recent research has further explored the impact of online learning on gender disparities in STEM education. Xu and Xu (2023) found that the transition to online learning during the COVID-19 pandemic exacerbated existing gender gaps in STEM fields, with female students reporting higher levels of stress and lower levels of engagement compared to their male counterparts. This highlights the need for targeted interventions to support female students in online STEM education. To address gender bias in STEM, Knezz et al. (2022) proposed embracing gender-blindness in hiring practices and implementing comprehensive strategies to foster diversity and inclusion. Building on this, García-Holgado et al. (2023) developed a framework for integrating gender perspectives into STEM education, emphasizing the importance of inclusive pedagogies and diverse role models. The future of STEM education lies in the effective integration of emerging technologies. Chung et al. (2023) explored the potential of artificial intelligence and virtual reality in creating more inclusive and engaging STEM learning environments. Their findings suggest that these technologies can help bridge gender gaps by providing personalized learning experiences and reducing implicit biases in assessment.

3. Method

3.1. Sample

To examine the perspectives of academics and managers from Higher Education Institutions (HEIs) in Spain, Italy, and Portugal, semi-structured interviews were conducted. Participants were selected through purposive sampling from four partner universities of the REMOTE

project, ensuring a broad representation of expertise in digital education and STEM assessment. Qualitative data collection took place from April to October 2023, during which a total of 37 interviews were completed. Each session lasted between 15 and 30 minutes and followed a standardized format in which respondents answered three predefined questions: 1) How do you imagine the university of the future?; 2) How will the students of the future differ from those of today?; 3) How do you think online/remote assessment methodologies might influence learning practices differently based on gender?… based on the typology of studies? Will it differ in STEM studies compared to others? The interviews were conducted and recorded virtually via Zoom, with a technician guiding the process question by question. The recordings were transcribed verbatim to ensure data integrity.

3.2. Gioia Method

The qualitative research was conducted using an adapted version of the Gioia Methodology (Gioia et al., 2012), which was essential for ensuring precise interpretative analysis and a comprehensive presentation of the research findings. The analysis involved initial coding of information extracted from interviews, organization of first-order themes into second-order codes, and finally, assembling terms and linking second-order codes into aggregate dimensions, creating a comprehensive framework for interpreting the research outcomes. The researchers conducted all coding using Atlas.ti.

4. Results

The analysis of the interview data revealed several key themes regarding the future of higher education, particularly in STEM. These themes were organized into aggregate dimensions.

Table 1. Aggregate dimensions of Question 1: How do you imagine the university of the future? Source: Own Elaboration

1st Order Concepts	2nd Order Themes	Aggregate Dimensions
AI will play a significant role in the future of education; VR and AR technology will become mainstream in education; technology will undoubtedly follow this rapid pace of innovation and will give more opportunities to the teaching and learning process; within 20 years, the ongoing digital transformation that is already happening will continue to evolve; will be further disrupted by digitalization.	AI	Technology
	AR & VR	
	Technology	
	Digitalization	

The University of the Future will be a learner students' competencies centre, not focusing only on acquiring a grade; the focus will be on the knowledge that we acquire, but also on the skills, attitudes, and values that we develop as persons; what is more important will be critical thinking and how individuals should critically assess and analyze their overall environment.	Competency - Based	Competence Development
	Skills-Based	
	Critical Thinking	
Student-centered learning, student-centered assessment; instead of having this traditional lecture-driven model, the students will be at the center; it's no longer about passive education, it's more important than ever that higher education institutions give students the opportunity to get to know themselves deeper and better; learning modalities in higher education will need to be flexible, both in how and where students are learning; universities will increasingly adopt personalized learning approaches, tailoring education to individual student needs, considering their interests and learning styles.	Student - Centered	Student - Centered
	Personal Development	
	Flexibility	
	Personalization	
The current differentiation among universities, disciplines, types of students, intensity, and level of courses is already significant and will likely increase; a university will be mission-driven, focused on addressing global challenges that require the community to work collaboratively or in the best way to address them; the competition between universities will be very high. Universities without strong reputation may disappear in the future; universities will become more inclusive, not only in terms of people with disabilities, but also geographically; a different type of internationalization will emerge; smaller universities will cooperate with each other, cooperating in different countries; higher education institutions have survived for so many years because they have adapted.	Differentiation	Mission - Driven Institutions
	Mission-driven	
	Reputation	
	Competition	
	Inclusivity	
	Internationalization	
	Cooperation	

The future university will be significantly shaped by technological advancements, particularly in artificial intelligence (AI), augmented reality (AR), and virtual reality (VR). These technologies will drive the ongoing digital transformation, making education more student-centred, flexible, and personalized. Universities will prioritize the development of competencies, critical thinking, and skills-based learning, tailored to the individual needs of students. Additionally, there will be a marked differentiation among universities, with some focusing on mission-driven goals, inclusivity, and international cooperation. This evolution will ensure that higher education institutions remain adaptive and relevant in addressing global challenges and fostering a diverse and inclusive academic environment.

Table 2: Aggregate dimensions of Question 2: How will the students of the future differ from those of today? Source: Own Elaboration

1st Order Concepts	2nd Order Themes	Aggregate Dimensions
They feel comfortable with artificial intelligence; students will demand and expect from institutions more technology-driven, immersive experiences to capitalize on their capacities and competencies; every institution has a learning management system, leveraging technology to receive assignments, grade students, and assess learning	Artificial Intelligence	Technology
	Technology-Driven	
A challenge for universities is adapting their program offerings to meet these demands without compromising the quality of education; they will anticipate tailored educational paths, adaptive learning technologies, and individualized support to meet their unique needs, interests, and career aspirations; a whole group of students will independently learn, gain skills, and apply those competencies in practice, developing a community of self-learners.	Adaptation	Personalization and Autonomy
	Personalization	
	Autonomy	
	Self-Learners	
Students may expect universities to offer more flexible programs and structures, including part-time options, online learning, and the ability to integrate personal and professional commitments; Institutions should provide students with micro-credentials, which are small pieces of learning	Flexibility	Flexibility
	Micro-credentials	
Adult learners will become more important in many places; older students will return to university while they are in the professional world more and more often than today; they will embrace lifelong learning as a must, recognizing the need to continually acquire new skills, new knowledge, and a path to evolving careers and industries	Adult Learning	Lifelong Learning
	Lifelong Learning	
	Re-skilling	
They pay to get the skills, competencies, and knowledge. So, they want to gain it now because they have ample opportunities to get information from outside sources and don't need to pay for it; but if there is a need to understand why something is being done and to develop strategic and critical thinking to improve the work being done.	Competencies	Skills and Competencies
	Skills	
	Critical Thinking	

Students will likely demand in the future more than now is to be more related to sustainability, ecology, and how to preserve the environmet; environmental sustainability and social responsibility will be significant concerns for future students; they will look for institutions that care for the well-being of students, including mental health and the appropriate services to support their academic journey; quality of life and well-being.	Sustainability	Sustainability and Well-being
	Social Responsibility	
	Well-being	

Future students will exhibit greater autonomy and will seek technology-enhanced learning experiences. They will demand personalized and flexible educational pathways, including part-time and online learning options. Lifelong learning will become a cornerstone of their educational journey, with continuous acquisition of new skills and knowledge being essential for career adaptability. The student demographic will become increasingly diverse, encompassing adult learners and individuals from varied socio-economic backgrounds. Moreover, future students will place a high value on sustainability and well-being, expecting educational institutions to address environmental and social responsibilities comprehensively. This shift will necessitate institutions to create inclusive, adaptable, and supportive learning environments.

Table 3: Aggregate dimensions of Question 3: How will online / remote assessment methodologies affect learning practices in STEM, differently depending on…Gender? Studies typology? Source: Own elaboration

1st Order Concepts	2nd Order Themes	Aggregate Dimensions
With the artificial intelligence, there is a long way to go to fully integrate all of these features in the teaching and learning experience for students; there will be the possibility, with augmented reality, to simulate any kind of experiment or experience; virtual reality in laboratory activities is one of the challenges of the future; right now, discussions are taking place about the metaverse and how it can be used in learning and teaching in STEM.	AI	Emerging Technology
	AR	
	Virtual Reality	
	Metaverse	
Anonymizing informational personal data can likely help erase or make it more difficult for gender bias to exist, particularly in on-site evaluations. This approach could be an effective way to reduce potential gender bias; Online assessments can provide a more inclusive and equitable environment for female students in STEM, helping to mitigate gender bias that may exist in traditional	Gender Bias	Gender Bias
	Gender Bias Reduction	

classroom settings; Assessment and methodology, along with remote access to learning, are unlikely to differ. Over time, this will likely lead to greater equity between men and women in higher education, particularly in STEM.	Gender Equity	
The potential of teaching based on diversity factors might include gender, disabilities, location, or even times of the day. There is a huge spectrum of opportunities for different learning that online platforms facilitate; when talking about inclusion, this is one of the positive examples, providing accessibility and flexibility to different profiles of students, which stands as one of the missions of universities and society beyond these organizations	Diversity of Student Profiles	Diversity and Accessibility
	Accessibility	
In 20 years, each field of learning will likely have its own set of evaluation tools and methodologies, specifically designed to assess the skills, methods, knowledge, and competencies required for that particular field of study; AI and digital platforms will increase technological awareness and competencies of digitalization skills among learners; digital platforms will boost this type of course, engaging students more because the new generation, not only millennials and Generation Z, but the next generations to come, will be highly affected by technology and digital platforms.	Assesment of Skills	Skills and Engagement
	Digital Skills	
	Engagement of Students	

Online and remote assessment methodologies will likely impact learning practices in STEM fields differently based on gender and study typology. The incorporation of emerging technologies in STEM education can create more inclusive and equitable learning environments, potentially reducing gender biases. Online assessments can offer a more supportive setting for female students in STEM, helping to mitigate biases that are often present in traditional classroom settings. Furthermore, assessment methodologies in STEM will increasingly focus on practical application and problem-solving skills, while assessments in other fields may emphasize critical reflection and written communication. This differentiation will ensure that assessment strategies are aligned with the specific needs and characteristics of each field of study, promoting fairness and effectiveness in evaluating student performance.

5. Discussion and implications

This research highlights the transformative impact of digitalization and emerging technologies on higher education, particularly in STEM disciplines. Technologies such as AI, AR, and VR are making education more personalized, interactive, and inclusive. In line with Chung et al. (2023), our findings suggest that these innovations can help reduce implicit biases and improve student engagement. The COVID-19 pandemic has accelerated the adoption of hybrid learning models, combining online and in-person instruction to create flexible, student-centred pathways.

As supported by Jordan (2023) and Skliarova et al. (2022), the integration of digital assessment tools has improved efficiency and responsiveness in evaluating student performance. Our findings also reinforce the need for competency-based learning frameworks, emphasizing critical thinking, adaptability, and lifelong learning. These align with the views of MacDonald et al. (2020) on the importance of tailoring STEM education to evolving student needs. Future students will expect personalized, flexible learning pathways that integrate professional and personal development. One of the study's key contributions is its reflection on gender equity in STEM education. Echoing Xu and Xu (2023), we found that while online environments can exacerbate stress among female students, they can also offer more equitable spaces through anonymity and flexible participation. These observations support the proposals of Knezz et al. (2022) and García-Holgado et al. (2023), who advocate for inclusive pedagogies and systemic strategies to address bias. STEM assessments will focus on practical application and problem-solving, while other fields may emphasize critical reflection and written communication. This differentiation will promote fairness and effectiveness in evaluating student performance. In conclusion, the future of higher education will be defined by mission-driven and technology-focused universities. Future research should incorporate student perspectives.

References

Chung, J. Y., Kim, H. J., & Lee, S. Y. (2023). Bridging the gender gap in STEM education: The role of AI and VR technologies. Computers & Education, 189, 104598.

García-Holgado, A., Verdugo-Castro, S., Sánchez-Gómez, M. C., & García-Peñalvo, F. J. (2023). Gender perspectives in STEM education: A comprehensive framework for curriculum design. International Journal of Engineering Education, 39(2), 559-573.

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2012). Organizational research. Organizational Research Methods, 16(1), 15-31. https://doi.org/10.1177/1094428112452151

Jordan, S. (2023). Computer-marked assessment and concept inventories. In Effective Teaching in Large STEM Classes (pp. 1-6). Bristol, UK: IOP Publishing.

Knezz, S. N., Pietri, E. S., & Gillian-Daniel, D. L. (2022). Addressing gender bias in STEM graduate and post-graduate students using equity in STEM for all genders course. Journal of Science Education and Technology, 31(5), 638-648.

MacDonald, A., Danaia, L., & Murphy, S. (2020). STEM education across the learning continuum. Singapore: Springer.

Skliarova, I., Meireles, I., Martins, N., Tchemisova, T., & Cação, I. (2022). Enriching Traditional Higher STEM Education with Online Teaching and Learning Practices: Students' Perspective. Education Sciences, 12(11), 806.

Xu, D., & Xu, Y. (2023). The impact of online learning on gender disparities in STEM education during COVID-19. Journal of Higher Education, 94(3), 456-478.

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Enhancing Readiness for Virtual and Blended International Collaboration in Higher Education: Insights from an Online Training Module

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Abstract

International collaboration activities in virtual or blended modalities are becoming increasingly common, enhancing the internationalisation of higher education institutions in teaching and learning. This is crucial for equipping students with intercultural competencies and fostering open-mindedness. One key strategy to promote such activities is faculty and staff training. This study examines the outcomes of an online training module involving higher education teachers and administrative/technical staff. The course positively influenced participants' perception of international collaboration, especially for the group with a less initially positive perception of similar activities. Moreover, it improved the participants' readiness to engage in these activities by contributing to developing their teaching strategies. The findings highlight the role of professional development in fostering international collaboration in education and suggest that targeted training can support higher education institutions in integrating virtual and blended collaboration more effectively.

Keywords: *Blended learning; International collaboration; Online learning; Teacher training; Professional development; Teacher readiness.*

1. Introduction

In today's interconnected world, the ability to work collaboratively across cultures, embrace diverse perspectives, and demonstrate flexibility is not just a valuable skill—it is essential.

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Higher Education (HE) institutions are key in equipping students with these competencies (Mananay et al., 2024). International activities are powerful tools for fostering intercultural understanding, teamwork, and open-mindedness, helping students thrive in an increasingly globalised society (Liang & Schartner, 2022). Traditionally, internationalisation in HE has relied heavily on physical mobility programmes, where students spend extended periods abroad. While this remains important, we are witnessing the emergence of innovative approaches to international collaboration in virtual or blended modalities, such as Blended Intensive Programs (BIPs) (European Commission, 2022; Barana et al., 2024) and Collaborative Online International Learning (COIL) (Hackett et al., 2024). These models enable more inclusive and flexible participation, reaching students who may not have the means or opportunity to engage in traditional mobility (Barana & Marchisio Conte, 2024). Very often, similar activities rely on the HE teachers' initiative and are based on their research collaborations (Kučerová, 2023; Perfölz & López-Varela, 2022). One of the ways to enhance the HE institutions' capability to implement virtual or blended international collaboration activities is by promoting faculty and staff training programmes that enable faculty and staff's readiness to organise and support similar activities (Mananay et al., 2024). According to Mananay et al. (2024), readiness, in this context, refers to how well-equipped stakeholders are regarding the abilities, attitudes, and knowledge needed to participate in internationalisation projects. It is influenced by cultural competence, language proficiency, pedagogical strategies, professional development, attitudes and beliefs, and experience in internationalisation. According to Nyagau (2019), to enable teachers to organise international teaching and learning activities, they should have strong leadership skills, good interpersonal and communication skills, organisational knowledge and problem-solving skills, open-mindedness, empathy, and the ability to tolerate ambiguity. While HE teachers generally have a highly positive perception of internationalisation (Mananay et al., 2024), the main barriers they face are the lack of recognition and institutional support for this work (Nyangau, 2019).

The INVITE Erasmus+ Project aims to develop teaching and learning competencies for designing and implementing new virtual and blended modalities of international collaboration in HE institutions. The INVITE consortium, composed of Aalborg University (Denmark), Columbus Association (France), Hellenic Mediterranean University (Greece), and University of Turin (Italy), organised an online training module for teachers and institutional staff to prepare them to design, implement, and support the realisation of activities such as COILs and BIPs. This paper aims to understand if this training module effectively improved faculty and staff's perceptions of these new modalities of international collaboration and their readiness, knowledge, and skills to promote their development.

2. The INVITE training module

The training module organised within the INVITE project was open to HE teachers and administrative/technical staff to promote mutual collaboration in implementing virtual or blended international collaboration activities. The module was asynchronous, self-paced, and fully online to maximise participation possibilities. It was open from April to October 2024, with an estimated training time of approximately 6 hours. Following the ADDIE model of instructional design (Peterson, 2003), it interactively showed participants how to create a COIL, BIP, or similar activity, guiding them step-by-step. Contents and activities focused on: how to conceive an idea for an international collaboration, finding partners and funding; define the international added value of the activities and suitable learning outcomes based on the students' composition; design the activities incorporating active learning strategies and digital technologies; develop culturally sensitive and culturally relevant contents, also using available open educational resources; encourage peer interaction and intercultural discussion; evaluate the achievement of international goals and learning outcomes, by providing feedback to improve. In a modular structure, participants could explore videos and resources, engage in quizzes, reflect with questionnaires, discuss with forums, and develop their activities by submitting the tasks. Participants could work collaboratively on tasks, even if mainly conceived to put into practice the learning contents. More details about the structure of the training module are available in (Barana et al., 2025).

3. Research method

This paper aims to answer three research questions (RQs). RQ1: How did the training module impact the participants' perceptions of virtual and blended international collaboration activities? RQ2: How did the training module impact the participants' readiness to organise or support a similar activity? RQ3: Which skill area did the training module significantly impact the most?

To address these RQs, the answers to the initial (IQ) and final (FQ) surveys of the participants who completed the training module were collected and analysed. The sample consists of 150 answers from the participants who completed the module and accepted that their data were used for research purposes. 118 were provided by participants who followed the path for teachers and 42 by those who followed the path for staff. Table 1 lists all the items that were considered for this study. Answers were in Likert-scale form 1 (lower agreement value) to 5 (higher agreement value).

Items Q01a-f were used to evaluate the impact of the training module on perceptions of international collaboration activities (RQ1). Besides descriptive statistics on single items, we computed the Wilcoxon signed-rank test to evaluate differences between final and initial answers. Then, for each participant, we computed the mean of the answers to the six items to have an index of perception and the mean difference between the final and initial questionnaires

to have an index of improvement in perception. We compared the improvement in perception between those with an initial low perception (25th percentile) and the others.

Q1g was used to evaluate readiness for virtual or blended international collaboration (RQ2). We compared the initial and final values through the Wilcoxon signed-rank test. Moreover, we computed the Pearson's coefficient between answers to Q01g and Q01h in the final questionnaire to understand how much the training module impacted the participants' readiness. Cronbach Alpha was computed on items Q01a-h to measure the questionnaire reliability.

Question Q2 was used to address RQ3 and identify the skill areas on which the training module had the highest impact. In particular, we focused on Digital and IT skills (Q02b), pedagogical skills (Q02c-d), intercultural skills (Q02a, Q02e, Q02h), team and collaborative work (Q02f), attitude to professional development (Q02g), communication skills (Q02i-j), creativity (Q02k). Items Q2a-k were analysed through descriptive statistics.

Table 1. 5-point Likert-scale items from the initial and final survey used for this study.

Item	Text	Survey
Q01	Thinking about international collaboration activities such as COIL or BIPs, to what extent do you agree to the following sentences?	
Q01a	They are valuable experiences for students.	IQ, FQ
Q01b	They are valuable experiences for teachers.	IQ, FQ
Q01c	They can bring added value to HE institutions.	IQ, FQ
Q01d	I would like to participate in a similar experience as a teacher.	IQ, FQ
Q01e	I find it feasible to organise similar experiences in my institution.	IQ, FQ
Q01f	My institution supports the realisation of international collaboration activities.	IQ, FQ
Q01g	I feel ready to carry out/support the realisation of a similar activity.	IQ, FQ
Q01h	This module gave me useful knowledge and instruments to carry out/support the realisation of a similar activity.	FQ
Q02	To what extent did you improve the following skills during this experience?	
Q02a	Empathy	FQ
Q02b	Digital and IT skills	FQ
Q02c	New teaching approaches	FQ
Q02d	Learning design	FQ
Q02e	Tolerance and respect for others	FQ
Q02f	Team and collaborative work	FQ
Q02g	Learning-how-to-learn	FQ
Q02h	Flexibility and Adaptation to different contexts and situations	FQ
Q02i	Communication in formal settings	FQ
Q02j	Communication in social settings	FQ
Q02k	Creativity	FQ

4. Results and discussion

As a first step, the Cronbach Alpha was computed on items Q01a-h, considering both the initial and final questionnaires, as indicator of questionnaire reliability. The result, 0.891, indicates a high level of internal consistency.

We start focusing on RQ1, that is, the effect of the training module on the perception of virtual or blended international collaboration. Since the answers to items Q01a-f were not normally distributed, we used the Wilcoxon signed-rank test to compare the initial and final values item by item. Results are shown in Table 2. The results show very positive levels of perception about virtual or blended international collaboration, both at the beginning and at the end of the module. This result is in line with those found by Mananay et al. (2024). Answers to the single items about perception are not significantly modified after the course; we hypothesise that this is due to a ceiling effect: since most of the values are at their maximum at the beginning of the course, it is difficult to measure an improvement. Therefore, for each participant, we computed the mean value of items Q01a-f at the beginning and end of the course and their difference. We divided the participants into two groups based on their initial perception level. Since the median value is high (4.7/5), the lower perception group includes those below the first quartile (corresponding to 4.2), while the higher perception group includes all the others. We compared the improvement in perception across these two groups. We found that the perception of the initial lower group improved by 0.40 points out of 5, while the perception of the higher group remained approximately stable (-0.08 points out of 5). The difference is statistically significant to the ANOVA test ($F=25.38$, $p<0.001$): even if the participants' initial perception of international collaboration is relatively high and remains stable, the training module improved the perception in those who, at the beginning of the course, had a lower perception.

Table 2. Results of the Wilcoxon signed-rank test on items about perception of virtual or blended international collaborative activities in HE.

Item	Mean IQ	St. Dev. IQ	Mean FQ	St. Dev. FQ	Z	p-value
Q01a	4.67	0.565	4.75	0.464	-1.479	0.139
Q01b	4.63	0.645	4.70	0.516	-1.104	0.270
Q01c	4.61	0.591	4.64	0.585	0.000	1.000
Q01d	4.51	0.658	4.61	0.541	-1.725	0.084
Q01e	4.17	0.790	4.30	0.816	-1.721	0.085
Q01f	4.37	0.755	4.37	0.750	-0.023	0.982

We now focus on participants' readiness to carry out or support these activities (RQ2). Item Q01g was analysed through the Wilcoxon signed-rank test, similar to what was done for items Q01a-f, and a significant difference in the participants' answers was found (see Table 3). The initial value of the participants' readiness to carry out or support activities such as BIPs or COILs is lower than the initial values about the perception of the same activities. If, before attending

the course, HE teachers and staff were aware of the benefits that international collaboration activities can bring to their institution and work, they did not feel equally ready to realise them before attending the course. However, after attending the training module, their responses significantly increased: we can assume that it positively affected their readiness. To verify this assumption, we cross-checked the answers to items Q01g and Q01h in the final questionnaire. In particular, we computed the Pearson's coefficient to verify if there is a correlation between the answers to the two items. The Pearson's coefficient is 0.47 ($p<0.001$), indicating a good level of correlation between the two variables: those who, at the end of the module, feel ready to carry out or support a BIP or a COIL also affirm that the training module provided them with valuable instruments to realise a similar activity. We also note that the answers to Q01h are generally high, having a mean near 4.5 out of 5: the training module was generally appreciated for its effectiveness in helping teachers and staff implement international collaboration activities in virtual or blended modalities. We also checked through ANOVA if there is any difference in the answers to Q01h between the teachers and staff groups, and we did not find any significant differences (teachers: mean=4.49, staff: mean=4.36. $F=1.317$, $p=0.253$). These results show that the paths were considered equally effective.

Table 3. Statistics of items Q01g-h and results of the Wilcoxon signed-rank test on Q01g.

Item	Mean IQ	St. Dev. IQ	Mean FQ	St. Dev. FQ	Z	p-value
Q01g	3.92	0.997	4.19	0.799	-3.072	0.002
Q01h			4.45	0.641		

Lastly, we focus on the skills provided by the training module according to the participants (RQ3). We computed descriptive statistics on the items of Q02. Results are shown in Table 4. The skills on which the training module has the primary effect, according to the participants, are pedagogical skills (Q02c and Q02d), followed by the attitude to professional development (Q02g) and creativity (Q02k). The least impacted skills are empathy (Q02a), digital and IT skills (Q02b), team and collaborative work (Q02f) and communication in formal settings (Q02i). New teaching approaches and learning design are the primary learning outcomes of the training module, so the participants' answers testify that the course activities were in line with its objectives. Participants had the opportunity to practice learning how to learn and be creative by exploring the resources and completing the tasks that asked them to design a virtual or blended international activity. On the other hand, the training module offered participants a limited occasion to develop digital and IT skills and communication in formal settings since they only had to describe the design of an activity in a written form and not implement it or present it in front of the public or necessarily communicate with peers to design the activity. Similarly, collaboration was encouraged but not mandatory, and many participants preferred to complete the tasks individually, as observed in (Barana et al., 2025). Thus, they had little opportunity to improve their empathy and teamwork skills within the course.

Table 4. Statistics of items Q01g-h and results of the Wilcoxon signed-rank test on Q01g.

Item	Mean	St. Dev.	Percentage of 1	Percentage of 2	Percentage of 3	Percentage of 4	Percentage of 5
Q02a	3.40	1.24	11%	10%	32%	24%	23%
Q02b	3.52	1.18	8%	8%	29%	31%	23%
Q02c	4.36	0.69	0%	1%	10%	42%	48%
Q02d	4.43	0.72	0%	1%	11%	32%	55%
Q02e	3.68	1.19	8%	8%	22%	33%	29%
Q02f	3.56	1.18	7%	9%	29%	29%	25%
Q02g	4.06	0.90	0%	7%	17%	39%	37%
Q02h	3.97	0.98	2%	5%	21%	37%	35%
Q02i	3.58	1.11	9%	4%	27%	41%	19%
Q02j	3.60	1.12	8%	4%	30%	36%	22%
Q02k	4.01	0.86	1%	3%	22%	41%	32%

5. Conclusion

This study examines the effectiveness of an online training module for HE teachers and staff in enhancing their perceptions, readiness, and skills to implement virtual or blended international collaboration activities. The analysis of initial and final questionnaires confirms the findings of Mananay et al. (2024), which indicate that HE teachers generally have a very positive perception of international teaching and learning activities. Furthermore, participants who initially had a lower perception showed a significant improvement. The module significantly enhanced participants' readiness to adopt these approaches, particularly by strengthening their teaching and learning skills, professional development mindset, and creativity. Discussions with some participants revealed that several implemented BIP or COIL after completing the course. To further assess the module's impact, a follow-up survey was launched to gather additional feedback on how effectively the course supported them in implementing these activities. The main limitations of this study are the small sample size and the self-assessment nature of the data collected. However, the project consortium is working on revising the module to launch it as an open online course. This will enable a larger participant base, allowing for a more robust validation of these preliminary results. Such a course can help HE institutions foster international collaborations and develop the necessary skills to activate these initiatives. By equipping educators with the right tools, this type of training can expand international learning opportunities and strengthen institutions' capacity to offer a more globally connected curriculum. As shown in the findings, teachers' training helps to increase the awareness and value of international activities in teaching practice. It especially equips those who are already aware with skills to shift towards designing a concrete activity, such as BIP or COIL. Those skills are mainly related to the design of new teaching approaches, the attitude towards professional development and creativity. Other least-developed teacher skills, such as digital and IT skills, team and collaborative work, and communication in formal settings, might suggest the need for adapting teacher training environments with a more collaborative approach, where teachers can experiment with international peers in the co-design of their activities.

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References

Barana, A., Cambria, A., Marchisio Conte, M., & Spinello, E. (2024). Unpacking the three spheres of interest in a Blended Intensive Programme: Collaborative Learning, Blended Learning and Internationalisation. *Proceedings of the 21st International Conference on Cognition and Exploratory learning in the digital age*, IADIS Press, pp. 43-50. https://doi.org/10.33965/CELDA2024_202408L006.

Barana, A., Chatzea, V., Henao, K., Hildebrandt, A., Marchisio Conte, M., Samoilovich, D., Triantafyllidis, G., & Vidakis, N. (2025). Designing an online training module to develop virtual and blended international modalities in higher education. *Proceedings of the International Conferences Mobile Learning 2025 and Educational Technologies 2025,* IADIS Press, pp. 117-124.

Barana, A., & Marchisio Conte, M. (2024). Eight Sustainable Practices for Digital Activity Development: Drivers and Barriers in International Higher Education Collaboration. *Computer*, *57*(3), 117–122. https://doi.org/10.1109/MC.2023.3344236

European Commission. (2022). *Erasmus+ Programme Guide 2023*. https://erasmus-plus.ec.europa.eu/document/erasmus-programme-guide-2023-version-1

Hackett, S., Dawson, M., Janssen, J., & Van Tartwijk, J. (2024). Defining Collaborative Online International Learning (COIL) and Distinguishing it from Virtual Exchange. *TechTrends*, *68*(6), 1078–1094. https://doi.org/10.1007/s11528-024-01000-w

Kučerová, K. (2023). Benefits and Challenges of Conducting a Collaborative Online International Learning Class (COIL). *International Journal on Studies in Education*, *5*(2), 193–212. https://doi.org/10.46328/ijonse.110

Liang, Y., & Schartner, A. (2022). Culturally Mixed Group Work and the Development of Students' Intercultural Competence. *Journal of Studies in International Education*, *26*(1), 44–60. https://doi.org/10.1177/1028315320963507

Mananay, J. A., Sanchez, J. M. P., Boholano, H. B., & Beltran, N. Y. (2024). Patterns and Pathways: Teachers' Perceptions, Readiness, Support, and Barriers to Internationalization in Higher Education. *International Journal of Learning, Teaching and Educational Research*, *23*(9), 401–431. https://doi.org/10.26803/ijlter.23.9.21

Nyangau, J. Z. (2019). Faculty Engagement in Internationalization: The Role of Personal Agency Beliefs. *International Journal of Research in Education and Science*, *6*(1), 74. Peterson, C. (2003). Bringing ADDIE to Life: Instructional Design at Its Best. *Journal of Educational Multimedia and Hypermedia*, *12*(3), 227–241.

Perfölz, R., & López-Varela, A. (2022). Internationalisation of Teaching and Learning through Blended Mobility: Potentials of Joint International Blended Courses and Challenges in Their Implementation. *Education Sciences*, *12*(11), 810.

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Students' motivation in online learning: a trend analysis

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Abstract
This study aims to explore the trend in undergraduate tax students' motivation to engage with learning activities in an online environment over a three-year period based on the ARCS model (Attention, Relevance, Confidence, Satisfaction) of motivation. The data was collected over a period of three years, 2020 – 2022, from undergraduate tax students. Principal component analysis was employed to extract the components that most likely measure each of the dimensions of the ARCS model and the mean values in each of the datasets are used to illustrate the trend in motivation and determine the dimension of motivation that appears to be the weakest. A thematic analysis was used to identify categories or factors of attention as a motivational domain from student responses. The results showed that attention was a problematic domain, with little improvement over the three years and the importance of stimulating curiosity and participation is highlighted.

Keywords: *remote teaching; ARCS model of motivation; online learning; tax education; student motivation*

1. Introduction

A call for lecturers to incorporate the best of online into residential settings appears to be the future of teaching and learning (Harvard Task Force, 2022). Online learning was adapted by universities after the migration to emergency remote education in 2020 because of the pandemic (Unesco, 2021). This was the start of a new future for education, more so for those who never experienced online learning.

A large number of scholarly research has been published since 2020. Studies by García-Morales, Garrido-Moreno and Martín-Rojas (2021); Hermanto and Srimulyani (2021); and Dhawan (2020), focus on the challenges of online learning by higher education institutions and students. One of the challenges identified was keeping students motivated and engaged in the online learning process. For students to be highly motivated, they must have a sustained

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level of attention. Motivation and attention are vital for successful academic learning, students who struggle with learning are often not able to sustain attention (Hutchings, 2010).

Keller's (2009) ARCS model of motivation can be used to measure student motivation and to identify which dimension of motivation appears to be lacking in students. The present study will determine in terms of the ARCS model's dimensions, the motivational gaps and identify the dimensions that are consistently low scoring over the three years.

2. Recent literature on motivation in online learning

Chiu, Lin and Lonka (2021) reviewed 9 empirical studies on student motivation in online learning during the covid pandemic. They identified that students who relate to online self-regulated learning, showed an increase in perceived learning gain and satisfaction, while online collaborative learning has been identified to have more impact on students learning from home alone than self-regulated learning. They further highlighted that factors such as social interaction, personal interest, and practical utility of tasks were identified as strongly related to student motivation.

Studies by Yan, Xiaohui and Yufei (2023); Kim, Knotts, Albers and James (2022); Gumasing, Dela Cruz, Piñon Nicolaison, Rebong and Sahagun (2023); and Vo and Ho (2024) all contribute different approaches to exploring student motivation and focus on different aspects, ranging from investigating relationship between lecturer and student to the effect of ergonomic factors on motivation. According to Maran, Tanggur and Bulu (2024) educators play a crucial role in sustaining and boosting student motivation, particularly in online learning environments. Ozdil, McDonald-Kerr, Tharapos, Khosa and Burch (2025) further open discussions about concerns in online learning which can negatively impact motivation, such as absence of networking and difficulty in deep engagement with complex module content. They stress the importance of addressing both the academic and psychological needs in education. A study done by Karyadi and Paristiowati (2024) identified that students who study in an online environment can get distracted easily due to their surrounding environment.

3. John Keller's ARCS motivational design theory

To be motivated means to be moved to do something (Ryan & Deci, 2000). People have different levels of motivation, but even more so, people have different reasons for being motivated. Keller's (2009) ARCS model of motivation informed the approach to the study. ARCS refers to Attention, Relevance, Confidence and Satisfaction.

Learners' **attention** should first be stimulated, then sustained, and then be directed to the concepts or skills to be learned for learning to take place (Keller, 2009). **Relevance** as

motivational dimension is based on the argument that people are more likely to pursue a desired outcome if such outcomes are aligned to their personal goals, motives and values (Keller, 2009).

"People's behaviour is strongly influenced by their **confidence** in their ability to perform" (Ajzen, 1991: 184). Keller (2008) proposes that when students believe they can master a learning task, motivation to learn appears to be greater. **Satisfaction** can be described as the positive feelings learners may experience while engaging in learning activities (Keller & Suzuki, 2004). These positive feelings can be intrinsic or extrinsic satisfaction which in turn sustain desirable learning outcomes (Keller, 2016).

4. Objective

This study aims to explore the trend in undergraduate tax students' motivation to engage with learning activities and material in an online environment over a three year period starting from the first year of Covid-19 lockdown restrictions. Two specific objectives are addressed namely, 1) to determine the trend and motivational gaps in the sample of students in terms of the ARCS model's dimensions of motivation; and 2) to identify and explore the dimension that is consistently low scoring over the three years.

5. Methodology

Over a three-year period, a survey instrument based on Keller's Course Interest Survey (CIS) was administered yearly to undergraduate tax students. The goal with the CIS instrument is to measure how motivated students are with respect to a particular course and not their general level of motivation towards learning (Keller, 2009).

The populations in each year were third-year students at a South African University registered in 2020, 2021 and 2022, thus resulting in three sets of data. The number of students registered every year respectively was 457 in 2020; 480 in 2021 and 412 in 2022. Response rates per year are 17.9%; 26.5% and 12.6%.

Principal component analysis was employed to identify the groupings of statements belonging to satisfaction, confidence, attention and relevance as dimensions of motivation and only the items per motivational dimension that had a factor loading higher than 0.5 were retained. In addition, a scale reliability test, the Cronbach Alpha, was also performed on each of the dimensions with the final grouping of statements as decided.

In this paper, mean values of the grouped statements in each of the datasets are used in the analysis. A thematic analysis was also employed, used to identify categories or factors of attention as motivational domain from student responses.

6. Results and discussion

A detailed view of the trend in students' motivation to engage with the online learning environment was done by comparing the mean scores in each of the dimensions of motivation over the three years. For 2022, we did not do a full survey and therefore do not have comparable scores for satisfaction and relevance. Figure 1 below shows the movement in the dimensions of motivation over the three years.

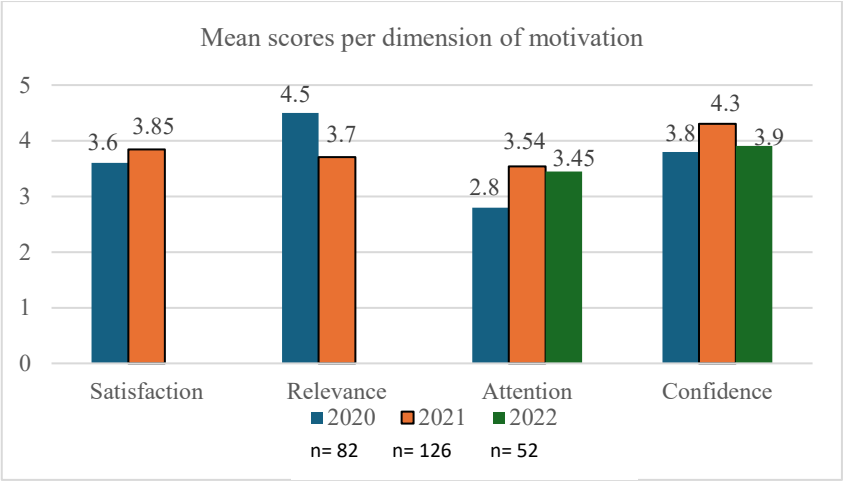


Figure 1. Trend in students' motivation per dimensions of motivation Source: Authors own display.

We expected that students would have felt more prepared to engage with online learning activities in the second year after the first year of emergency remote teaching and learning. Therefore, we anticipated students' confidence to have improved. Similarly, satisfaction with the experience of learning online, is also expected to show an upward trend, as lecturers should be more comfortable and prepared to present a lecture online compared to first year of crisis management in the sudden move to emergency remote teaching.

6.1. The gap in students' motivation

It is clear from Figure 1 that attention appears to be the dimension that is lacking most in all three of the populations surveyed. Although an improvement was seen in 2021, it dropped again slightly in 2022. The improvement signifies a more positive feeling of motivation and may indicate that students have found the online learning activities more interesting and stimulating in the second year of online learning. The importance of stimulating interest as a key factor in enhancing online learning was confirmed by both teachers and students in a study by Su, Xu, Zhang, Xin-yu, and Hao (2024).

Three statements measuring attention in our survey are:

- The lecturers knew how to make us feel enthusiastic about taxation
- I often felt bored during the online tax classes
- My curiosity was often stimulated by the questions asked or the assignments given for tax

The three elements of attention addressed in these questions, namely: enthusiasm; boredom; and curiosity are displayed in Figure 2 and the movement in the sentiment around enthusiasm, boredom and curiosity over the three years is illustrated.

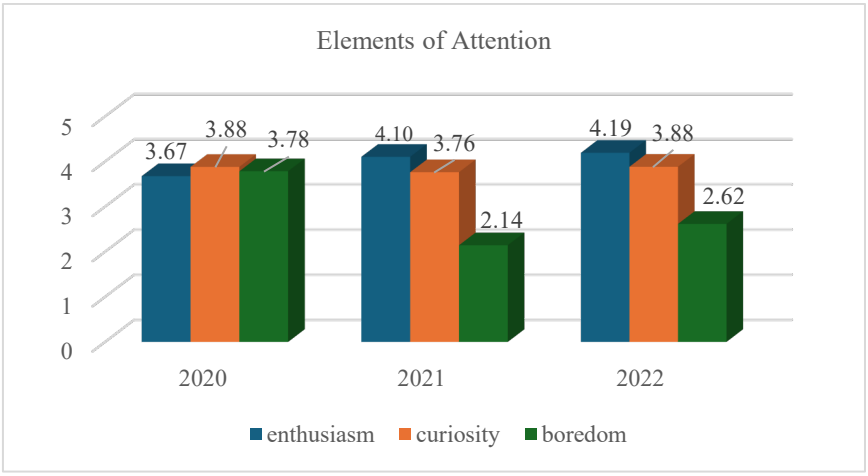


Figure 2. Trends in elements of attention. Source: Authors' own display.

From Figure 2 it can be seen that enthusiasm improved slightly each year, and curiosity remained relatively constant. Both elements indicate a positive sentiment, however the little movement in curiosity may be a concern. The sentiment around being bored, however, changed much from 2020 to 2022. A lower mean is a positive result, since the question were stated as "I often felt bored…". Therefore, in 2021, students appear to be more active and engaged in the online lectures and had less feelings of boredom.

We further analysed some open-ended responses to a question posed to students in 2022 asking them to provide a reason on why they enjoy a certain learning environment. We specifically looked for reasons which pertains to how learning in a certain environment impacted their attention. Before coding, we first consulted a number of other studies which addressed attention as dimension of motivation in student learning to consider other theoretical codes. These studies are presented below and additional codes or categories for attention are highlighted.

Studies by Xu, Zhang and Wang (2024) and Yan, Xiaohui and Yufei's (2023) confirm the vital role of attention in motivating students to participate in learning. Yan, et al. (2023) identified five attention sub-categories, namely "incongruity and conflict, concreteness, humor, inquiry

and participation" as elements of attention. Of these, humor of instructors and inquiry seemed less critical. Incongruity and conflict in this context refer to the conflict between real-world experience and theoretical classroom learning, while concreteness is explained as having well defined objectives in the programme.

Kim, et al. (2022, p.9) found that "a close relationship between an instructor and students is particularly important for enhancing students' learning motivation and sustained attention in the online learning context". A third study explored the influence of ergonomic factors on academic attention in distance learning (Gumasing, et al., 2023) and founds that cognitive and macro-ergonomic factors significantly affects students' academic attention. Cognitive factors are described as the process of designing and organizing the learning environment and includes to effectively communicate proper instructions, goals and expectations, similar to "concreteness" mentioned in the study of Kim, et al. (2022). Macro-ergonomics refers to organisational infrastructure such as the learning management system (LMS) and ease of access to technology and the internet.

Given the elements highlighted in the three studies above, we coded responses obtained from students in the third round of the survey on a question probing reasons for why they prefer a certain learning environment. We carefully considered each response to identify if the response pertained to 'attention' and if we could allocate codes that reflect any of the following elements: enthusiasm, boredom, curiosity, participation, humour, concreteness, incongruity, relationship, LMS, and easy internet access.

A total of 69 responses were analysed and assigned codes. Of these, 36 responses could be coded in the context of attention. The main categories found are 'participation' and 'curiosity', a few instances of 'boredom' and single responses coded with 'relationship' and 'enthusiasm'. A new code was also developed, named 'focus' and assigned to a few responses that indicated that the online environment afforded them an opportunity to engage with a lecture with no disturbances.

7. Conclusion

Our paper demonstrated that **attention** is a problematic element of student motivation and that it showed little improvement in student sentiment over the three year period in the populations of students surveyed. Further, with a thematic analysis, we identified participation, curiosity, focus, relationship and boredom as elements that could shape student attention. From the literature, a further few elements were identified, namely incongruity, concreteness and humour.

The relevance of the study lies in understanding the gaps in student motivation and to purposefully develop strategies to address those areas of motivation. It is important to stimulate curiosity, for example to use real life examples and interesting facts and then to maintain that

interest with encouraging participation in class, allowing time for activities to counter boredom, build good relationship with students and provide clear learning goals.

We acknowledge that low-class attendance typically could result in lower student perception scores and therefore may affect the results of this study. Future research in student motivation could also consider class attendance as a variable to investigate.

References

Ajzen, I. (1991). The Theory of Planned Behaviour. *Organizational Behavior and Human Decision Processes*, 50(2), 179-211.

Chiu, T.K., Lin, T.J. and Lonka, K., 2021. Motivating online learning: The challenges of COVID-19 and beyond. *The asia-pacific education researcher*, 30(3), pp.187-190.

Dhawan, S., 2020. Online learning: A panacea in the time of COVID-19 crisis. Journal of educational technology systems, 49(1), pp.5-22.

García-Morales, V.J., Garrido-Moreno, A. and Martín-Rojas, R., 2021. The transformation of higher education after the COVID disruption: Emerging challenges in an online learning scenario. *Frontiers in Psychology*, 12, 616059.

Gumasing, M.J.J., Dela Cruz, I.S.V., Piñon, D.A.A., Nicolaison, H., Rebong, M., and Sahagun, D.L.P. (2023). Ergonomic Factors Affecting the Learning Motivation and Academic Attention of SHS Students in Distance Learning. *Sustainability,* 15(9202), 1-20. https://doi.org/10.3390/su15129202

Harvard Task Force (2022). Report of the Harvard Future of Teaching and Learning Task Force. Reimagining the Classroom, Enriching Content, and Expanding the Harvard Community. Retrieved from: https://ftltaskforce.harvard.edu/files/future-teaching-learning/files/harvard_ftl_final_3.8.22_2.pdf

Hermanto, Y.B. and Srimulyani, V.A., 2021. The challenges of online learning during the covid-19 pandemic. Jurnal Pendidikan Dan Pengajaran, 54(1), pp.46-57.

Hutchings, N. (2010). Increasing student motivation and attention using computer game development within a cooperative learning setting. *Journal of the Queensland Society for Information Technology in Education*, 11(3), 24-7.

Karyadi, P. A., & Paristiowati, M. (2024). Evaluating Learning Motivation: An Analysis of Students' Engagement in Online Learning Environments. *Journal of Educational Management and Learning*, *2*(1), 44-49.

Keller, J., & Suzuki, K. (2004). Learner motivation and e-learning design: A multinationally validated process. *Journal of educational Media*, 29(3), 229-239.

Keller, J.M. (2008). First principles of motivation to learn and e3-learning. *Distance Education*, *29*(2), 175-185. https://doi.org/10.1080/01587910802154970

Keller, J.M. (2009). *Motivational design for learning and performance: The ARCS model approach*. Springer Science & Business Media.

Keller, J.M. (2016). Motivation, Learning, and Technology: Applying the ARCS-V Motivation Model. *Participatory Educational Research, 3*(2), 1-13.

Kim, M., Knotts, T.L., Albers, N.D. & James, K.E. (2022). Emoji Use as a Catalyst for Relationship Building and Sustaining Attention in Online Classes: An Empirical Study. *Education Sciences.* 12(874), 1-14. https://doi.org/10.3390/educsci12120874

Maran, T. U., Tanggur, F. S., & Bulu, V. R. (2024). Innovative teacher reinforcement strategies to enhance student motivation in online learning. *Journal of Innovative Technologies in Learning and Education*, *1*(1), 36-45.

Ozdil, E., McDonald-Kerr, L., Tharapos M., Khosa, A., Burch, S. (2025). Accounting students' motivation during the COVID-19 pandemic: A self-determination theory perspective. *Accounting & Finance*, 00: 1-21. DOI: 10.1111/acfi.13403

Ryan, R.M., & Deci, E.L. (2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology*, 25(1), 54-67.

Su, Y., Xu, X., Zhang, Y., Xin-yu, X., & Hao, S. (2024). Looking back to move forward: comparison of instructors' and undergraduates' retrospection on the effectiveness of online learning using the nine-outcome influencing factors. *Humanities and Social Sciences Communications*, 11(1). https://doi.org/10.1057/s41599-024-03097-z

Unesco. (2021). Closing now to reopen better tomorrow? Pedagogical continuity in Latin American Universities during the pandemic. UNESCO International Institute for Higher Education in Latin America and the Caribbean (IESALC). Retrieved from https://www.iesalc.unesco.org/en/2021/07/12/closing-now-to-reopen-better-tomorrow-pedagogical-continuity-in-latin-american-universities-during-the-pandemic/. Accessed October 5, 2021

Vo, H. & Ho, H. (2024). Online learning environment and student engagement: the mediating role of expectancy and task value beliefs. *The Australian Educational Researcher*, 51, 2183–2207 https://doi.org/10.1007/s13384-024-00689-1

Xu, W., Zhang, N., & Wang, M. (2023). The impact of interaction on continuous use in online learning platforms: a metaverse perspective. Internet Research, 34(1), 79-106. https://doi.org/10.1108/intr-08-2022-0600

Yan, G., Xiaohui, S., and Yufei, J. (2023). Exploring Chinese College Students' Motivations to Participate in Cross-Border E-Commerce Skill Training. *Journal of Higher Education Theory and Practice* Vol. 23(10), 30-38

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Preparing pre-service teachers for e-learning - case study

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Abstract

The rapid integration of ICT in education, accelerated by the COVID-19 pandemic, has exposed gaps in teachers' digital competencies. Despite existing e-learning platforms, many educators struggle with online pedagogy. This study examines pre-service teacher education, emphasizing the need for comprehensive training in digital competencies, technology integration, and online learning design. Focusing on the Electronic Educational Environments (EEE) MA-level course at the University of Zagreb, 37 student-developed courses (2022–2025) were analyzed. Findings show a shift toward student-centered online interactions, a decrease in recorded lectures, and an increased workload in planned courses. Future teachers balance digital and traditional methods, resisting unnecessary digitalization. The study underscores the importance of embedding digital competencies throughout teacher education curricula. By applying structured learning design principles, pre-service teachers can create effective learning environments, ensuring readiness for the evolving demands of modern education.

Keywords: *pre-service teacher education; learning design; digital competencies, online pedagogy.*

1. Introduction

The rapid advancement of ICT and its integration into different sectors and institutions due to digital transformation inevitably influence the educational environment. Although most universities implemented e-learning platforms years and even decades(s) ago and developed blended learning courses and programs, even before the crisis generated by COVID-19, the teaching staff experienced difficulties in using these platforms and in creating and adapting the course content, as it needed to be quickly adapted to a fast-evolving and complex situation. A review of the literature reveals numerous studies on student satisfaction and attitudes toward digital education, as well as teachers' perspectives on their preparedness for a digital educational environment during formal training. This research is scattered across different scientific fields,

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as people are challenged to adapt education in their field to the demands of the digital environment. The main challenge most are struggling with is the need for teachers to update their existing knowledge of digital competencies. Similarly, discussions about the digital transformation of education in the EU have resulted in the Digital Competence Framework (Digicomp 2.2, 2022). This is not the only framework, and there are others, such as the ones proposed by UNESCO and ISTE. The evolving landscape of education demands that future teachers possess digital literacy skills, pedagogical knowledge related to e-learning, and the ability to navigate and harness the potential of educational technologies effectively "...teachers become the key element of imparting digital skills and are therefore required not only to possess these kinds of skills but also to have the necessary technological pedagogical knowledge to teach them" (Dolezal et al, 2025, p.1). The philosophy of a balanced learning design based on learning types and student-centred design was seen in the work of Divjak et al. They argue that the current use of digital technologies in higher education (HE) has not always been effective in supporting learning. (Divjak et al, 2022) They promote innovative pedagogies through the learning design concept and tool called BDP. By adopting a balanced approach, educators can leverage various instructional strategies and technologies to actively engage students, promote critical thinking, and facilitate knowledge construction. The conversational framework provides a structured framework for designing interactive and collaborative learning experiences, ensuring meaningful exchange between learners and content. Using these tools and methods in pre-service teacher education can help create successful teachers in a digital environment capable of responding to their students' educational needs.

2. Digital competencies of teachers

There is a common agreement between researchers and policymakers that digital competence is one of the basic skills that modern teaching staff should possess (Tomczyk & Fedeli, 2022), and that digital competence plays a pivotal role in modern education, serving as a foundational skill set for both teachers and students. (Momidjan et al, 2024) As stated by Zhang et al. (2023) and further explained by Dolezal et al. (2025), "a common thread in the literature on digital skills of teachers is that their digital competence should go beyond the mere use of digital technologies and towards the pedagogical usage of ICT — how educators teach is sometimes even more important than what they teach" (Dolezal et al, 2025, p. 2). Cabero-Almenara (Cabero-Almenara, 2021) identified that the basic-intermediate level of digital competences is no longer sufficient for complex environments. Pongsakdi et al. (2021) showed that educating teachers on developing digital competences lowers their negative perceptions of e-learning.

In our own research (Banek Zorica, 2022), we have observed that both students and teachers see advantages in the implementation of e-learning, but there is a lack of systematic support. From the teachers' perspective, the greatest obstacles are the lack of training to deliver education in an online environment, converting activities and content for use in e-learning, and

authentically assessing students' progress. Tomczyk found that experts in the field of pre-service education emphasise that the "key areas of digital competence today are e-learning and blended learning" and that "the new generations of teachers should be better prepared methodologically to implement this kind of educational form" (Tomczyk, 2024, 9). Velasco (2023) investigating the perspectives of student teachers regarding the effectiveness of their educational program and practicum in enhancing their digital teaching skills revealed that while some pre-service teachers felt confident in their ability to use digital tools, they were less confident in their ability to integrate these tools into teaching and learning processes. (Momdjian, 2024) Newly qualified teachers often do not develop sufficient digital competence to utilize the possibilities for integration, and to critically evaluate the use of digital technologies in the classroom (Gudmundsdottir & Hatlevik, 2018; Tondeur et al., 2018). (Andreasen et al, 2022) In relation to teacher education, Lund et al. (2014, according to Falloon 2020) comment on the unique challenges faced by teacher educators in developing a holistic view of digital competence in their students. They point out that teacher educators are required to educate their students on using present and emerging digital resources in their own professional practice, but also make them, "capable of using technology in productive ways" (Falloon, 2020, p.286).

3. Methodology

An active methodology was employed that combined theoretical instruction on major learning design models and frameworks, including the Balanced Design Planning (BDP) tool, Laurillard's Conversational Framework, and the Digital Competence Framework (DigCompEdu), with practical, hands-on course design and development tasks. Students were introduced to principles of constructive alignment, types of learning activities (acquisition, discussion, investigation, practice, production, assessment), and workload management based on ECTS standards. Students first created draft outlines for an original course using one design model of their choice and received formative feedback from instructors. Following feedback, students developed detailed course plans using the BDP online tool (https://learning-design.eu), specifying learning activities, types, workload estimates for both students and teachers, preferred delivery modes (online, offline, hybrid), collaboration expectations, feedback mechanisms, and assessment strategies. All 37 students enrolled in the Electronic Educational Environments (EEE) course at the MA level at FHSS (Faculty of Humanities and Social Sciences, University of Zagreb, Croatia) during the academic years 2022/23, 2023/24, and 2024/25 participated in this study. The sample consisted primarily of double-major students (approximately 70%), with a smaller proportion of single-major students (30%). Among the participants, 22 identified as female and 15 as male. All participants had at least 3 years of experience using the MOODLE LMS as students at the BA level. The EEE course marked their first teaching/creator experience within an online environment. In this study, we used a mix of quantitative and qualitative approaches through both statistical analysis and course content

analysis, in comparison to different design models. After the introduction of major learning design models and frameworks, each student had to design and develop their own courses guided by one of the design models of their choice. First, they had to prepare a rough draft of the course outline and obtain the initial feedback, after which they were supposed to develop those topics in more detail using the BDP online tool (https://learning-design.eu)[1], where they had to set what activities and of which activity learning type (acquisition, discussion, investigation, practice, production, and assessment) they were going to use, workload, preferred delivery method, whether it is a collaborative activity, who will provide feedback (teacher, automated, peer), and does it include assessment. This tool also provided them with an automatic analysis of their future course (learner workload, learning activity types, ECTS workload vs. course ECTS, constructive alignment, and so on). After the teacher's feedback and final adjustments, they could export their course plan and content as a MOODLE backup that could be imported into FHSS LMS called Omega, where they completed the course by uploading content and configuring activity settings. This sped up the process of course deployment and reaffirmed the notion of the value of using such pedagogical tools, enabling them to focus on pedagogy and fine-tune the activities to the intended goals. Data collection consisted of course content exported from MOODLE (number and types of activities and resources), analytic reports generated by the BDP tool, draft course plans submitted by students, peer evaluation done by other students, and student reflections collected through feedback.

4. Results and discussion

All courses were created in MOODLE LMS, which differentiates between activities and resources: Activity is something students use to interact with their peers or teachers, like forum, quiz, chat, usually it can be graded and/or given feedback for, while resources are used solely for presenting information, such as pages, files, links, and so on. The sample of courses had 37 courses in it (created by the same number of students) from the academic years 2022/23, 2023/24, and 2024/25, with activity totals and percentage ratios shown in Tables 1 and 2. We analysed the number of activities and resources on actual courses developed by future teachers, their BDP online tool analysis data including workload, and their draft plans (in which they stated their audience, goals, topics, and planned activities). For 19 courses in the last two academic years (2023/24 and 2024/25), we have data from BDP online tool analysis, while for 18 courses from academic year 2022/23, data are available only for some courses (because most of the students have removed their accounts and courses because they have graduated in the meantime). We opted to analyse those courses without the BDP analysis data.

Table 1. Number of activities

Acad. year	H5P	Glossary	Wiki	Quiz	Lesson	Assignment	Chat	Choice	Big Blue Button	Forum	Total
2024/25 total no.	23	1	2	24	1	43	2	5	27	46	174
2024/25 average	1.64	0.07	0.14	1.71	0.07	3.07	0.14	0.36	1.93	3.29	12.43
2023/24 total no.	3	4	0	4	0	11	0	2	5	10	39
2023/24 average	0.6	0.8	0	0.8	0	2.2	0	0.4	1	2	7.8
2022/23 total no.	6	0	2	33	14	52	1	10	48	34	200
2022/23 average	0.33	0.00	0.11	1.83	0.78	2.89	0.06	0.56	2.67	1.89	11.11
Total	**32**	**5**	**4**	**61**	**15**	**106**	**3**	**17**	**80**	**90**	**413**
Average	**0.86**	**0.14**	**0.11**	**1.65**	**0.41**	**2.86**	**0.08**	**0.46**	**2.16**	**2.43**	**11.16**

We can observe that, when analyzed on an annual basis (Table 3), there was an overall decrease in the percentage of activities from ac. year 2022/2023 to ac. year 2024/25 of 5.48% (49.75% to 44.27%). The largest drop in activity was in video lecture participation (BigBlueButton activity) from 48 to 27, which can also contribute to students' experience during emergency remote teaching from 2020 to early 2022 and the need at that time to record all the lectures and classes (in the actual educational context they were in) which they have mirrored in their design process and decisions on what type of activities are most suitable for their intended course. There was also a decrease in the number of lesson activities from 14 to just 1, but this student choice can be partly explained by a similar increase in the number of H5P interactive activities. There was a notable increase in the number of forum activities, from 34 to 46, mainly used not as a discussion tool but as an open assignment grading solution, providing all the course participants with insight into grading practices and feedback given to their peers.

Table 2 shows the resource totals and percentage ratios for these courses. While the percentage of activities decreased as stated before, there was an overall increase in the percentage of resources from ac. year 2022/23 to ac. year 2024/25 of 5.48% (50.25% to 55.73%). As shown in Table 3, the resource type with the largest number increase was text and media area (former label resource) from 38 to 67 (mainly used to explain to course participants what is expected of them in a certain section, even before they open the activities in question). There was also a moderate increase in the number of file resources, mainly at the expense of link resources (files

were uploaded to the LMS directly, not linked as an external resource). Decreases in numbers were notable for link (73 to 62), book (8 to 1), and page (42 to 35) resources. When compared for all courses, the percentage of resources versus activities stands at 52.91% vs. 48.38% and can be considered somewhat balanced, but given that some of the subject matters / topics covered by the future teachers were best covered with offline activities or a smaller number of more complex activities, we can say that those courses are using the technology to support underlying pedagogical models and goals that pre-service teachers have used to develop them.

Table 2. Number of resources

Acad. year	File	Map	Link	Book	Page	Text & media area	Total
2024/25 total no.	53	1	62	1	35	67	**219**
2024/25 average	3.79	0.07	4.43	0.07	2.50	4.79	**15.64**
2023/24 total no.	25	0	12	0	1	5	**43**
2023/24 average	5	0	2.4	0	0.2	1	**8.6**
2022/23 total no.	40	1	73	8	42	38	**202**
2022/23 average	2.22	0.06	4.06	0.44	2.33	2.11	**11.22**
Total	**118**	**2**	**147**	**9**	**78**	**110**	**464**
Average	**3.19**	**0.05**	**3.97**	**0.24**	**2.11**	**2.97**	**12.54**

Table 3. Total number of resources and activities, workload

Acad. year	Resources	Activities	Total res. and activities	Resource %	Activity %	Workload in hours
2024/25 average	15.64	12.43	28.07	55.73	44.27	24.89
2023/24 average	8.6	7.8	16.4	52.44	47.56	16.76
2022/23 average	11.22	11.11	22.33	50.25	49.75	-
Average	**12.54**	**11.16**	**23.70**	**52.91**	**48.38**	**20.83**

In their draft plans for course development, they stated their intended audience, and out of 37 courses, 23 were developed for higher education level, five for middle and three for elementary school, and six for life-long learning programs. The increased number of planned and created activities closely followed the complexity or higher level of education. Given all the plans,

workload, and topics, as well as the ratio of activities that could be used or delivered offline, it can be observed that future teachers have taken into consideration both the pedagogical needs of their intended audience while respecting their inevitable socio-economic state and educational context at present. It is also evident that there is present fatigue among students for using and designing fully online courses without explicit need or benefit, especially when it comes to the number of recorded video lectures they have planned in 2022/23 vs. 2024/25. While they all agree during the discussions on video-recorded lectures that those recordings have great impact and value when it comes to studying and revisiting some topics, when it comes to planning their own courses, they tend to record fewer video lecture activities than their colleagues a few years ago, as shown in the tables before.

5. Conclusion

The evaluation of the EEE course and the students' course outputs demonstrates the effectiveness of an active, design-based methodology in building digital pedagogical competence among pre-service teachers. Qualitative reflections highlighted that exposure to structured course planning frameworks improved students' attitudes toward the use of digital teaching tools, emphasizing greater confidence and intentionality in course design. These findings show that structured teacher education programs positively impact future educators' readiness to integrate technology into pedagogy. In summary, a balanced learning design approach that combines Laurillard's conversational framework, recognition of different learning types, and student-centered and active learning methodologies can enhance teaching and learning experiences in both physical and digital environments. However, findings indicate that systematic training in workload estimation, course alignment, and meaningful integration of technologies is crucial. Curricular reforms should therefore emphasize not just digital literacy, but also pedagogical strategies for e-learning, course design analytics, and evidence-based refinement of teaching practices. By doing so, we can ensure that future teachers are equipped to navigate the challenges and opportunities of the digital world, while delivering high-quality, context-sensitive education. Ultimately, integrating structured design methodologies in pre-service training can enhance future teachers' adaptability, technological confidence, and alignment of pedagogical goals with digital learning environments.

References

Andreasen, J. K., Tømte, C. E., Bergan, I., & Kovac, V. B. (2022). Professional digital competence in initial teacher education: An examination of differences in two cohorts of pre-service teachers. *Nordic Journal of Digital Literacy*, *17*(1), 61–74. https://doi.org/10.18261/njdl.17.1.5

Banek Zorica, M. (2022). DIGITOOLS project-users perspective on the current state of digital education. In *EDEN 2022 Research Workshop* (pp. 31-38).

Biggs, J. (2003). Aligning teaching for constructing learning. *Higher Education Academy*, 1-4.

Cabero-Almenara, J. G.-G.-P.-R. (2021). Digital competence of higher education professor according to DigCompEdu. Statistical research methods with ANOVA between fields of knowledge in different age ranges. Education and Information Technologies.

Divjak B, Grabar D, Svetec B, Vondra P. (2022). Balanced Learning Design Planning: Concept and Tool. J. inf. organ. sci. (Online) [Internet]. 2022 Dec. 22 [cited 2023 May 7];46(2). Available from: //jios.foi.hr/index.php/jios/article/view/1742

Dolezal, D., Motschnig, R., & Ambros, R. (2025). Pre-Service Teachers' Digital Competence: A Call for Action. Education Sciences, 15(2), 160. https://doi.org/10.3390/educsci15020160

Falloon, G. (2020). From digital literacy to digital competence: the teacher digital competency (TDC) framework. *Education Tech Research Dev* 68, 2449–2472. https://doi.org/10.1007/s11423-020-09767-4

Hansen, D., Laurillard, D., Murray, M., Fernandes, L., Gilleran, A., Rojas Ruiz, D., & Rutkauskiene, D. (2022). A pedagogical model for effective online teacher professional development—findings from the Teacher Academy initiative of the European Commission. *European Journal of Education*, 57, 142–159. https://doi.org/10.1111/ejed.12486

Kharade K, Peese H. (2014). Problem-Based Learning: A Promising Pathway for Empowering Pre-Service Teachers for ICT-Mediated Language Teaching. Policy Futures in Education (SAGE Publications). 2014 Jan;12(2):262-272.

Kulkarni, V., & Kukade, R. (2019). Problem-based learning approach for pre-service language teacher preparation for ICT-mediated teaching. Journal of Education for Teaching, 45(4), 471-473.

Laurillard, D. (1999). A conversational framework for individual learning applied to the 'learning organisation' and the 'learning society'. *Systems Research and Behavioral Science: The Official Journal of the International Federation for Systems Research*, *16*(2), 113-122.

Momdjian, L., Manegre, M. & Gutiérrez-Colón, M. (2024). Bridging the Digital Competence Gap: A Comparative Study of Preservice and In-Service Teachers in Lebanon Using the DigCompEdu Framework. Tech Know Learn. https://doi.org/10.1007/s10758-024-09794-7

Pongsakdi, N. K. (2021). The impact of digital pedagogy training on in-service teachers' attitudes towards digital technologies. Education and Information technologies, 26, 5041–5054

Starkey, L. (2019). A review of research exploring teacher preparation for the digital age. *Cambridge Journal of Education*, *50*(1), 37–56. https://doi.org/10.1080/0305764X.2019.1625867

Tomczyk, Ł. (2024). Digital competence among pre-service teachers: A global perspective on curriculum change as viewed by experts from 33 countries. Evaluation and Program Planning. 105. 2024 https://doi.org/10.1016/j.evalprogplan.2024.102449

Tomczyk, Ł., & Fedeli, L. (Eds.). (2022). *Digital literacy for teachers*. Springer. https://doi.org/10.1007/978-981-19-1738-7

Vuorikari, R., Kluzer, S., & Punie, Y. (2022). *DigComp 2.2: The digital competence framework for citizens – With new examples of knowledge, skills and attitudes* (EUR 31006 EN). Publications Office of the European Union. https://doi.org/10.2760/115376

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Evaluating Practicum Performance in ELT: Multi-Stakeholder Perspectives and Implications for Teacher Development

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Abstract

Teaching practicum and its evaluation in language teacher education programs is a complex and multi-faceted phenomenon. This study investigated multiple perspectives on performance evaluation during the teaching practicum in an English Language Teacher Training Program by examining perspectives of university supervisors, cooperating teachers, peers, and the student teachers themselves. Utilizing a 45-item observation checklist and a combination of quantitative and qualitative analyses, findings revealed significant variance in evaluations across groups, with cooperating teachers providing the highest ratings. Interviews and group discussions highlight that while the checklist aids structured assessment, modifications are needed to accommodate diverse teaching contexts. Peer assessment and self-assessment were valued for fostering professional growth, though concerns about objectivity arose when linked to grading. The study suggests refining assessment tools, promoting reflective practices, and training evaluators to improve practicum experiences and support future teachers' development.

Keywords: *Teaching Practicum; English Language Teaching (ELT); Teacher Development; Performance Evaluation.*

1. Introduction

The teaching practicum component of teacher education programs is a dynamic and intricate process involving a range of participants including student teachers, cooperating teachers, university supervisors, and students. Assessing the performance of teacher candidates during practicum presents a significant challenge, given the diverse range of factors and considerations involved in this experience. The primary purpose of this study is to examine the diverse perspectives on performance evaluation within the teaching practicum, as viewed by various stakeholders: student teachers, their peers, mentor teachers, and university supervisors. Specifically, this research aims to identify the extent to which these groups perceive and value

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performance evaluation differently. Additionally, the study seeks to explore student teachers' attitudes toward the observation and evaluation of teaching practices, as well as their views on self-assessment and peer assessment. By investigating these perspectives, the study intends to provide a comprehensive understanding of the evaluative practices in the practicum context and highlight areas for potential improvement in teacher education programs.

The literature identified several approaches to practicum assessment, each highlighting distinct aspects of teaching competencies. Subedi (2009) emphasized a comprehensive approach, including elements such as planning, preparation, classroom presentation, classroom management, communication skills, and evaluative techniques. The use of documentation portfolios was another established method, which allows for a reflective and longitudinal view of student teachers' development, as discussed by researchers like Goodman et al. (1989), Ryan and Kuhs (1993), and others (Shannon, 1994; Naizer, 1997; Gelinas, 1998; Rakow, 1999; Meeus et al., 2009). Additionally, Al-Mutawa and Al-Dabbous (1997) proposed an evaluation framework focusing on personal qualities, linguistic knowledge, interpersonal skills, and planning and implementation abilities. Similarly, Brooker et al. (1998) underscored the importance of planning and preparation, communication, teaching for learning, classroom management, student assessment, and professionalism in practicum assessment. Chen et al. (2011) introduced the Assessing Quality Teaching Rubrics (AQTR), which assesses task design, task presentation, classroom management, and response to students as core competencies. Good and Weaver's (2003) Professional Education Personnel Evaluation (PEPE) approach emphasized preparation, instructional organization, student performance assessment, classroom management, fostering a positive learning environment, communication, and leadership skills. Lastly, Darling-Hammond et al. (2013) proposed a holistic model encompassing planning, instruction, assessment, reflection, and academic language as essential components of effective practicum assessment. This overview of practicum assessment approaches highlights the multifaceted nature of teaching evaluations, suggesting that a blend of these components may provide a more comprehensive evaluation framework for student teachers. Within a study in Turkish context, Merç (2015) highlighted that while effective planning and preparation are vital for enhancing student teachers' practicum experiences, the evaluation process often faces challenges such as inconsistent qualifications of cooperating teachers, the undervaluation of peer feedback, and the limitations of report writing as an assessment tool.

All in all, this study addresses a critical gap in the literature by integrating and comparing diverse stakeholder perspectives on practicum performance evaluation, an area often neglected in existing research by answering the following research question:

- How do university supervisors, cooperating teachers, peers, and the student teachers themselves evaluate the performance of pre-service EFL teachers within the teaching practicum component of a language teacher education program?

2. Methodology

2.1. Setting and Participants

The study was conducted within the English Language Teacher Training Program at Anadolu University Faculty of Education, Türkiye. The participants were 30 fourth-year students, who were required to complete a 14-week practicum at a state secondary school within a *Teaching Practice* course. The practicum involved a commitment of six class hours per week, during which student teachers were expected to conduct a minimum of six teaching sessions. In this practicum setting, three student teachers were assigned to work under the guidance of a cooperating teacher. The university supervisor, who also served as the primary researcher, visited the practicum school twice throughout the duration of the course to observe and evaluate the performance of the student teachers, ensuring adherence to pedagogical standards and providing constructive feedback.

2.2. Data Collection

For the purpose of assessing the performance of teacher candidates during their practicum, an observation checklist was used. The checklist consisted of 45 items, organized into five distinct categories. *Preparation* (four items) focused on the extent to which the teacher candidate was adequately prepared for the lesson, including aspects such as lesson planning and organization. *Presentation* (ten items) assessed the candidate's ability to deliver content clearly, engage students, and effectively use instructional materials. *Execution* (thirteen items) evaluated the actual implementation of the lesson, including the ability to manage classroom dynamics, implement teaching strategies, and adapt to students' needs. *Personal characteristics* (eight items) examined the teacher candidate's professional demeanor, confidence, and communication skills. Finally, *Teacher-student interaction* (ten items) focused on the candidate's ability to foster a positive and productive relationship with students, promoting an environment conducive to learning. The checklist utilized a Likert-type scale for ratings: 1 = *Unsatisfactory*, 2 = *Average*, 3 = *Above average*, and 4 = *Excellent*.

The procedure for the research involved the completion of the observation checklist for each teaching performance. The checklist was filled out by each stakeholder. While the university supervisor and cooperating teachers evaluated the student teachers' performance based on their professional expertise and observations of instructional practices, student teachers self-assessed their own performance, reflecting on their lesson delivery and classroom management. Peer student teachers, who observed each other's lesson, offered assessments based on collaborative observations.

Following each teaching performance, group discussions as feedback sessions were held to provide constructive evaluations and highlight areas for further development. Finally, semi-

structured interviews were carried out with the participants to gather insights into their experiences with the observation process. The interviews included open-ended questions such as "*Do you think the checklist is appropriate for observing student teachers' lessons?*", "*How do you feel about observing and evaluating yourself?*", and "*How do you feel about observing and evaluating your peers?*"

2.3 Data Analysis

The data analysis for this study was conducted using both quantitative and qualitative methods to ensure a comprehensive examination of the teaching performance evaluations. For the quantitative analysis, *descriptive statistics* were first used to summarize the overall ratings across the five categories of the observation checklist. This allowed for an initial overview of the performance trends for each student teacher. Additionally, *One-Way Analysis of Variance (ANOVA) for repeated measures* was employed to examine whether there were significant differences in the evaluations provided by the four groups of participants. This analysis helped us determine whether the ratings varied across different observer perspectives and provided insight into the consistency or divergence of evaluations within each category. For the qualitative aspect of the analysis, a *data-driven methodology* was utilized. Semi-structured interview responses and feedback from group discussions were analyzed through thematic coding to identify recurring patterns and themes.

3. Findings

3.1. Quantitative Data

The descriptive analysis, presented in Table 1, highlights mean ratings across different assessment categories, as evaluated by four groups: The *University supervisor* (US), *Cooperating teachers* (CT), *Self-evaluations by student teachers* (ST), and *Peer student teachers* (PT). Each group assessed the five categories in the checklist: preparation, presentation, execution, personal characteristics, teacher-student interaction.

Table 1. Descriptive Analysis

	US	CT	ST	PT
Preparation	3,32	3,68	3,47	3,57
Presentation	3,01	3,65	3,48	3,61
Execution	3,17	3,61	3,39	3,49
Personal Characteristics	3,18	3,75	3,45	3,55
Teacher/Student Interaction	3,28	3,70	3,57	3,64
Overall	3,17	3,66	3,47	3,57

As Table 1 shows, *Preparation* received the highest average score from *CTs* (3.68), while *USs* rated it at 3.32. *Presentation* was rated highest by *CTs* (3.65) and lowest by *USs* (3.01). *Execution* was given a different rating across groups, with *CTs* scoring it at 3.61, while *USs* rated it at 3.17. *Personal Characteristics* showed a high score from *CTs* (3.75) but a lower rating from *USs* (3.18). *Teacher-Student Interaction* scored highest with *CTs* (3.70), with all groups showing relatively high agreement except USs (3.28). For the *Overall* category, *CTs* rated highest (3.66), while *STs* scored it slightly lower (3.47), and USs rated the lowest (3.17). These results suggest that CTs generally provided the highest ratings across most categories, particularly in *Preparation* and *Presentation*, while USs the lowest ones in all categories.

A one-way ANOVA analysis was conducted to examine the statistical significance of differences between groups in each assessment category, revealing that all differences were statistically significant at the *0.05 level*. Specifically, significant results were found for *Overall* ($F(3,87)=11.311$, $p=.000$, *Preparation* ($F(3,87)=3.542$, $p=.018$, *Presentation* ($F(3,87)=17.515$, $p=.000$, *Execution* ($F(3,87)=6.513$, $p=.001$, *Personal Characteristics* ($F(3,87)=12.357$, $p=.000$), and *Teacher-Student Interaction* ($F(3,87)=7.084$, $p=.000$). These findings indicate significant variance in ratings among the evaluator groups across all categories, with the most substantial differences observed in *Presentation, Personal Characteristics,* and *Overall* scores.

Post hoc tests were conducted to further explore these differences, identifying specific pairs where differences were significant at the 0.05 level, with some exceptions. In the *Overall* category, no significant difference was observed between *CTs* and *PTs*, or between *STs* and *PTs*. For *Preparation*, non-significant differences were noted between *US* and *STs*, *US* and *PTs*, *CTs* and *PTs*, and *STs* and *PTs*. Similarly, in the *Presentation* category, no significant differences were found between *CTs* and *STs*, *CTs* and *PTs*, and *STs* and *PTs*. For *Execution*, non-significant differences were observed between *US* and *ST*, *CT* and *PT*, and *ST* and *PT*. In *Personal Characteristics*, only *STs* and *PTs* showed non-significant differences, while in *Teacher-Student Interaction*, no significant differences were found between *CTs* and *STs*, *CTs* and *PTs*, and *STs* and *PTs*. These results underscore a level of consistency in certain ratings between specific evaluator groups, particularly between self and peer evaluations, which generally exhibited fewer significant differences compared to ratings from the university supervisor or cooperating teachers

3.2. Qualitative Data

The qualitative data collected through interviews and group discussions revealed several insights into the use of the observation checklist and its impact on the practicum experience.

Effectiveness of the Checklist for Observation and Evaluation: Overall, participants found the checklist to be a useful tool for observing and evaluating student teachers' teaching performance. One participant noted that the checklist provided a clear structure for assessing

the essential components of a lesson, stating, "*The checklist gives us an idea about the components and specific features of a lesson. Each item is like a guideline to check*." Another participant reflected on how the checklist helped track their progress throughout the practicum, stating, "*I am even able to see my progress throughout the teaching practice, from the first lesson I delivered towards the end*." This suggests that the checklist was not only a valuable source of immediate feedback but also contributed to long-term professional growth and self-reflection.

Need for Modifications to the Checklist: While the checklist was deemed helpful, some participants felt that it required modifications to better accommodate the diverse nature of teaching. One concern raised was that the checklist did not fully capture the variations in lesson structure. For example, a participant pointed out that certain types of lessons, such as those focused on language games or grammar presentations, might not align well with the existing checklist categories: "*What if all my lesson is allocated to playing a language game? No presentation, more classroom management issues. Or, what if I present a new grammar point for the whole 40 minutes? No group work, no pair work…*" This suggests that the checklist might benefit from greater specification regarding different teaching contexts, such as language skills (e.g., grammar, vocabulary, writing) or lesson types.

Importance of Self-Assessment for Awareness: Participants emphasized the importance of self-assessment in fostering greater awareness of their teaching practices. One participant shared that reviewing the checklist immediately after the lesson allowed them to reflect on their teaching, noting, "*When I look at the checklist just after I finish my lesson, I'm able to recall what happened there, and it's a good tool for reflection*." Self-assessment not only helped participants identify areas they had planned but failed to achieve but also facilitated personal insights into their teaching performance. For instance, one participant mentioned learning the significance of knowing students' names, as highlighted by the checklist item "*Teacher knows students' names," reflecting on the importance of addressing students by name rather than using generic references like "Yes, you, please*."

Value of Peer Assessment: Peer assessment was viewed as a valuable tool for professional development, although some participants expressed initial discomfort with the process. One participant remarked, "*Yeah, first, it was difficult to evaluate my friend, but I know that this is for her own development as a teacher. So, I was not very generous*." Despite this initial hesitation, participants acknowledged the importance of peer feedback in supporting mutual growth. However, concerns were raised regarding the use of peer assessment for grading purposes. As one participant noted, "*If it were for her grade to pass or fail, I wouldn't be, maybe, that much objective*." This suggests that while peer assessment is valuable for development, it may require careful consideration when tied to formal grading criteria.

4. Conclusions

Based on the findings of this study, several suggestions and implications can be made to enhance the observation and evaluation process during the teaching practicum, as well as to improve the overall practicum experience for student teachers.

First, it is essential to develop and use valid and reliable checklists for the observation and evaluation of student teachers' performance. These checklists should be comprehensive and aligned with the key teaching competencies, ensuring that they accurately capture the multifaceted nature of teaching. Regularly updating and refining these tools will enhance their effectiveness in guiding evaluations. Second, holding group discussions after each teaching performance, involving university supervisors, cooperating teachers, and student teachers, can be an effective way to reflect on the teaching experience. These discussions provide an opportunity for constructive feedback and foster a collaborative learning environment, promoting professional growth for all involved. Third, establishing clear norms or benchmarks for each evaluation criterion can help ensure consistency and objectivity in the assessment process. By identifying what constitutes satisfactory, above-average, and excellent performance for each category, evaluators will be better equipped to provide targeted and meaningful feedback. Fourth, it is crucial to teach student teachers the importance of self-assessment as a tool for personal and professional development. Encouraging reflective practices can help student teachers identify their strengths and areas for improvement, leading to more intentional growth as educators. Fifth, teaching student teachers the value of peer-assessment can foster a sense of accountability and mutual support within the learning community. Peer feedback can offer alternative perspectives on teaching practices and can be particularly useful in enhancing collaborative learning environments. Sixth, providing training for cooperating teachers on how to effectively observe and evaluate student teachers' teaching can improve the quality of feedback provided during the practicum. A well-trained cooperating teacher is better equipped to give constructive, specific, and actionable feedback that supports the development of the student teacher. Seventh, shifting the focus from predominantly quantitative evaluation to a more qualitative approach will provide richer, more nuanced insights into a student teacher's performance. Qualitative feedback allows for the capture of complex aspects of teaching, such as student engagement, classroom atmosphere, and the ability to adapt to dynamic classroom situations. Finally, creating a less stressful teaching practicum experience will benefit both student teachers and evaluators. Reducing unnecessary pressure can foster a more supportive and productive learning environment, where student teachers feel empowered to experiment with new teaching strategies and reflect openly on their growth.

The above-mentioned suggestions, if implemented, have the potential to enhance the effectiveness of the practicum process, support the professional development of future educators, and ultimately contribute to the improvement of teaching practices in the classroom.

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References

Al-Mutawa, N., & Al-Dabbous, J. (1997). Evaluation of student-teachers' performance in TEFL practicum at Kuwait University. *Journal of the Educational Research Center, 6*(11), 27–48.

Brooker, R., Muller, R., Mylonas, A., & Hansford, B. (1998). Improving the assessment of practice teaching: A criteria and standards framework. *Assessment & Evaluation in Higher Education, 23*(1), 5–24. https://doi.org/10.1080/0260293980230101

Chen, W., Hendricks, K., & Archibald, K. (2011). Assessing pre-service teachers' quality teaching practices. *Educational Research and Evaluation: An International Journal on Theory and Practice, 17*(1), 13–32. https://doi.org/10.1080/13803611.2011.578008

Darling-Hammond, L., Newton, S. P., & Wei, R. C. (2013). Developing and assessing beginning teacher effectiveness: The potential of performance assessments. *Educational Assessment, Evaluation and Accountability, 25*(3), 179–204. https://doi.org/10.1007/s11092-013-9163-0

Good, J. M., & Weaver, A. (2003). Evaluation of preservice teachers' internships: A model to encourage career continuity and program reform. *Journal of Personnel Evaluation in Education, 17*(3), 263–275. https://doi.org/10.1007/s11092-005-2983-9

Goodman, K., Goodman, Y., & Hood, W. (1989). *The whole language evaluation handbook*. Heinemann.

Gelinas, A. M. (1998). *Issues of reliability and validity in using portfolio assessment to measure foreign language teacher performance* (Unpubl. doctoral diss.). The Ohio State University.

Meeus, W., Van Petegem, P., & Engels, N. (2009). Validity and reliability of portfolio assessment in pre-service teacher education. *Assessment & Evaluation in Higher Education, 34*(4), 401–413. https://doi.org/10.1080/02602930802062659

Merç, A. (2015). Assessing the performance in EFL teaching practicum: Student teachers' views. *International Journal of Higher Education, 4*(2), 44–56. https://doi.org/10.5430/ijhe.v4n2p44

Naizer, G. L. (1997). Validity and reliability issues of performance-portfolio assessment. *Action in Teacher Education, 18*(4), 1–9. https://doi.org/10.1080/01626620.1997.10463359

Rakow, S. J. (1999). Involving classroom teachers in the assessment of preservice intern portfolios. *Action in Teacher Education, 21*(1), 108–115. https://doi.org/10.1080/01626620.1999.10462951

Ryan, J. M., & Kuhs, T. M. (1993). Assessment of preservice teachers and the use of portfolios. *Theory into Practice, 32*(2), 75–81. https://doi.org/10.1080/00405849309543578

Shannon, D. M. (1994, July 10–15). *An evaluation approach for the development of preservice teachers* [Conference presentation]. Annual Meeting of CREATE (Center for Research on Educational Accountability and Teacher Evaluation) National Evaluation Institute, Gatlinburg, TN, United States.

Subedi, D. (2009). Assessing English language teaching student teachers on teaching practice. Journal of NELTA, 14(1), 138–145Bloom, B. S. (1956). *Taxonomy of Educational Objectives*. David McKay.

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Industry Partnered Learning: A strategy to enhance STEM student employability and career development

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Abstract

This paper outlines an approach by the STEM College, RMIT University to enhance student employability and long-term career outcomes by embedding Industry Partnered Learning (IPL) across STEM degrees. Through a curriculum mapping exercise led by the Learning, Teaching & Quality Portfolio in the STEM College, we identified gaps in integrating career development, employability skills and industry engagement throughout these degrees. To address this, we developed STEM IPL Standards aligned with institutional principles, providing a structured framework for embedding industry engagement and professional connections within curricula. The outcomes highlight the importance of a whole-of-program approach to career development, moving beyond late-stage WIL experiences to create more scaffolded development for students. This structured approach provides a model for colleges seeking to better prepare students for their future careers through IPL-related curriculum innovation.

Keywords: *Industry Partnered Learning; Career Development Learning; Industry Embedded Activities; Work-Integrated Learning; Graduate employability*

1. Introduction

Efforts to enhance graduate employability and long-term career outcomes have driven the global adoption of work-integrated learning (WIL) across institutional and disciplinary contexts. Vocationally aligned degrees, such as nursing and teaching, have long embedded industry placements and internships as integral components. Contrastingly, disciplines such as arts and science, while fostering valuable generic skills, have often provided less clearly defined pathways to employment after graduation (Palmer et al., 2018). To address this, WIL initiatives have expanded to include internships, placements, research projects, and field trips (Kaider et al., 2017), with evidence of their benefits in boosting student engagement, academic success (Trede, 2012), graduate employability (Jackson & Cook, 2023), and skills development

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(Jackson, 2013). Despite such evidence, WIL remains predominantly confined to the later stages of degree programs, such as capstone courses and final-year placements. What is often missing is a holistic approach to integrate career development, employability skills, and industry-engaged activities across degrees.

In response to both national (Social Research Centre, 2020) and institutional data showing a lack of career readiness and low graduate employability in areas of Computing, and Natural and Physical Sciences, RMIT University implemented the Industry Partnered Learning (IPL) framework in 2021. The framework aligns with the Australian Government's Job-Ready Graduates Package and National Priorities (Australian Government, 2020) and strengthens the Government and tertiary sector focus on graduate employability.

This paper outlines the approach the Learning, Teaching & Quality (LTQ) Portfolio in the STEM College undertook to scaffold IPL in their undergraduate Science and Computing programs. The LTQ Portfolio provides support in designing and delivering strategic learning and teaching initiatives, drawing on expertise from third space professionals such as learning specialists, learning designers, and quality teams. The Scaffolded IPL Project aims to determine the extent to which its STEM curricula embed industry experiences and connect learners with industry and professional communities. The project had four main objectives:

1. Map IPL activities across programs and identify IPL gaps in curricula
2. Set STEM IPL Standards to guide expectations of IPL activities in programs
3. Support Program Managers and teaching teams to gain a solid understanding of IPL
4. Embed scaffolded IPL activities in all STEM undergraduate programs.

2. Background

2.1. What is IPL?

IPL embeds industry engagement and professional connections into curricula, meeting RMIT's promise of authentic, industry-ready pedagogy. The University's IPL framework provides high-level principles to be interpreted and implemented within College programs. Developed with industry input, the IPL framework is grounded in contemporary theories of experiential learning (Kolb, 1984), the 'learning view' (Campbell et al., 2021), and service learning (Hickey, 2016), bridging discipline knowledge and skills with real-world practice. While IPL aligns with other WIL models that connect course and industry learning, such as cooperative education (Jackson & Cook, 2023) and apprenticeship programs (Hughes & Saieva, 2019), IPL is designed as a systemic, whole-of-course experience for students, connecting learning with career development and strengthening their employability skills. The IPL framework comprises three elements: Career Development Learning (CDL), Industry-Embedded Activities (IEA), and Work Integrated Learning (WIL) (Table 1).

Table 1. The three interconnected IPL elements (CDL, IEA, WIL) at RMIT University

Element	Descriptor	Examples
Career Development Learning (CDL)	CDL prepares students for career management and equips them to plan and make informed career decisions as they develop a professional identity. Students can better articulate their skills and knowledge to future employers.	Career planning and reflection Industry networking Professional identity development Mentorship opportunities
Industry Embedded Activities (IEA)	IEA embeds industry and community partner contributions into curriculum activities not independently warranting academic credit. When strategically integrated with CDL, these activities are credit-bearing outcomes.	Guest lectures, industry panels Industry co-designed assessments Hackathons, competitions Entrepreneurial activities Joint research projects
Work Integrated Learning (WIL)	WIL integrates practical, real-world work experiences into curricula, enhancing students' employability through discipline-specific industry experiences with targeted pre- and post-experience support. Students engage with real-world problems and collaborate directly with industry and community partners	Placements, internships Industry co-designed projects Simulated workplaces Capstone courses Online WIL via Industry Partnered Online Learning (IPOL) projects

RMIT's programs have structured curriculum blocks: a foundational first-year block (FYB), a major (primary focus study area), a minor (secondary focus study area), and a capstone. The IPL framework mandates one IPL experience in the FYB, two in a major and one in a minor.

2.2. IPL Principles in the RMIT Curriculum Architecture

Implementation of IPL at RMIT is guided by four principles (RMIT University, 2023a):

- **Integration:** IPL is embedded across all programs, scaffolding WIL, career development learning and industry/community connections throughout curricula.
- **Alignment:** IPL is fully integrated and contextualised within RMIT curricula, aligning with the University's Capabilities framework.
- **Employability-Focused:** Underpinned by data, IPL is designed to enhance students' employability, deepen their understanding of industry, inform career planning, and strengthen professional identities.
- **Applied and Equitable:** IPL ensures accessibility and equity, incorporating authentic, meaningful assessments.

3. Research methods

The study was grounded on RMIT institutional frameworks and strategies, including the College's Education Plan. The Plan identified IPL as a key priority to deepen students' understanding of their values and professional aspirations, refine their career identity, awareness and opportunities, and enhance their engagement with networks and industry. IPL was also framed contextually with the RMIT Capabilities: Ethical Global Citizens; Connected; Adaptive; Digitally Adept; Expert; Critically Engaged (RMIT University, 2023b).

An important part of the Scaffolded IPL project was the LTQ team's engagement and collaboration with the University's Education Portfolio and school leaders, together with course coordinators and academics at the teaching coalface. This process facilitated a bottom-up approach, as relevant educational leaders provided the context for program and course coordinators, and strong leadership and support to strengthen educator engagement to design and implement context-specific IPL in bespoke learning activities.

The Scaffolded IPL Project comprised two phases. Phase 1 included two parts: (i) Mapping of IPL in Science and Computing programs; (ii) Development of STEM IPL Standards based on the institutional principles. This paper reports on Phase 1 of the Scaffolded IPL Project.

Phase 2 of the IPL project, to be reported later, focuses on implementation of discipline-specific, capability development workshops for educators to review IPL mapping and address IPL gaps, evaluate their understanding of IPL, the strength of their industry connections and perceived challenges to the implementation of IPL in their programs.

3.1. IPL Mapping

The mapping of IPL activities across programs was a crucial first step in benchmarking industry engagement and identifying opportunities for enhancement. The mapping used CDL, IEA, and WIL descriptors (Table 1) to categorise and analyse the extent of IPL across five programs in the Schools of Science (SSCI) and Computing Technologies (SCT).

IPL mapping involved a comprehensive analysis of and course syllabi to identify explicit references to student career development and industry interactions. A systematic approach was used to the location and sequencing of IPL experiences in the first-year block, and in minors, majors and capstone courses. Key elements reviewed were course learning outcomes (CLOs), assessment tasks, and industry-partnered components (e.g. industry guest lectures, industry projects, placements and career planning activities). A framework, developed by LTQ, linking CDL-specific CLOs to RMIT's Graduate Capabilities (Table 2) was used to determine where CDL was taught, practiced and assessed across early, mid and late stages of a program.

Table 2. Framework linking CDL-specific Course Learning Outcomes and RMIT Capabilities (*Italicized*) across early mid and late stages of a program

Early (Introducing)	Mid (Reinforcing)	Late (Mastery)
Explore individual interests, motivations, and values related to career options and industry expectations *(Adaptive)*	Demonstrate awareness of career progression, industry trends and the evolving nature of work *(Critically Engaged)*	Articulate a clear professional identity, integrating feedback from peers, mentors, and industry *(Adaptive)*
Identify personal strengths, areas for growth and strategies for adapting to change and new opportunities *(Adaptive)*	Reflect on personal values, interests, align with professional practice opportunities and career paths *(Adaptive)*	Develop a career management plan that includes strategies for adaptability and lifelong learning *(Adaptive)*
Discover and connect with professional groups, networks, and associations relevant to career interests *(Connected)*	Actively engage with professional contacts, build connections in industry and community settings *(Connected)*	Develop strategies to strengthen, maintain industry and professional networks *(Connected)*
Investigate digital platforms and tools relevant to professional and enterprise opportunities in the field of study *(Digitally Adept)*	Apply digital skills in *workplace or simulated contexts*, integrating these with interpersonal and professional competencies *(Digitally Adept))*	Validate proficiency in using digital tools to solve complex problems, collaborate, communicate in professional settings *(Digitally Adept))*
Identify key skills, qualifications, and industry expectations related to the field of study *(Critically Engaged)*	Investigate employment landscapes, use insights to create a critically informed career plan *(Critically Engaged)*	Critically evaluate career options using self-awareness and industry insights *(Critically Engaged)*
Develop a plan for activities aligned with career goals and skills development *(Expert)*	Use reflection to refine career goals based on professional experiences *(Expert)*	Assess advanced professional skills, aligning expertise with career goals *(Expert)*

The type and sequencing of IPL experiences in a program were then classified based on their location (early, mid, or late stages) and the nature of the IPL (CDL, IEA WIL). This mapping generated an 'IPL program map', highlighting both strengths and gaps for further review and remediation. Particular attention was given to the extent of structured scaffolding that provides students with engagement with industry at multiple points in their program. Insights gained through the mapping informed part (ii) of the project: the IPL STEM Standards.

3.2. IPL Standards

To operationalise the IPL Principles, the STEM IPL Standards were designed to provide structured guidance for implementation and application by program teaching teams. Development of the Standards was iterative and collaborative, underpinned by contextual education research (Dean et al., 2022) and best practices in employability skill development (Jackson, 2015). Initial drafts were developed, incorporating insights and feedback at multiple

stages from academic colleagues and curriculum leaders across the STEM College, allowing for progressive refinement before educators to consider. For practical application, an exemplar IPL-embedded Biotechnology program was used as a model for educators, illustrating how discipline-specific learning activities can authentically meet the STEM IPL Standards.

4. Results and Discussion

4.1. IPL Mapping

Mapping of IPL in the SSCI (85 courses) and SCT (28 courses) revealed strengths and areas requiring development. While both Schools had implemented early-stage CDL, together with reflective assessments, and IEA, they differed in how IPL was distributed across programs.

For the SSCI, IPL activities were concentrated in later stages of programs, typically through capstones or final-year WIL experiences. However, there was a lack of mid-stage CDL & IEA strengthening (together with associated assessments), both of which are crucial for progressive skill development and industry exposure before students undertake their final year.

Programs in the SCT included early-stage IPL activities, connecting students with industry early in their programs. However, later-stage IPL experiences, particularly those focusing on mastery and professional readiness, were less developed. While capstone projects exist, WIL delivery varied across programs; some offered robust, structured WIL experiences with strong industry engagement, while others had few or no WIL opportunities embedded. This inconsistency underscores the need for enhanced industry engagement initiatives to ensure all students are adequately prepared for complex, real-world professional challenges.

For both Schools, IPL was absent in certain minors and the lack of explicit integration of CDL into Course Learning Outcomes (CLOs) meant it was absent in some assessment activities. While some IEA was identified in early and mid-stages of programs, it was rarely assessed.

4.2. IPL Standards

The IPL Standards (Table 3) were structured to articulate expectations and provide guidance on how IPL activities can meet the Standards. The Standards provide criteria for embedding CDL, IEA, and WIL at early, mid, and late program stages, together with discipline-relevant examples of IPL activities, drawn from existing practice for adoption by educators.

Table 3. The STEM IPL Standards

#	Standard
1	IPL experiences are sustainable and meaningfully embedded across a Program
2	WIL activities are student-focused and authentic, providing students with opportunities to gain valuable professional experience and apply their learning in novel employment contexts
3	CDL is scaffolded at Early, Mid and Late stages of a program, in both disciplinary and interdisciplinary contexts
4	IPL activities [such as Industry Embedded Activities (IEA)] connect theory with practice to enhance students' professional identity and employability skills
5	IPL activities integrate, strengthen and assess future-focused RMIT Capabilities &technologies
6	IPL activities include co-curricular, career-related events contextual with curricula
7	IPL is co-designed with industry/community partners, using authentic pedagogical principles, including active learning
8	IPL is informed and refined by evidence and data from multiple sources
9	IPL activities are equitable and accessible to support diverse learners and support our culture
10	Assessment of IPL activities must be authentic, enhance students' higher-order thinking skills (such as reflection) and the application of knowledge and skills

As IPL practices evolve and further discussions take place in the next phase of the project, the STEM IPL Standards remain a living document, subject to ongoing refinement and application. Future iterations will incorporate structured validation with industry partners to ensure the Standards reflect evolving workforce needs, strengthen industry-university collaboration, and enhance student readiness for professional practice.

5. Conclusions and future work

This paper outlined the approach undertaken by the LTQ Portfolio to scaffold IPL across undergraduate programs. Systematic IPL mapping across SSCI and SCT identified strengths and areas for improvement, particularly the need for mid-stage IPL scaffolding and greater integration of CDL with specific CLOs and assessments. Leadership within Schools and LTQ support from third space professionals have been central to this process, facilitating implementation and reinforcing IPL as a core curricular component of programs.

To strengthen IPL integration, CLOs should be reviewed and aligned with the CDL framework, ensuring structured progression from early (Introducing CDL concepts), mid (Reinforcing and applying CDL skills) to late (Mastering CDL competencies) stages of learning. Additionally, assessment tasks should be refined to explicitly evaluate CDL outcomes, enabling students to demonstrate and articulate their industry-related learning to better align with professional expectations. Stronger integration of IEA with CDL, with contextual assessments, will enhance

students' industry connections, employability skills and ability to recognise and leverage industry-related learning and career progression.

Phase 2 of the project will focus on educator capability development through discipline-specific workshops to support staff in authentic IPL design and scaffolding, using the IPL Standards. We will also evaluate Program Managers' and teaching teams' understanding of IPL, and by capturing IPL activities embedded in STEM undergraduate programs, determine the project's impacts to refine IPL scaffolding. Finally, Phase 2 will provide insights into how the project meets industry and workforce needs, further informing future curriculum development.

References

Australian Government (2020) *National Priorities and Industry Linkage Fund: Final Report.* Department of Education, Skills and Employment. Downloaded on 31 January, 2025 at: NPILF Final Report - Department of Education, Australian Government

Campbell, M., Cooper, B., Smith, J., & Rueckert, C. (2021). The framing of employability policy and the design of work-integrated learning curriculum. In S. Ferns, A. D. Rowe, & K. E. Zegwaard (Eds.), *Advances in research, theory and practice in work-integrated learning: Enhancing employability for a sustainable future* (pp. 17-26). Routledge.

Dean, B. A., Ryan, S., Glover-Chambers, T., West, C., Eady, M. J., Yanamandram, V., Moroney, T., & O'Donnell, N. (2022). Career development learning in the curriculum: What is an academic's role?. *Journal of Teaching and Learning for Graduate Employability, 13*(1), 142-154. https://ojs.deakin.edu.au/index.php/jtlge/

Hickey, M. G. (Ed.). (2016). *Reflecting on service-learning in higher education: contemporary issues and perspectives*. Lanham, MD: Lexington Books.

Hughes, C. J., & Saieva, G. (2019). Degree apprenticeships – an opportunity for all?. *Higher Education, Skills and Work-Based Learning*, *9*(2), 225-236. https://doi.org/10.1108/HESWBL-10-2018-0113

Jackson, D. (2013). The contribution of work-integrated learning to undergraduate employability skill outcomes. *Asia-Pacific Journal of Cooperative Education, 14*(2), 99-115. https://ro.ecu.edu.au/ecuworks2013/19

Jackson, D. (2015). Employability skill development in work-integrated learning: Barriers and best practice. *Studies in Higher Education, 40*(2), 350-367. https://doi.org/10.1080/03075079.2013.842221

Jackson, D., & Cook, E. J. (2023). Benefits of work-integrated learning for students. In K. E. Zegwaard & T. Pretti (Eds.), *The international handbook of work-integrated learning* (pp. 93-112). Routledge. https://doi.org/10.4324/9781003156420-8

Kaider, F., Hains-Wesson, R., & Young, K. (2017). Practical typology of authentic work-integrated learning activities and assessments. *Asia-Pacific Journal of Cooperative Education*, *18*(2), 153-165.

Kolb, D. A. (David A. (1984). *Experiential learning: experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.

Palmer, S., Campbell, M., Johnson, E., & West, J. (2018). Occupational outcomes for Bachelor of Science graduates in Australia and implications for undergraduate science curricula. *Research in Science Education*, *48*, 989-1006. https://doi.org/10.1007/s11165-016-9595-x

RMIT University (2023a). *RMIT Industry Partnered Learning Framework*. Retrieved from https://tinyurl.com/5h58cuxx

RMIT University (2023b). *RMIT Capabilities.* Retrieved from https://tinyurl.com/3kxemjbu

Social Research Centre. (2020). 2020 Graduate Outcomes Survey National Report. Quality Indicators for Learning and Teaching. Retrieved ex https://www.qilt.edu.au/docs/default-source/default-document-library/2020-gos-national-report.pdf

Trede, F. (2012). The role of work-integrated learning to develop professionalism and professional identity. *Asia-Pacific Journal of Cooperative Education, 13*(3), 159-167.

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Evaluation of Learning and Teaching Centers in Turkish Higher Education in terms of Competencies Framework

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Abstract

This study aims to evaluate the learning-teaching centers in Türkiye through views of their directors and documents through a multidimensional framework, PROFXXI, based on contextualized understanding of institutional characteristics. Within the scope of the research, documents such as activity reports, annual evaluation reports, bulletins and policy documents openly published by centres or universities on their institutional web pages and interviews with directors of seven different centers have been analysed using qualitative content analysis. The findings reveal that Learning and Teaching Centers (LTCs) in Türkiye show substantial progress in instructor support, yet student support, technology integration, and evidence-based decision-making remain underdeveloped. Institutional differences affect engagement and structural maturity. To enhance impact, the study recommends establishing robust student feedback mechanisms, allocating dedicated staffing and budgeting for LTCs, and formally integrating these centers into institutional quality assurance and strategic planning processes.

Keywords: *Advancement of learning and teaching; quality education; education and teaching in higher education; centres for learning and teaching in higher education.*

1. Introduction

While the rise of the knowledge economy and globalization has positioned universities as key drivers of innovation and growth, emphasis shifted from teaching to research. Rankings and funding systems that prioritize research output reinforced this trend. However, teaching remains essential for shaping future generations, fostering critical thinking, and equipping students for a changing world. Today's rapid technological and societal changes have renewed focus on inclusive, student-centered teaching that meets diverse needs and prepares graduates for dynamic careers. This includes organizing teaching processes based on varying knowledge

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levels, student profiles, individual differences, and expectations (D'Andrea & Gosling, 2005). Learning and teaching centers which aim to promote effective teaching and learning practices are designed as institutional and professional learning communities. Sorcinelli's (2002) study has offered a foundational framework for creating and sustaining such centers, emphasizing their role in meeting faculty needs and enhancing education quality.

Developed in response to the growing need for systemic transformation of Learning and Teaching Centers (LTCs) in Latin America and the Caribbean, the PROF-XXI framework (Kloos et al., 2021) provides a foundation for evaluating LTCs in diverse higher education contexts such as Türkiye, where higher education has critically enlarged in the last couple of decades. A notable study examining learning and teaching centers through a competency framework (Pérez-Sanagustín et al., 2022) applied the PROF-XXI model during the COVID-19 pandemic to identify and develop key competencies, particularly in teacher support and technology for learning. Findings highlighted initiatives that enhanced faculty members' digital and pedagogical skills, fostering sustainable transformation. In Türkiye, Elçi and İşeri (2022) emphasized the importance of such centers for faculty development amidst digitalization and lifelong learning demands, while Akınlar and Kavgaoğlu (2024) explored how Ivy League centers contribute to quality education through various support mechanisms. The emergence of these centers in Turkey reflects growing efforts to align with global trends and improve teaching quality. However, existing studies are largely limited to document analysis. This study contributes to the literature by providing a multi-layered analysis of LTCs in Türkiye through the integration of document analysis and interview data. By applying the PROF-XXI framework, it offers a contextualized understanding of institutional strengths. It also informs policy by highlighting development areas and offering insights for institutional transformation. In this context, the aim of this research is to evaluate existing learning-teaching centers through faculty views and university documents, and to offer a multidimensional perspective by diversifying qualitative data. To reach this aim, this study seeks to answer the following research question: How do faculty perspectives and national-level documents reveal the effectiveness of LTCs in Türkiye, when analyzed through the lens of the PROF-XXI framework?

2. Method

2.1. Research Design

The research was designed as a qualitative case study by evaluating the LTCs through the opinions of the faculty members and documents to conduct an in-depth examination of the phenomenon and present a special case.

2.2. Sources of data

The higher education institutions selected as the study group have been determined by criterion sampling method, based on the primary condition of having an LTC available. Of a total of 209 universities in Turkey, 31 institutions have a center. Documents from the websites of centers whose directors were interviewed have been included in the analysis.

For the interview data, 7 faculty members from different universities who act as directors or heads of LTCs in universities have been included as participants, based on the criterion that they have knowledge, expertise and experience on the activities and policies of LTCs. In interview studies, the diversity, richness and depth of the language produced are essential rather than the number of participants. The participants consisted of four female and three male faculty, all specialized in the field of education.

2.3. Data Collection

As the first qualitative data collection tool, a semi-structured interview protocol for directors of centers was created based on the dimensions of the PROF-XXI framework, which are teacher support, student support, leadership, culture and transformation, technology for learning and evidence-based practices (Kloos, et al., 2021). The draft form for faculty members was reviewed by two experts, revised and finalized. Seven semi-structured interviews were conducted online and face to face in durations varying from 30-70 minutes. The audio recordings taken upon consent of the participants during the interviews were transcribed. Documents such as activity and annual reports published openly on the web pages of the centers included in the research have been subjected to qualitative content analysis.

2.4. Data analysis

The qualitative content analysis followed Strauss and Corbin's (2015) coding strategies, using open, axial, and selective coding to systematically examine university reports within the Prof XXI Competency Framework. This systematic approach ensured a rigorous, framework-driven analysis of teaching and learning centre activities, which resulted in the emergence of six themes as: multifaceted needs analysis, digitalization and innovation, faculty support and interaction, student support and engagement models, cultural transformation, and monitoring.

3. Findings

3.1. Multifaceted Needs Analysis

Effective identification of teaching and learning needs forms the foundation of strategic planning within LTCs, shaping their programs and long-term relevance. Centers use a multi-layered approach, combining tools such as institutional surveys to capture both explicit and

latent needs. As one participant explained, "We administered a needs assessment survey to all academic staff… the highest demand was for digital tools, particularly AI-related applications" (P1), while another emphasized the role of qualitative input: "We have mentors as part of our mentoring program; we rely on their feedback, …. and insights from benchmarking other universities, to shape our initiatives" (P2). Institutional reports echo this dual approach. At University M., it was noted that "training needs of academic staff were identified through regular feedback collection," and University Y. described using "data from mentoring sessions and institutional evaluation surveys" to inform planning. Planning was shaped not only by strategic goals but also by bottom-up engagement, as staff proactively sought discipline-specific training. As described by one participant, "Faculty members came to us and said, 'we want training as well.' Sometimes we notice that change has already begun within departments even before we launch a program" (P6). Another noted, "Some faculties are quite proactive -for instance, we developed a separate program specifically for the Faculty of Aviation because they had distinct needs and explicitly requested support" (P4). These assessments reveal not only functional skill gaps but also contextual and evolving academic needs. By triangulating institutional data, mentoring insights, and faculty-driven demands, LTCs position themselves as responsive and strategically aligned actors in educational development.

3.2. Digitalization and innovation

Digital transformation emerged as a central theme across all universities, with LTCs actively supporting faculty in adopting LMS platforms, MOOCs, and hybrid models, particularly during the emergency transition to distance learning. As one participant noted, "Right after the pandemic, there was an intense demand… things like how to conduct interactive digital learning, how to integrate courses into learning management systems, and how to manage distance education became very prominent" (P3). While AI integration varies, some institutions have adopted a demand-driven approach - surveying faculty needs and organizing hands-on workshops. "The highest demand was for digital tools, especially artificial intelligence. Before the spring semester, we held a course design workshop where we experimented with AI-based content creation" (P7). Institutional documents mirror these developments; for example, University E. noted that "guides and tutorial videos were prepared to assist both instructors and students in using online learning systems." Similarly, University S. reported that "hybrid research training workshops were conducted using virtual collaboration tools," highlighting the growing shift toward more advanced digital pedagogies. Overall, data reveal that this momentum has triggered some progress in adaptive learning and AI-based assessment.

3.3. Faculty support and interaction

Faculty development remains a core function of Learning and Teaching Centers (LTCs), typically encompassing pedagogical training, instructional design, academic orientation, and,

in some cases, faculty mentorship. For instance, at University H., "orientation programs and digital tool trainings were provided to support the pedagogical development of faculty members," while University M. reported that "instructors were offered observation-based feedback opportunities upon request, especially for active teaching strategies." In this regard, P1 similarly noted, "Many instructors said they had never received any training on assessment or active teaching strategies, so we emphasized these topics in our orientation programs." Adding to this, P5 reported that "faculties themselves acknowledged a lack of training in assessment methods, and even standard pedagogical techniques were perceived as innovative by many instructors." Document and interview data depict that despite these structured supports, innovative approaches such as AI-driven learning analytics, gamification, and inclusive education frameworks are still in a development process. These areas often rely on individual faculty initiative rather than being integrated into a system-wide strategy.

3.4. Student support and engagement models

While Learning and Teaching Centers (LTCs) prioritize faculty training, student-focused support mechanisms are generally less developed. Most institutions offer orientation programs covering academic writing, research skills, and ethics. For example, University A. noted that "workshops on academic writing and academic integrity were held to enhance undergraduate students' awareness of responsible scholarship." Some universities, such as University M., have also implemented peer mentoring programs, reporting that "student peer support systems and competence development modules were integrated into the learning platform." However, as illustrated by P4, such efforts often lack sustainability: "In 2022, I designed a peer support program… it was a very effective initiative, but we couldn't sustain it. Sustainability requires committed human resources and institutional ownership, … when key people change; the projects often fade out." In contrast, P2 has been able to offer a more institutionalized engagement model: "Our mentors convey what it means to be a member of University S. It's not just about knowledge, but a transfer of culture and belonging. Each mentor is responsible for about 20 students and follows up with them throughout the semester." Efforts to enhance digital literacy are evident through online modules and LMS guides, yet adaptive or AI-driven student support tools have not been widely adopted. Although psychosocial support has gained interest particularly after recent crises, initiatives such as well-being services and career counseling remain secondary in most universities, suggesting a need for more structured and proactive student-centered strategies.

3.5. Cultural transformation

The extent to which LTCs influence institutional leadership and transformation differs markedly across universities. In some cases, LTCs have been restructured to highlight a strategic emphasis on innovation and digital pedagogy, as reflected in the naming of units like the *Centre for Innovative Teaching and Learning and AI*. The inclusion of both public and foundation (private)

universities in the sample reveals varying levels of institutional autonomy, resource availability, and strategic visibility, which may influence how LTCs operate and evolve. The findings suggest that foundation universities, benefiting from relatively greater institutional resources and flexibility, tend to demonstrate more sustained faculty engagement and a more deeply embedded identity transformation within their Learning and Teaching Centers. At University O., it is stated that "Learning and Teaching Centers contribute directly to strategic decisions, especially in digital education and curriculum transformation." Similarly, University H. reported that "university-wide meetings with senior leadership and faculty were held to foster a culture of innovation in teaching." In line with this, P3 emphasized the strategic influence gained through alignment with accreditation processes: "The administration relies on us due to monitoring and accreditation processes. Quality assurance in teaching aligns perfectly with our scope. When we demonstrate impact, our leverage increases and we become more visible in strategic decision-making." P2 also highlighted cultural transmission from a student perspective: "Mentorship among students help transferring values, identity, and a sense of belonging". P6 also pointed to a growing sense of shared learning among faculty: "It's gradually becoming part of the culture. As our trainings become known, faculty begin sharing them with one another, and we start receiving requests from other departments. This is slowly building a culture of shared learning." Findings reflect how LTCs can contribute to cultural transformation at strategic, academic, and interpersonal levels, while pointing to the need for broader institutional commitment to fully integrate such practices across universities.

3.6. Monitoring

In several universities, sustainability of improvement in teaching and learning is subject to continuous evaluation through annual performance reports and academic development indicators, which were used to assess the long-term effectiveness and impact of training programs by including views of different stakeholders. University of E., for instance, reported that "student and instructor feedback mechanisms were established to evaluate teaching quality and continuously improve course design across academic units." P1 confirmed this approach through: "We conducted a follow-up study based on student feedback to evaluate our recent training. We observed whether active learning strategies and web 2.0 tools were used in courses." P2 similarly stressed responsiveness and improvement: "We try to evaluate all routine activities and one-on-one sessions. From orientation to mentoring, we collect feedback on effectiveness and impact; if some aspects are not working, we revise them based on student needs." In sum, these practices reflect a growing commitment to monitoring of quality performance through data-driven strategies that enhance teaching and learning processes.

4. Discussion and conclusion

The findings of this study highlight the significant role of LTCs in fostering faculty development and student learning through driving institutional transformation, integrating educational technology, and monitoring the sustainability of efforts. While LTCs have made notable progress in faculty training, digital learning adoption, and pedagogical innovation, their focus remains largely on teacher support, with student-centered initiatives and data-driven decision-making receiving comparatively less emphasis. Similarly, Forgie et al. (2018) describe how the role of LTCs often progresses from offering individualized support toward fostering teaching communities. This shift reflects a broader transformation in which LTCs gradually reposition themselves from service-oriented units to more strategically integrated structures.

While our findings indicate a growing commitment to improvement in LTCs, they are parallel with Kolomitro and Anstey's (2017) finding that most centers still focus primarily on participation and satisfaction data, with fewer evaluating changes in teaching practice or student learning outcomes. The integration of AI-driven learning analytics, adaptive assessment models, and personalized education strategies remains in its early stages, and institutional leadership varies in its engagement with LTCs as drivers of systemic change. As highlighted by Challis et al. (2009), LTCs need to evolve from peripheral support structures into strategic hubs for institutional learning. Additionally, their role in university governance should be reinforced, ensuring they contribute directly to policy formulation and institutional strategy. By embracing a more holistic and data-driven approach, LTCs can transition from being support units to key strategic entities, and from being local university-based organizations to internationally interacting organisms, shaping the future of higher education in a rapidly evolving digital landscape.

When considered in relation to the PROF-XXI framework, the findings suggest that the instructor support dimension has shown significant progress across institutions in Türkiye. However, the areas of student support, technology and evidence-based decision-making require further development to ensure a more balanced and comprehensive transformation in teaching and learning practices. These differences may not only stem from disparities in financial resources but also from variations in governance structures, institutional culture, and strategic priorities, all of which shape how Learning and Teaching Centers are positioned within universities. While this study is limited to the Turkish context and relies solely on qualitative data, future research could expand its scope by student evaluations and mixed-method studies to assess the effectiveness of LTCs. Cross-cultural comparative analyses could also offer valuable cross-contextual insights.

References

Akınlar, A., & Kavgaoğlu, D. (2024). An Investigation of Teaching and Learning Centers of Ivy League Universities in Terms of Their Contribution to Quality Higher Education. *Journal of Education for Life*, 38(3), 610–625. https://doi.org/10.33308/26674874.2024383781

Challis, D., Holt, D., & Palmer, S. (2009). Teaching and learning centres: Towards maturation. *Higher Education Research & Development*, 28(3), 371–383. https://doi.org/10.1080/07294360903067021

D'Andrea, V.-M., & Gosling, D. (2005). Introduction. In Improving teaching and learning: A whole institution approach (pp. 1-9). *Open University Press.*

Elçi, A.& İşeri, E. (2022). Türkiye'de öğretim elemanı mesleki gelişimi için öğrenme ve öğretme merkezleri: Yönetim ve örgüt yapısı. *Yükseköğretim Dergisi*, 12(2), 280–295. doi:10.2399/yod.21.734565

Forgie, S. E., Yonge, O., & Luth, W. (2018). The evolution of teaching and learning centres: From theory to practice. *The Canadian Journal for the Scholarship of Teaching and Learning*, 9(1). Retrieved from https://ir.lib.uwo.ca/cjsotl_rcacea/vol9/iss1/9

Kloos, C., Alario-Hoyos, C., Morales, M., Rocael, H., Jerez, O., Pérez-Sanagustín, M., ... & López, A. (2021). PROF-XXI: Teaching and Learning Centers to Support the 21st Century Professor. *2021 World Engineering Education Forum/Global Engineering Deans Council* (WEEF/GEDC), 447-454.

Kolomitro, K., & Anstey, L. M. (2017). A survey on evaluation practices in teaching and learning centres. *International Journal for Academic Development*, 22(3), 186–198. doi: 10.1080/1360144X.2017.1313162

Pérez-Sanagustín, M., Kotorov, I., Teixeira, A., Mansilla, F., Broisin, J., Alario-Hoyos, …Gonzalez Lopez, A. H. (2022). A competency framework for teaching and learning innovation centers for the 21st century: Anticipating the post-COVID-19 age. *Electronics*, 11(3) 413. https://doi.org/10.3390/electronics11030413

Sorcinelli, M. D. (2002). Ten principles of good practice in creating and sustaining teaching and learning centers. In A guide to faculty development: Practical advice, examples, and resources. Ed. by K. J. Gillespie & D.L. Robertson. Wiley & Sons, 9-23.

Strauss, A., & Corbin, J. (2015). Basics of qualitative research: Grounded theory procedures and techniques (4th ed.). *Sage Publications*, Inc.

https://yulearnt.yeditepe.edu.tr/sites/default/files/YU-LEARNT-2023-January-December-Annual-Report-Final-ENG.pdf

https://stl.hacettepe.edu.tr/en/publications/

https://ogem.atauni.edu.tr/izleme/

https://www.sabanciuniv.edu/tr/akademik/egitim-ve-kariyere-destek/bireysel-ve-akademik-gelisim-merkezi-bagem

https://mukemmeliyet.ogu.edu.tr/

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Enhancing Staff Satisfaction through E-Learning: A Humanistic Focus on Development in Higher Education

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Abstract

This study assesses e-learning initiatives' impact on staff satisfaction and development in a higher education setting using a mixed-method approach. Survey data from 39 participants reveal high engagement and satisfaction, with 44% studying weekly and 72% completing courses. Qualitative insights from interviews with four participants highlight personal and professional benefits but also identify time management challenges. Suggestions include creating learning communities and flexible learning requirements. The study also discusses the challenges of time management and balancing workload to improve employee engagement with e-learning platforms. Results emphasise the need for accessible e-learning platforms and continuous support to enhance staff development.

Keywords: *E-learning, Staff Development, Staff Satisfaction, Transnational Higher Education.*

1. Introduction

Staff satisfaction can be looked at from various perspectives. Morris and Ye (2024) emphasise the importance of adopting a humanistic approach by considering employees' voice to enhance satisfaction and retention. A key takeaway from their study is the intrinsic motivation plays a vital role in driving employee engagement and satisfaction. In the ever-evolving higher education, universities and colleges strive to stay at the forefront of innovation and excellence. Staff members value self-development programmes not only for personal improvement but also to remain competitive in the labour market and for potential promotions. Consequently, effective staff development programmes have become a critical influencing factor for staff satisfaction. This study employs a mixed-method approach to explore e-learning initiatives for staff development and satisfaction. Specifically, it combines quantitative data from a survey of 40 participants who have engaged in e-learning with qualitative insights from in-depth interviews with four of these participants.

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The study aims to:

- Assess the overall satisfaction of staff with e-learning initiatives in higher education.
- Identify specific factors in e-learning contributing to or detracting from staff satisfaction.

2. Literature Review

Technological advancements have enabled the learning environments to be extended from traditional in-house training to the possibilities of online learning. This shift to a technology-based approach provides flexible planning to enhance staff development and inspire students to take ownership of their education (Blackburn, 2015). Teaching staff as enablers must have the required skills so that students can be better coached and inspired. Digital mobility, in this case, highlighted by digital competency, has emerged to be a focusing part, which can also be utilised to be a tool to measure staff engagement and satisfaction (Shindina et al., 2024). As Artificial Intelligence (AI) continues to develop, the purpose for life-long learning seems to have a more focused direction as staff members should be equipped with more up-to-date skills for future challenges and unexpected rapid technology advancements.

Recent studies have demonstrated that e-learning can significantly enhance employee engagement and satisfaction by providing flexible, customised and interactive learning experiences. For instance, research has identified key factors such as accessibility, customisation, interactivity, and flexibility as crucial elements in fostering positive outcomes in e-learning. Additionally, a study on the impact of e-learning on employee satisfaction highlighted that technology, educational content, motivation, and attitude are significant variables influencing learning satisfaction (Navimipour & Zareie, 2015).

However, researchers have also reported the reoccurring challenges such as time conflicts, busy schedules, and workload negatively affecting motivation and engagement in staff development. The lack of flexibility in traditional training programmes has contributed to further frustration due to the added pressure, especially with some mandatory training and qualifications required for promotion and personal development. E-learning platforms, in this case, play an important role in bridging the gap. It has been proven to be a beneficial added initiative to support individual development, and the platforms provide a range of topics that staff need and should enhance. That said, the effectiveness of e-learning is hard to assess. For example, to what extent is the knowledge being transferred, is it fully grasped, and could it be applied in the daily work environment? It is rather difficult for programme managers to measure outcomes of e-learning, identify areas for improvement, and provide additional support where necessary.

3. Methodology

This study employs a mixed-method approach, combing quantitative and qualitative data collection methods for a comprehensive understanding of staff satisfaction with e-learning initiative. A structured questionnaire was designed and sent out to collect detailed insights among staff members who have been using an e-learning platform for two years at a transnational higher education provider. The university has distributed 100 e-learning accounts among staff members across all faculties and departments, ensuring EDI in this practice. The questionnaire covered accessibility, interactivity, content relevance and quality and overall satisfaction. 39 responses were collected, and four participants were invited to provide more in-depth feedback and elaborate on their experiences and perceptions on how e-learning has affected their developmental planning and satisfaction working at the institution through semi-structured interviews. All participants were assured of confidentiality and anonymised. There might have been selection bias as the volunteers might have more positive or negative experiences from the interviews. To address the bias, the study acknowledges the potential limitations of convenience sampling and suggests future research with broader participant pools.

4. Results and Findings

4.1. Survey Findings

The survey showed that 44% of respondents engaged with the e-learning platform on a weekly basis, 33% reported studying monthly, and 3% of participants engaged quarterly (Figure. 1). While 21% reported occasional use, it showed this initiative has been utilised among staff members.



Figure 1. Frequency of studying on the e-learning platform

72% of participants reported they have successfully completed a course, which shows a high commitment. On the contrary, 28% of respondents only browsed the platform and failed to

complete a course. This means that while the platform attracted interest, not all users were able to complete the courses they started.

The majority of the respondents found the content provided on the online courses were quite relevant. Specifically, 51% found the content very relevant to their professional development, while 46% reported it as relevant (Figure 2). Only 3% of participants were neutral on this point. This suggest that the platform's content was generally well-aligned with staff needs and interests.

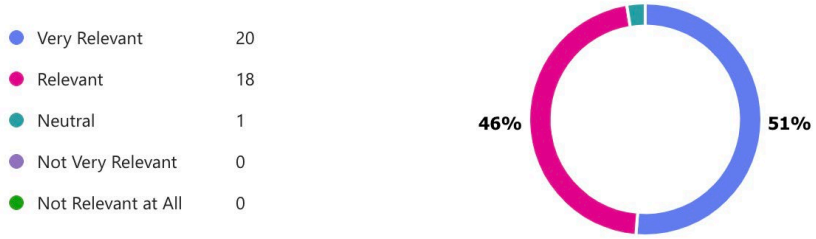


Figure 2. Relevance of the content provided on the e-learning platform

Overall satisfaction with the e-learning platform was also high. The survey found that 51% of respondents were very satisfied with their experience, and 44% were satisfied (Figure 3). A small percentage, 5%, reported neutral satisfaction levels. This shows that most users had a positive experience with the e-learning platform, which demonstrates the effectiveness in meeting staff development needs.

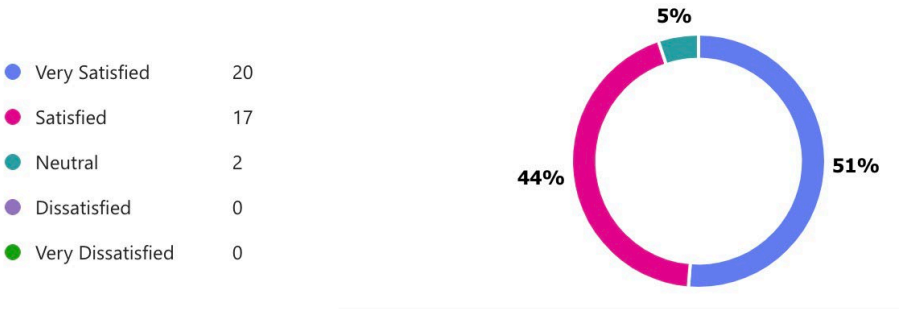


Figure 3. Satisfaction with the e-learning platform

4.2. Interview Findings

The interviews revealed that the e-learning platform significantly contributed to both personal and professional development. Participant 1 noted,

> *"The courses containing topics of brain and communication, which contribute to my personal interest in learning about brain functioning. The learning process prepares me for further exploration of communication strategies that can improve my work efficiency."*

In terms of professional development, they mentioned that they acquired leadership management skills and applied them to their team management through some leadership enhancement courses. Participant 2 emphasised the value of the platform for professional development, and said,

> *"This online platform keeps me up to date with new trends and tools to help me keep abreast of new developments and technologies in my area of work, especially improved my performance in a team through skillful communication and understanding the trending tech in data management."*

Participant 3 and 4 both found the platform inspirational and beneficial for preparing learning materials in teaching, as Pp 3 said,

> *"The platform has various resources, including pedagogical courses necessary for high quality teaching, research-related courses, e.g. programming in various software, which is necessary for high-quality research, and my field-specific courses that help me to learn how the modules are taught in other schools by other professors. I think it is invaluable platform for my professional development."*

Participant 4 also highlighted how much this e-learning initiative served as an added tool to developing pedagogical skills, noting,

> *"First, the university provides limited opportunities to develop our pedagogical skills, while the e-learning platform covers this gap. For instance, recently I completed a module on how to use AI in education. No such courses are provided by our university while it is essential. Similarly, I am now learning how to create chatBox without programming which is very useful knowledge for educators. Second, edX offers research-related modules, e.g. programming with Python or R. it helps to cover the gap in research-related knowledge/skills of academics. I believe the university must have this kind of learning platform. Also, let me mention that this platform offers flexibility - during the semester I tried to use if over the weekend, but not always I had free time so I could easily catch up during the winter and summer break when I spent more time on learning. So it provides a flexible personalised learning experience."*

Additionally, participant 1 highlighted the challenge of finding a fixed time weekly to engage with the platform, noting that,

> *Though I have an account, it is very difficult to find a fixed time weekly to take the course. After one or two weeks without learning the course, you need to retake the previous*

sessions again. This platform looks useful but really need time to focus on it. It is good if university can continuously provide the online resources, but it is still hard to balance the self-learning time with the tasks.

Participant 2 mentioned that, regarding study metrics, the platform does not track time spent on projects and assignments. The courses are very project-based, requiring several hours for weekly sessions on assignments outside the platform before submission. As the university requires a certain amount of time to ensure the utilisation of the resources, they argue that eliminating the minimum learning hours learning requirement should be considered as it is not a relevant criterion to evaluate the benefits of the online courses to the course participants. The online courses are utilised as inspirational sources and the heavy workloads of the academic staffs might not allow a regular learning schedule.

Participant 1 further proposed the establishment of a community that could meet monthly to discuss progress in online learning and recommend beneficial courses to improve the e-learning experience.

5. Discussion

The study's findings highlight the positive feedback the e-learning initiative brought to enhance staff development in higher education institutions. The results demonstrated high levels of engagement and satisfaction among staff members, as the online learning platform meets the professional and personal development needs. This aligns with previous research emphasising the importance of flexible and accessible learning opportunities in promoting job satisfaction and professional growth (Blackburn, 2015; Morris & Ye, 2024).

The interview participants then further reported the benefits for keeping them updated with new trends and technologies, improved communication and leadership skills, and the additional support valuable pedagogical and research-related courses. These insights underscore the intrinsic motivation of staff to engage in self-development activities and the e-learning creates a positive impact.

Despite the positive feedback, participants identified challenges such as time management and the need for more collaborative learning experiences. Participants suggested establishing a learning community and eliminating rigid learning hour requirements. The findings suggest that higher education institutions should prioritise flexible and accessible e-learning platforms, provide continuous support, and foster collaborative learning environments. Eliminating rigid requirements and adopting a more personalised approach can better accommodate staff needs and schedules, which in return, enhance overall satisfaction and development.

The use of convenience sampling in this study may have introduced bias, as participants who volunteered for the interviews might have had more positive or negative experiences. Future

research should consider broader participant pools across multiple institutions to improve the robustness and generalisability of findings.

6. Conclusion

The study's results indicate that the e-learning platform generally has a positive impact on staff satisfaction and development. The quantitative data demonstrate high levels of satisfaction and engagement, while the qualitative data provide rich insights into the platform's contributions to personal and professional growth. Participants' suggestions highlight the need for flexibility, continuous support, and community engagement to enhance the e-learning experience. By addressing identified challenges and implementing suggested improvements, institutions can further optimise their e-learning initiatives to support continuous professional growth in higher education.

References

Blackburn, G. (2015). Innovative eLearning: Technology shaping contemporary problem based learning: A cross-case analysis. *Journal of University Teaching & Learning Practice*, *12*(2), 5.

Morris, G., & Ye, J. (2024). Enhancing Higher Education Recruitment and Retention through Considering the Employee Voice. Editorial Universitat Politècnica de València. https://doi.org/10.4995/HEAd24.2024.17211

Navimipour, N. J., & Zareie, B. (2015). A model for assessing the impact of e-learning systems on employees' satisfaction. *Computers in Human Behavior*, *53*, 475-485.

Shindina, T., Mikhaylova, I., Knyazeva, N., & Usmanova, N. (2024, April). Assessment of Job Satisfaction of a University Teacher in the E-Learning System as a Tool for Managing the Development of Digital Competencies of Faculty Members. In *2024 7th International Conference on Information Technologies in Engineering Education (Inforino)* (pp. 1-7). IEEE.

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The Pathways to Entrepreneurship: How Identity Style Influence Entrepreneurial Identity Aspiration and Intention

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Abstract

The aim of this study is to investigate the mechanisms leading to entrepreneurship by examining how different identity styles influence entrepreneurial identity aspiration and intention. Specifically, the research seeks to understand the role of identity styles in shaping individuals' entrepreneurial aspirations and their intention to engage in entrepreneurial activities, thereby providing deeper insights into the processes underlying entrepreneurial decision-making. The results indicate that commitment ($r=0.387$, $p<0.01$) plays a crucial role in fostering entrepreneurial identity aspiration, which strongly predicts entrepreneurial intentions ($r=0.811$, $p<0.01$). The informational identity style ($r=0.309$, $p<0.01$) and normative identity style ($r=0.314$, $p<0.01$) positively correlate with entrepreneurial identity aspiration, while a diffuse-avoidant identity style ($r=0.053$, $p>0.05$) shows no significant association. Understanding these relationships can help design targeted interventions that strengthen entrepreneurial self-concept and decision-making processes. Although some styles may hinder constructive decision-making tactics, decision-making skills can be improved over a lifetime.

Keywords: *Entrepreneurial intention; entrepreneurial identity aspiration; identity style; commitment; business students.*

1. Introduction

The methodologies used so far in studying the future entrepreneur have changed over the years, as the entrepreneur's profile undergoes metamorphoses over time (Liñán & Rodríguez, 2004). Identifying the determinants of entrepreneurial intentions is a key problem in economic and entrepreneurship research (Turulja et al., 2020). Entrepreneurial identity may be the "missing link" in explaining the widely cited Ajzen (1991) model of entrepreneurial intention and an "important channel for the influence of antecedents identified in other models on entrepreneurial

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intention" (Celuch et al., 2017). Before starting a business, a young person must aspire to an entrepreneurial identity, thereby adopting its associated meanings and potential behaviors (Murnieks et al., 2014). To bridge the gap between their current self and their future self, individuals engage in activities that align their actions with long-term goals and strengthen their self-concept (Erikson, 1968; Marcia, 1980), as also recently explored by Pattnaik et al. (2024). The aspiration represents a crucial but underexplored motivational driver in the transition to actual entrepreneurship (Seibert et al., 2020).

2. Theoretical background

2.1. Entrepreneurial Self-Perception: Identity Asperation and Decision-Making

Entrepreneurial identity plays an important role in the connection between intention and behavior. A discrepancy between a person's current "self" and ideal "self" can create negative emotions, which in turn can lead to low self-efficacy and inaction (Tsou et al., 2023). Studies (e.g., Valencia, 2020) suggest that entrepreneurial identity is a key factor in starting a business, often even more important than entrepreneurial knowledge and skills. According to Monereo (2017), individuals who strengthen their self-perception as entrepreneurs continuously engage in internal dialogue and self-reflection on their self-concepts, such as “I-as-Leader,” “I-as-Innovator,” or “I-as-Owner” etc. Before making a decision, various options and roles are actively explored, while 'commitment' refers to the process of selecting and fully committing to a specific alternative. Several studies (e.g., Brännback et. al., 2021; Rosenfeld et.al., 2021; etc.) have confirmed the importance of “Self-concept” in entrepreneurship, indicating that a person’s self-concept directly influences entrepreneurial behavior. This suggests that self-concept always incorporates the way individuals interpret their reality. Individuals with “identity chaos” are indifferent to important life decisions, tend to avoid making choices, and lack a sense of direction in their identity formation (Marcia, 1966). Some individuals actively explore options but avoid making decisions. Such individuals are characterized by frequently trying out different roles in search of who they are. Marcia (1966) calls this status an identity moratorium.

In contrast, individuals who have evaluated possible alternatives and made a choice regarding their identity can be described as having achieved identity. Berzonsky (1989) focuses on identity formation styles - informational, normative, and diffuse-avoidant - which are characterized by differences in the strategies individuals use to deal with their life choices. According to Berzonsky (2008), identity processing styles characterize the cognitive processes of an individual and influence the formation of identity. The scientist's approach is process-oriented, paying attention to the dynamics of how identity is constructed and changed over time.

Wang et al. (2021) argue that the causal link between identity and entrepreneurial intention has not been thoroughly examined. Research on the factors that influence, and shape students'

entrepreneurial identity has been recognized as a problem (Mei & Symaco, 2022), as the transition from a student self-concept to an entrepreneurial role can lead to "identity confusion" (Nielsen & Gartner, 2017).

2.2. Entrepreneurial Identity Aspiration and Entrepreneurial Intention

Individuals with strong entrepreneurial intentions are much more likely to choose entrepreneurship as their career choice (Biswas & Verma, 2021). Research indicates that entrepreneurial intention develops over time, making commitment and self-regulation highly significant (Donaldsons, 2019). According to the findings of Gabay-Mariani (2022), commitment is a key factor that drives individuals to do whatever is necessary to achieve their long-term goals, regardless of external challenges, and positively influences entrepreneurial startup activities. Research indicates that entrepreneurial intention develops over time, making commitment and self-regulation highly significant (Donaldsons, 2019). According to the findings of Gabay-Mariani (2022), commitment is a key factor that drives individuals to do whatever is necessary to achieve their long-term goals, regardless of external challenges, and positively influences entrepreneurial startup activities.

It is important to encourage individuals to take actions related to their potential future identity, as such activities are a means of validating their intended identity and supporting the process of becoming who they intend to become, according to scientists Farmer (2011).

In addition, studies in behavioral economics suggest that entrepreneurial decisions are influenced not only by identity, but also by cognitive biases and risk aversion (Saksonova & Jansone, 2021). Understanding how individuals manage uncertainty complements identity-based models.

3. Hypothesis Development

There is still a lack of sufficient theoretical understanding of the dynamics of entrepreneurial identity formation and development. It remains unclear whether entrepreneurial identity emerges primarily because of social construction or if it is influenced by other processes (Poudel, 2014). Theoretical insights (e.g., Marcia, 1980; Krueger, 2007a; Berzonsky, 2010, etc.) suggest that a strong identity forms the foundation for an individual's ability to make decisions and effectively solve problems, make choices, and draw conclusions.

Based on this, the following hypotheses are proposed:

H1: The Diffuse-Avoidant Identity Style (DAS) negatively affects Entrepreneurial Identity Aspiration (EIA).

H2: There is a relationship between the Informational Identity Style (IS) and Entrepreneurial Identity Aspiration (EIA).

H3: There is a relationship between the Normative Identity Style (NS) and Entrepreneurial Identity Aspiration (EIA).
H4: Commitment (C) positively affects business students' Entrepreneurial Identity Aspiration (EIA).
H5: Entrepreneurial Identity Aspiration (EIA) positively influences students' Entrepreneurial Intention (EI).

4. Methods. Research design

The purpose of this study is to explore the impact of Identity Style formation on Entrepreneurial Identity Aspiration (EIA) to determine whether the style of identity formation influences the development of Entrepreneurial Intention (EI). The study investigates how different identity styles - such as informational, normative, and diffuse-avoidant - contribute to the aspiration for an entrepreneurial identity and, in turn, influence the intention to engage in entrepreneurial activities. Additionally, it examines the mediating role of Entrepreneurial Identity Aspiration (EIA) in strengthening the relationship between identity styles and entrepreneurial intention.

To investigate the entrepreneurial intentions of business students, the Entrepreneurial Intention Questionnaire (EIQ) Version 3.1, developed by Liñán, Bradley, Basuki, and Redford (2006), was employed. Additionally, the Identity Style Inventory Version 5 (ISI-5), developed by Berzonsky, Soenens, Luyckx, and Smits (2013), was applied to measure identity styles. To evaluate Identity Aspiration, the scale developed by Farmer, Tierney, and Kung-McIntyre (2003) was utilized. All items across the questionnaires were measured using a 6-point Likert scale.To ensure scale validity and reliability, Cronbach's alpha was calculated for each part, all exceeding the 0.7 threshold. Potential biases due to convenience sampling and voluntary participation were acknowledged. A total of 147 business students aged 19 to 26 participated in the study, with 142 questionnaires considered valid for compiling the study results. Figure 1 presents the theoretical model of the study, which supports the proposed relationships between the key variables and illustrates the conceptual framework underlying the research hypotheses.

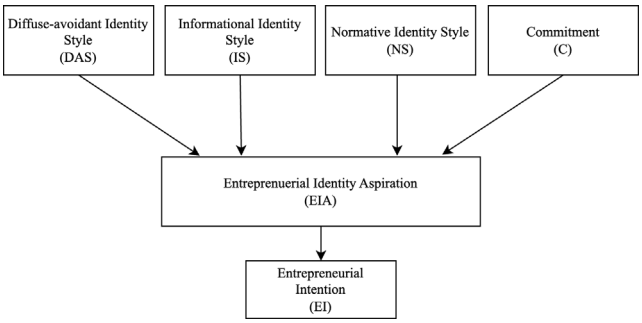


Figure 1. Theoretical model of the research. Source: Authors' research.

The Table 1 summarizes the number of valid and missing cases for six variables (DAS, IS, NS, C, EIA, and EI) in a dataset, generated using the statistical software SPSS for data corral.

Table 1. Descriptive statistics. Source: Authors' research

Variable	N	Minimum	Maximum	Mean	Std. Error	Std. Deviation
DAS	140	1,22	5,89	3,1365	0,07688	0,90966
IS	137	1,89	6	4,5296	0,06217	0,72764
NS	140	1,89	5,56	3,4865	0,06178	0,73103
C	139	2,33	5,89	3,8129	0,04334	0,56987
EIA	141	1	6	3,6613	0,11698	1,38909
EI	142	1	6	3,7324	0,12005	1,43062

Such statistics are used to assess the quality and completeness of the dataset before proceeding with analysis.

5. Data collection and discussion

Correlations between all main variables were calculated at the sum-score level (Table 2). The results provide insights into how identity styles relate to entrepreneurial identity aspiration, helping to understand the underlying mechanisms influencing entrepreneurial intention.

Table 2. Correlations between variables. Source: Authors' research

		EIA	EI	DAS	IS	NS	C
EIA	Pearson Correlation	1	,811**	,053	,257**	,309**	,387**
	Sig. (2-tailed)		,000	,533	,002	,000	,000
	N	141	139	140	137	140	138
EI	Pearson Correlation	,811**	1	,060	,297**	,241**	,368**
	Sig. (2-tailed)	,000		,480	,000	,004	,000
	N	139	142	139	136	139	138
DAS	Pearson Correlation	,053	,060	1	-,100	,539**	,417**
	Sig. (2-tailed)	,533	,480		,246	,000	,000
	N	140	139	140	137	140	138
IS	Pearson Correlation	,257**	,297**	-,100	1	,297**	,542**
	Sig. (2-tailed)	,002	,000	,246		,000	,000
	N	137	136	137	137	137	135
NS	Pearson Correlation	,309**	,241**	,539**	,297**	1	,611**
	Sig. (2-tailed)	,000	,004	,000	,000		,000
	N	140	139	140	137	140	138
C	Pearson Correlation	,387**	,368**	,417**	,542**	,611**	1
	Sig. (2-tailed)	,000	,000	,000	,000	,000	
	N	138	138	138	135	138	139

This study examines the relationships between different identity styles, entrepreneurial identity aspiration (EIA), and entrepreneurial intentions (EI). Commitment describes the extent to which an individual feels personally invested in the formation of their identity and is willing to make decisions that support the commitment to implement the identity.

The strong positive correlation observed in the analysis is between entrepreneurial identity aspiration and entrepreneurial intentions ($r=0.811$, $p<0.01$). This correlation indicates that individuals with high entrepreneurial identity aspiration are highly likely to develop entrepreneurial intentions.

The correlation analysis reveals no significant relationship between diffuse-avoidant identity style and entrepreneurial identity aspiration, ($r=0.053$, $p>0.05$). This indicates that a diffuse-avoidant identity style, characterized by a tendency to procrastinate or avoid making decisions about one's identity, does not significantly influence entrepreneurial identity aspiration. The normative identity style also shows a moderate positive correlation with entrepreneurial identity aspiration ($r=0.314$, $p < 0.01$). This suggests that individuals who adhere to societal expectations and conform to established norms are more likely to aspire toward an entrepreneurial identity. While a normative identity style may seem contrary to the innovative nature of entrepreneurship, these results imply that adherence to socially accepted values, such as responsibility and commitment, can contribute to entrepreneurial aspirations. Interestingly, social norms did not have a significant impact on entrepreneurial intention. This could be attributed to cultural or generational shifts, where youths prioritize self-directed goals over societal expectations.

Commitment demonstrates a positive correlation with entrepreneurial identity aspiration ($r=0.387$, $p<0.01$). This finding underscores the importance of identity stability and dedication to specific goals in fostering entrepreneurial aspirations. Strong commitment likely provides individuals with a clear sense of direction and purpose, supporting the development of entrepreneurial aspirations and subsequent behaviors. Commitment, or the ability to remain dedicated to a set of long-term goals, emerged as a significant predictor of entrepreneurial identity aspiration in this study. Commitment emerged as a significant predictor of entrepreneurial identity aspiration. It provides individuals with clarity, direction, and the perseverance needed to face entrepreneurial challenges.

6. Theoretical and practical implications

The findings provide compelling evidence for the critical role of identity processes in shaping entrepreneurial aspirations and intentions. Informational and normative identity styles, along with identity commitment, emerge as significant predictors of entrepreneurial identity aspiration. An informational identity style, characterized by active self-reflection and openness to new information, is a critical driver of entrepreneurial identity aspiration. Individuals with this style seek out and process information about themselves and their environment, enabling them to make informed decisions about their career paths. For aspiring entrepreneurs, this

reflective approach is particularly important, as it facilitates the recognition of opportunities, the evaluation of risks, and the development of innovative ideas, which could be achieved by using a multidisciplinary approach (Braslina et al., 2024). Diffuse-avoidant identity style is not conducive to entrepreneurial aspirations. This finding reinforces the notion that decision-avoidant tendencies and a lack of goal orientation hinder the development of an entrepreneurial identity. The results align with and extend identity-based intention models, suggesting that entrepreneurial education must evolve beyond skill-building to identity formation as a core objective. Also, these findings imply that entrepreneurship education should emphasize self-reflection, identity exploration, and long-term commitment. Curriculum could integrate identity-development exercises to foster entrepreneurial mindsets

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References

Ajzen, I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84(2), 191–215.

Berzonsky, M. D. (2010). Cognitive processes and identity formation: The mediating role of identity processing style. Psychologia Rozwojowa, 15(4), 13–27.

Berzonsky, M. D. (2008). Identity formation: The role of identity processing style and cognitive processes. Personality and Individual Differences, 44(3), 645–655.

Berzonsky, M. D. (1989). Identity style: conceptualization and measurement. Journal of Adolescent Research, 4, 267–281.

Braslina, L., Batraga, A., Kellerte, K., Šalkovska, J., Šķiltere, D., Braslins, G. (2024). Theoretical frameworks shaping innovative product development for the regional improvement: a multidisciplinary perspective. Research for Rural Development, 39, 108–114.

Brännback, M., Carsrud, A., & Elfving, J. (2021). Self-concept and entrepreneurial intentions: The role of perceived environmental uncertainty. Journal of Small Business Management, 59(2), 404-420.

Biswas, A., & Verma, R. K. (2021). Attitude and alertness in personality traits: A pathway to building entrepreneurial intentions among university students. The Journal of Entrepreneurship, 30(2), 367–396.

Celuch, K., Bourdeau, B., & Winkel, D. (2017). Entrepreneurial identity: The missing link for entrepreneurship education. Journal of Entrepreneurship Education, 20(2).

Donaldson, C. (2019). Intentions resurrected: A systematic review of entrepreneurial intention research from 2014 to 2018 and future research agenda. International Entrepreneurship and Management Journal, 15, 953–975.

Erikson, E. H. (1968). Identity, youth, and crisis. W. W. Norton & Company.

Farmer, S. M., Yao, X., & Kung-McIntyre, K. (2011). The behavioral impact of entrepreneur identity aspiration and prior entrepreneurial experience. Entrepreneurship Theory and Practice, 35(2), 245–273.

Gabay-Mariani, L., & Boissin, J. P. (2021). Commitment profiles of nascent entrepreneurs: Insights from an empirical taxonomy among French student entrepreneurs. International Journal of Entrepreneurial Behavior & Research, 27(5), 1214–1240.

Gregori, P., Holzmann, P., & Schwarz, E. J. (2021). My future entrepreneurial self: Antecedents of entrepreneurial identity aspiration. Education + Training, 63(7/8), 1175–1194.

Hoang, H., & Gimeno, J. (2010). Becoming a founder: How founder role identity affects entrepreneurial transitions and persistence in founding. Journal of Business Venturing, 25(1), 41–53.

Krueger, N. F. (2007). What lies beneath? The experiential essence of entrepreneurial thinking. Entrepreneurship Theory and Practice, 31(1), 123–138.

Liñán, F., & Rodríguez, J. C. (2004). Entrepreneurial attitudes of Andalusian university students. In 44th ERSA Conference, Porto, Portugal, August 21-25.

Marcia, J. E. (1980). Identity in adolescence. In J. Adelson (Ed.), Handbook of adolescent psychology (pp. 159–187). Wiley.

Murnieks, C. Y., Klotz, A. C., & Shepherd, D. A. (2020). Entrepreneurial motivation: A review of the literature and an agenda for future research. Journal of Organizational Behavior, 41(2), 115–143.

Murnieks, C. Y., Mosakowski, E., & Cardon, M. S. (2014). Pathways of passion: Identity centrality, passion, and behavior among entrepreneurs. Journal of Management, 40(6), 1583–1606.

Nielsen, S. L., & Gartner, W. (2017). Am I a student and/or entrepreneur? Multiple identities in student entrepreneurship. Education + Training, 59(2), 135–154.

Pattnaik, S., Mmbaga, N., White, T. D., & Reger, R. K. (2024). To entrepreneur or not to entrepreneur? How identity discrepancies influence enthusiasm for academic entrepreneurship. Journal of Technology Transfer, 49(4), 1444–1470.

Rosenfeld, D. L., Wilson, M. J., & Rogers, J. R. (2021). Psychological practice in the era of COVID-19: A roadmap for navigating new challenges and opportunities. Professional Psychology: Research and Practice, 52(4), 275-284.

Saksonova, S., Jansone, M. (2021). Economic Factors of Labor Migration Analysis. Lecture Notes in Networks and Systems, 195, 649 – 659.

Seibert, S. E., Nielsen, J. D., & Kraimer, M. L. (2020). Awakening the entrepreneur within: Entrepreneurial identity aspiration and the role of displacing work events. Journal of Applied Psychology. Advance online publication.

Tsou, E., Steel, P., & Osiyevskyy, O. (2023). The relationship between entrepreneurial intention and behavior: A meta-analytic review. The International Journal of Entrepreneurship and Innovation. Advance online publication.

Turulja, L., Agic, E., & Veselinovic, L. (2020). Motivation of the youth of Bosnia and Herzegovina to start a business: Examining aspects of education and social and political engagement. Economic Research-Ekonomska Istraživanja, 33(1), 2692-2712.

Valencia, A. (2020). The changes of the entrepreneurial identity: Case study. Quaderns *de Psicologia, 22*(2), e1574.

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Is Doing More a Good Idea? Students' Views of the Impact of Involvement on Academic Outcomes

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Abstract

Evidence exists that how students spend their time while pursuing an academic degree is linked to academic success. However, for commuting students, this link needs to be further examined. To this end, the present action research study specifically examined undergraduate students' participation in student life activities and their perceptions of the impact of such activities on academic performance, academic engagement, and more broadly, university experience. A survey was administered to a convenience sample of 336 full-time undergraduate students at an English-medium university who commuted daily. This study uncovered low participation rates as well as students' subjective views that academic performance and campus life activities are unconnected. The latter views were supported by the absence of an objective relationship between students' GPA and participation in campus life activities. Students, however, had more favorable views of the impact of campus life activities on academic engagement and, more broadly, on their overall experience in higher education. These findings inform an action plan for enhancing the integration between campus life activities and classroom learning. The goal is to ensure that classroom learning is practiced in the real world outside the confines of the classroom walls.

Keywords: *Engagement; academic performance; Middle East; campus life pursuits.*

1. Introduction

Astin's theory of involvement (1999), which focuses on how students spend their time while pursuing an academic degree, has informed much of the extant literature regarding academic success (Burch et al., 2015; Halm, 2015). The theory argues that positive academic outcomes are likely to result from students' devoting effort and time to learning, participating in student organizations, spending time on campus, and interacting with faculty members. A related theory

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is that of Tinto (1997; 2017), which argues that students who can integrate the social and academic demands of university life are more likely to persist and graduate. Empirical evidence supports a close relationship between students' engagement in a multitude of campus life activities and academic success (Kulp et al., 2021; Mayhew et al., 2016).

There are two main types of campus life activities. Co-curricular activities refer specifically to events or tasks that are considered to be part of the curriculum. They are intended to enhance its quality and improve learning (Camerato et al., 2019). Examples are undergraduate research opportunities and internships. Extra-curricular activities, instead, are outside of the academic curriculum and lack predefined academic outcomes (Camerato et al., 2019), such as athletics, student government, and clubs. For educators and administrators at universities with large numbers of commuters, students' involvement in activities outside those explicitly requested by the curriculum of a given program is particularly challenging. Yet, such activities are positively related to academic outcomes (Kulp et al., 2021).

Most of the extant literature supporting the link between participation in student life events and student success has focused on institutions of the Global North. As such, it has failed to highlight potential differences in the patterns of students' involvement and subjective views of such involvement in its different manifestations. Thus, our study focuses on an English-medium university in the Middle East following a US curriculum whose students are all commuters. The study is intended to be the first step of an action research plan (Sáez Bondía & Cortés Gracia, 2022), which entails gathering information about a given matter viewed as problematic, implementing changes, and then assessing whether improvement has been made. As the information stage requires, this action research study asked the following questions, each followed by a hypothesis to be tested:

Q1 How frequently do students participate in campus life activities? If activities are perceived as useful, students will be likely to report frequent participation. Of course, usefulness can be measured in a variety of ways, including one's academic performance, academic engagement, and, more broadly, university experience.

Q2 Do students see a link between campus life activities and academic performance? If students deem campus life activities to be useful to academic performance, they will report an increase in their performance as a function of participation in student life activities.

Q3 Do students see a link between campus life activities and academic engagement? More broadly, do they see such activities as linked with their university experience? If students deem campus life activities to be useful to either their academic engagement or their university experience, they will report an enhancement in their engagement or university experience arising from participation in student life activities.

Q4 Is there an actual link between participation in campus life activities and academic performance (as measured by self-reported GPA)? If the link is not merely perceived but exists in reality, increased participation in student life pursuits should be accompanied by a higher GPA (if participation is beneficial) or a lower GPA (if participation is distracting).

2. Method

2.1. Participants

Participants were 336 undergraduate students of an English-medium university in the Middle East. There were 154 males and 182 females. Students were enrolled in either STEM programs (e.g., engineering and computer science; n = 164) or non-STEM programs (e.g., law, business, and graphic design; n = 172). They represented a convenience sample of young learners across educational levels. Students were recruited through an email sent by the Department of Student Affairs during the second part of the fall semester. All participants were full-time students who commuted to and from the university daily during weekdays.

2.2 Materials and Procedure

A questionnaire was specifically developed to assess students' views of student life activities. Before administration, test-retest reliability and face validity were determined to be adequate. Informed consent was preceded by demographic questions (e.g., students' GPA, gender, and academic major) as well as factual and attitudinal questions.

Factual questions concerned the frequency of students' participation in campus life activities. They also included participation in different types of pursuits: (a) extra-curricular activities, such as participation in clubs, sports, or academic competitions, (b) community service and volunteer work, (c) student government and club leadership, and (d) internships, work-study programs or research activities. Answers were provided on a 5-point scale. For simplicity, answers were reorganized into a 3-point scale, including never or rarely (0), once a week (1), and several times a week or daily (2; see Table 1).

Attitudinal questions asked about participants' perceived impact of student life activities on their academic performance, academic engagement, and, broadly, university experience (see Table 2). Questions about the overall impact of student life on academic performance were followed by questions that specifically asked about how the different types of student life pursuits might affect academic performance. Answers were provided on a 3-point scale, including negative impact (-1), no impact (0), and positive impact (+1). The last two questions asked about students' satisfaction with the current array of campus life opportunities and whether campus life opportunities should be more connected with classroom learning activities.

2.3. Data Treatment

Descriptive statistics consisted of percentages, each illustrating the frequency of specific answers. Inferential statistics involved Chi-Squared analyses (i.e., non-parametric tests). These analyses aimed to assess whether significant differences existed in the frequency of participants' answers to a given question. Tests were considered significant at the 0.05 level.

3. Results

Descriptive statistics of students' responses are displayed in Tables 1 and 2. Statistics are organized by the questions they answer.

Q1. How frequently do students participate in campus life activities?

As illustrated in Table 1, most students did not participate or rarely participated in campus life activities (including all different types).

Table 1. Students' Self-Reported Frequency of Participation

Participation in campus life activities	
Never/rarely	61%
Once a week	16%
Several times a week/daily	23%
Specifically, participation in clubs, sports, or academic competitions	
Never/rarely	52%
Once a week	24%
Several times a week/daily	24%
Specifically, participation in community service/volunteer work	
Never/rarely	51%
Once a week	29%
Several times a week/daily	20%
Specifically, participation in student government or club leadership	
Never/rarely	60%
Once a week	16%
Several times a week/daily	24%
Specifically, participation in internships, work programs, or research	
Never/rarely	55%
Once a week	22%
Several times a week/daily	23%

One possible reason for low participation rates could be that activities were not perceived as beneficial. Thus, we asked whether students saw a link between student life pursuits and academic performance.

Q2. Do students see a link between campus life activities and academic performance?

We predicted that if students deemed campus life pursuits beneficial to academic performance, they would have reported an increase in their academic performance as a function of participation in student life activities. Students' answers were mostly in the no-impact categories [χs^2 (4) ≤ 225.88, *ns*]. Table 2 illustrates this pattern.

Table 2. Students' Views of The Impact of Activities

Participation in campus life activities	
Negative impact on overall university experience	2%
No impact on overall university experience	40%
Positive impact on overall university experience	58%
Decrease engagement	2%
No impact on engagement	44%
Improve engagement	54%
Decrease academic performance	8%
No impact on academic performance	57%
Improve academic performance	35%
Specifically, participation in clubs, sports, or academic competitions	
Decrease academic performance	4%
No impact on academic performance	62%
Improve academic performance	34%
Specifically, participation in community service/volunteer work	
Decrease academic performance	3%
No impact on academic performance	69%
Improve academic performance	28%
Specifically, participation in student government or club leadership	
Decrease academic performance	4%
No impact on academic performance	64%
Improve academic performance	32%
Specifically, participation in internships, work programs, or research	
Decrease academic performance	3%
No impact on academic performance	62%
Improve academic performance	35%

Q3. Do students see a link between campus life activities and academic engagement or their university experience?

We predicted that if students deemed campus life pursuits as beneficial to either their academic engagement or their university experience, they would have consistently reported an enhancement of their engagement or university experience arising from their student life participation. As illustrated in Table 2, students' subjective perceptions of the impact of campus life activities on academic engagement [χ^2 (4) = 150.64, $p < 0.001$] and university experience [χ^2 (4) = 169.95, $p < 0.001$] were mixed. Namely, campus life activities were mostly seen as having either no impact or a positive impact.

Q4. Is there an actual link between participation in campus life activities and academic performance (as measured by self-reported GPA)?

We questioned whether students who did not see a link between campus life activities and academic performance failed to acknowledge an actual link. Increased participation in student life pursuits (as measured by self-reported frequency) was not accompanied by a higher or lower GPA [χs^2 (4) ≤ 4.96, *ns*]. That is, the reason most students did not see a link between academic performance and campus life pursuits is that the link did not exist. In support of this finding, most students recognized the need for a greater connection between campus life opportunities and class activities (57%) as a tool to enhance their academic performance. The question about students' satisfaction regarding the variety of student life opportunities currently offered led to students being distributed into three groups: 44% were satisfied or very satisfied, 30% were neutral, and 26% were dissatisfied or very dissatisfied.

4. Discussion

The findings of the present investigation can be summarized in three points: First, a large number of students did not participate or rarely participated in campus life events. Second, most students did not see such events as having an impact on their academic performance. Consistent with this view, campus life pursuits were not related to students' self-reported GPA. Third, a considerable number of students perceived campus life events as either beneficial or neutral to their academic engagement and quality of university experience. These findings are inconsistent with those of Kulp et al. (2019) and Mayhew et al. (2016). Taken together, evidence suggests that the unique characteristics of an institution and its student population may be relevant factors in assessing the benefits of campus life activities.

The immediate implications of this action research study were focus-group discussions between faculty members and students (n = 31). Students frequently reported that the main culprit for dismal participation in campus life activities was the limited amount of time available outside the classroom. They mentioned completing homework assignments, studying, commuting, and complying with family obligations as absorbing most of their time. Both faculty and students reported the need for planning events outside the classroom that more directly allowed students to practice the learning acquired in the classroom. Another interesting aspect of the present study is that students who had been exposed to inquiry-based learning instruction (Waked et al., 2024) spontaneously offered concrete suggestions on linking classroom instruction with events in the outside world that would offer practice for materials and skills learned in the classroom (e.g., subject-specific fairs). Students also mentioned that their active participation in such events should be reflected in their course grades. The next step of this action research plan is to conduct a pilot study to determine whether addressing both needs can lead to students' improved GPA.

Our action research study has limitations that need to be addressed in future research. For instance, the assessment of the biasing influence of social desirability needs to be determined. A helpful strategy for limiting the biasing effects of social desirability may be to establish rapport (Bergen & Labonté, 2020) through in-depth interviews. In-depth interviews with students may highlight the particular characteristics of campus life activities that are deemed engaging. Furthermore, a larger sample may illustrate individual differences in the student population that may make some activities more or less attractive. Of course, the use of convenience sampling may question the generalizability of the results to students who did not participate (Golzar et al., 2022). Of course, an issue to be explored further is how classroom instructional modes and contents can shape the desire to do more outside the classroom in preparation for a career in one's chosen field. Evidence seems to indicate that learning modes that engage students' critical thinking skills in the classroom can be an effective propeller of change (Al Kuhayli et al., 2021). Another issue to be explored here is the relationship between one's choice of campus life activities and different types of engagement, such as cognitive (investment in learning), emotive (positive affective reactions), and behavioral (effort expended; Al-Obaydi et al., 2023; Li, 2021). How different campus life activities may foster each type of engagement needs to be considered in the decision-making process that governs the selection of suitable activities. Lastly, a survey of the needs of student commuters may suggest helpful changes in the schedules of classes and student life activities for the smooth integration of the two.

References

Al Kuhayli, H. A., El Alaoui, K., & Pilotti, M. A. (2021). Critical minds in Arabic and Islamic studies courses: A whiff of change. *Teaching Theology & Religion, 24*(3), 152-164. https://doi.org/10.1111/teth.12591

Al-Obaydi, L. H., Shakki, F., Tawafak, R. M., Pikhart, M., & Ugla, R. L. (2023). What I know, what I want to know, what I learned: Activating EFL college students' cognitive, behavioral, and emotional engagement through structured feedback in an online environment. *Frontiers in Psychology*, *13*, 1083673. https://doi.org/10.3389/fpsyg.2022.1083673

Astin, A. W. (1999). Student involvement: A developmental theory for higher education. *Journal of College Student Development, 40,* 518-529. https://psycnet.apa.org/record/1999-01418-006

Bergen, N., & Labonté, R. (2020). "Everything is perfect, and we have no problems": detecting and limiting social desirability bias in qualitative research. *Qualitative Health Research*, *30*(5), 783-792. https://doi.org/10.1177/1049732319889354

Burch, G. F., Heller, N. A., Burch, J. J., Freed, R., & Steed, S. A. (2015). Student engagement: Developing a conceptual framework and survey instrument. *Journal of Education for Business, 90*(4), 224-229. https://doi.org/10.1080/08832323.2015.1019821

Camerato, K., Clift, A., Golden, M. N., Gramajo Vivas, J., Rogers, P., & Strelecki, A. (2019). What does "high-impact" mean in extracurricular experiences? *The Journal of Campus Activities Practice and Scholarship, 1*(1), 60-67. https://doi.org/10.52499/2019008

Golzar, J., Noor, S., & Tajik, O. (2022). Convenience sampling. *International Journal of Education & Language Studies*, *1*(2), 72-77. https://doi.org/10.22034/ijels.2022.162981

Halm, D. S. (2015). The impact of engagement on student learning. *International Journal of Education and Social Science*, *2*(2), 22-33. https://ijessnet.com/wp-content/uploads/2022/10/3-6.pdf

Kulp, A. M., Pascale, A. B., & Grandstaff, M. (2021). Types of extracurricular campus activities and first-year students' academic success. *Journal of College Student Retention: Research, Theory & Practice*, *23*(3), 747-767. https://doi.org/10.1177/1521025119876249

Li, S. (2021). Measuring cognitive engagement: An overview of measurement instruments and techniques. *International Journal of Psychology and Educational Studies*, *8*(3), 63-76. https://doi.org/10.52380/ijpes.2021.8.3.239

Mayhew, M. J., Rockenbach, A. M., Bowman, N. A., Seifert, T. A. D., Wolniak, G. C.,

Pascarella, C., & Terenzini, E. T. (2016). *How college affects students: 21st century evidence that higher education works* (Vol. 3). Jossey-Bass.

Sáez Bondía, M. J., & Cortés Gracia, A. L. (2022). Action research in education: A set of case studies? *Educational Action Research*, *30*(5), 850-864. https://doi.org/10.1080/09650792.2020.1866631

Tinto, V. (1997). Classrooms as communities: Exploring the educational character of student persistence. *Journal of Higher Education, 68*(6), 599-623. https://doi.org/10.1080/00221546.1997.11779003

Tinto, V. (2017). Through the eyes of students. *Journal of college student retention: Research, Theory & Practice, 19*(3), 254-269. https://doi.org/10.1177/1521025115621917

Waked, A., Pilotti, M., & Abdelsalam, H. M. (2024). Differences that matter: inquiry-based learning approach to research writing instruction. *Scientific Reports*, *14*(1), 27941. https://doi.org/10.1038/s41598-024-78962-7

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Facing the Growing Attention Crisis in Higher Education – Learnings from an Action Research-Based Study on Swiss Business Students

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Abstract

This paper presents the results of a study investigating the impact of a focus- and attention-based learning intervention on the ability of higher education students to concentrate in several dimensions. The intervention, which was implemented with four bachelor classes at a Swiss university, combined instructional materials, a playbook, and reflection practices. An action research approach was used to collect quantitative data through pre- and post-semester surveys and qualitative insights through structured focus interviews. Results showed significant improvements in students' concentration, reduced fear of missing out, and decreased dependence on smartphone. Students reported increased self-awareness and perceived benefits to their academic and personal lives. The study highlights the potential of targeted interventions to address the 'attention crisis' in digitalized learning environments and underlines the need for interdisciplinary research and institutional dialogue to promote media literacy and self-regulation in higher education.

Keywords: *focus; attention; social media; digitalized learning environments; action research; intervention*

1. Introduction

Digitisation in higher education is both an opportunity and a challenge. While many focus on the application of technological innovations in the classroom, something else is becoming increasingly apparent. The proliferation of distractions, such as social media and the 'attention economy', is reducing students' uninterrupted attention in the classroom. This critical asset for students' learning success in higher education is at risk.

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Recent studies give an insight into the extent of this so-called attention crisis. Hari (2022) found that the attention span of American students is only about 60 seconds. Recently published findings by Mark (2023) show that the average attention span on a screen has dropped from 2.5 minutes in 2004 to just 47 seconds in 2023. When students lack attention and practice multitasking, so-called switching costs further reduce productivity (Gazzaley & Rosen, 2018). The consequences are not only visible in the classroom, where we see that students are finding it increasingly difficult to read longer texts (Goleman, 2014) and to stay focused. The side effects of this attention crisis and time fragmentation can also be seen in a decrease in well-being (Newport, 2022), higher levels of stress that can even lead to depression (Schuler et al., 2020), and a decrease in IQ (Hari, 2022; Eyal et al., 2021).

Higher education institutions are therefore called upon to find solutions to this challenge. Nevertheless, there remains a lack of training programmes or specialised courses designed to meet it. Solutions need to be developed and tested for the future success of higher education effectiveness. Educators should help future generations improve their self-efficacy through increased media literacy, attention, focus, and deeper learning.

This paper therefore addresses the following question: 'Can a learning unit based on focus and attention help students improve their ability to concentrate, reduce their fear of missing out and dependence on smartphones and social media, and thereby provide insight into tackling the attention crisis?'.

2. Research Setting

The first stage of the research project was to develop teaching materials that could form the basis of the project itself. The intention was to design a learning unit that business students could work on in groups over the course of an entire semester.

In order to address the above-mentioned situation, a teaching design with several components was developed, consisting mainly of online and offline teaching material and a playbook. The teaching materials introduce the topic of focus and attention, presenting and explaining the basic theories, related background information and insights into recent research findings. The aim is to arouse students' interest and curiosity about the topic, and to make the importance and benefits of increased attention and focus tangible.

The playbook forms the centrepiece of the teaching design and consists of a series of steps and concrete exercises (e.g. mindfulness practices, pomodoro-technique etc.) based on scientific evidence. It aims to provide students with strategies and tools to better cope with the accelerated and digitalised world. It also promotes mental health and aims to increase students' well-being. The playbook is divided into 6 chapters, each dedicated to a specific topic, ranging from homo digitalis over internal and external triggers for distraction, mindfulness to deep work. Each

chapter is enriched with exercises to increase self-awareness, awareness of internal and external distractions and stressors, and use of electronic tools by students.

The teaching materials were tested in two bachelor programmes at the University of Applied Sciences and Arts Northwestern Switzerland in the spring semester of 2024. Integrated into a mandatory module on Human Resources Management and Organisational Behaviour, students attended introductory classes and worked through the playbook in groups throughout the semester. After an initial introduction by the lecturers, students worked individually on the first three chapters and met biweekly for guided reflection. A mid-semester sharing session allowed students to share experiences, ask questions, and receive additional theory and tips from the lecturers. They then moved on to the second half of the playbook.

3. Methods, data collection and analysis

The action research involved a cyclical process of planning, acting, observing, and reflecting in order to improve the relevant situation or address the problem of focus and attention within the lecture setting. This approach was chosen because it is commonly used in similar contexts in the social sciences, education, and organisational development to bring about practical change in the relevant settings. Furthermore, by involving the lecture and students in the research process and focusing on collaboration and participation, this action research approach can promote ownership and sustainability of change (Krebs et al., 2023). Quantitative and qualitative methods were used to collect the data for this study. The quantitative method is based on a pretest-posttest control group design in a quasi-experiment.

Four bachelor classes were selected non-randomised as experimental group: three German-speaking business administration programmes and one English-speaking programme in International Management. Three classes were on campus, and one was online. Three other, non-randomised selected classes served as a control group. All students completed an initial survey via a link or QR code using Tivian at the beginning of the semester (t_1). The intervention took place during the semester. A second survey and focus interviews were conducted with all students during the last week of the semester (t_2).

As no suitable scales were found that explicitly measure focus and attention, this study measures five individual constructs that seem relevant in the context of the intervention: ability to concentrate, fear of missing out, dependence on the smartphone, self-control, and individual commitment. Each of these constructs forms the dependent variable. The independent variables are time of measurement and group assignment to the experimental or control group. All items could be answered on a five-point Likert scale (1=doesn't apply, 2=rather not applies, 3=partly-partly, 4=rather applies, 5=applies). The constructs are measured using items that are newly formulated or adapted from established scales (Table 1). For concentration, the short focusing subscale of the 'Attention Control Scale' (Judah et al., 2014) was adapted and two self-

formulated items were integrated. Fear of missing out was measured using modified items from Przybylski et al. (2013). Smartphone addiction was assessed with items from Montag's (2018) self-test and a self-formulated item. Self-control was measured with a modified version of the short 'Self-Control Scale' (Singh, 2022). The items on individual commitment are based on the 'Employee Experience Questionnaire' (Fischer et al., 2021), two self-formulated items and two further adapted items from the Swiss HR barometer 2014 (Doden et al., 2014).

Table 1: Scales used to measure the ability to concentrate, fear of missing out, smartphone dependency, self-control and individual commitment.

Scales	Number of items	Cronbachs α
Concentration (e.g. It's hard for me to concentrate on a difficult task when there are noises around.)	8	0.75
Fear of missing out (e.g. I get worried when I find out my friends are having fun without me.)	7	0.77
Smartphone addiction (e.g. I even think about my smartphone when I'm not using it.)	10	0.81
Self-control (e.g. I am able to work effectively toward long-term goals.)	8	0.76
Individual commitment (e.g. I invest a lot of energy in my studies.)	10	0.85

The survey data were analysed in RStudio, with scales created using mean item scores. Internal consistency was assessed using Cronbach's alpha. Experimental group scales were compared at the beginning and end of the semester using dependent samples t-tests. The same procedure was used for the control group. Experimental and control group samples were compared at t_2 using an independent samples t-test. Qualitative findings were gathered through structured focus interviews. After the t_2 survey, students in the experimental group reflected on the semester and the playbook using the 4L method (Liked, Learned, Lacked, Longed for). Contributions were documented, and qualitative content analysis was used to categorise the data.

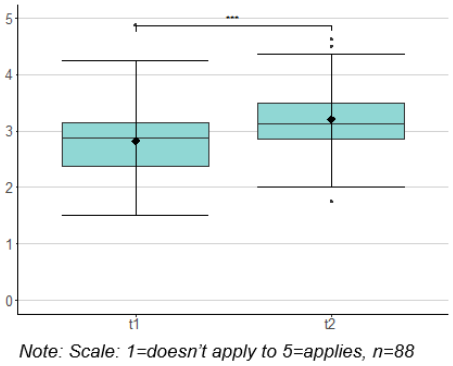
4. Results

A dependent sample of n=109 students was analysed. Table 2 shows the mean values and standard deviations of the experimental and control groups at t_1 and t_2. This sample is obtained after careful adjustment to ensured the students completed the survey at both times.

Table 2: Mean values and standard deviations of the experimental and control groups at t1 and t2.

Scale	Time	Experimental group (n=88) *M (SD)*	Control group (n=21) *M (SD)*
Concentration	t1	2.8 (0.6)	3.1 (0.6)
	t2	3.2 (0.5)	3.1 (0.8)
Fear of missing out	t1	2.5 (0.8)	2.4 (0.7)
	t2	2.1 (0.7)	2.3 (0.6)
Smartphone addiction	t1	2.8 (0.7)	2.2 (0.6)
	t2	2.5 (0.6)	2.4 (0.7)
Self-control	t1	2.9 (0.6)	3.2 (0.8)
	t2	3.2 (0.6)	3.0 (0.6)
Individual commitment	t1	3.5 (0.6)	3.8 (0.6)
	t2	3.5 (0.6)	3.6 (0.5)

The experimental group shows significant differences from t_1 to t_2 on almost all scales of interest, except individual commitment. While about 44% of the students rated their *ability to concentrate* as partly good to good at the beginning of the semester, 64% did so at the end of the semester. A t-test for dependent samples shows that the mean difference of the ability to concentrate between the experimental group at t_1 (M_{t1}=2.8, SD_{t1}=0.6) and at t_2 (M_{t2}=3.2, SD_{t2}=0.5) is significant ($t(87)$=6.8, p<0.001) (see Figure 1). *Fear of missing out* was rated as partly high to high by 30% of the students at the beginning of the semester. At the end of the semester, this value was 15%. The difference in the experimental group from t_1 to t_2 was tested using the parameter-free Wilcoxon test. The mean difference between t_1 (M_{t1}=2.5, SD_{t1}=0.8) and t_2 (M_{t2}=2.1, SD_{t2}=0.7) was significant ($Z(n=88)$=2593, p<0.001) (see Figure 2).



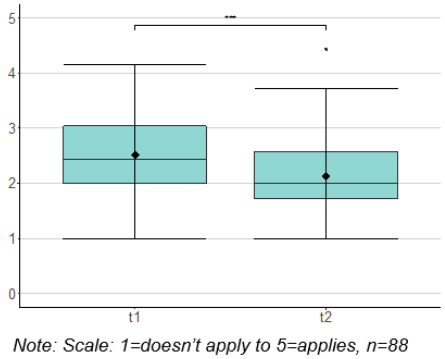
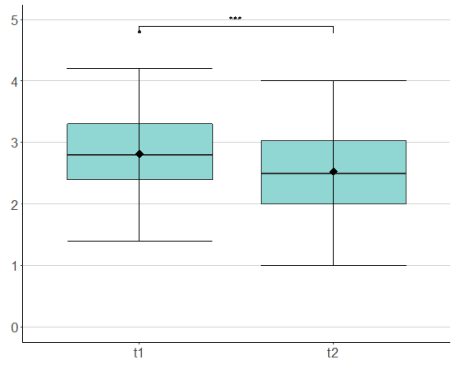
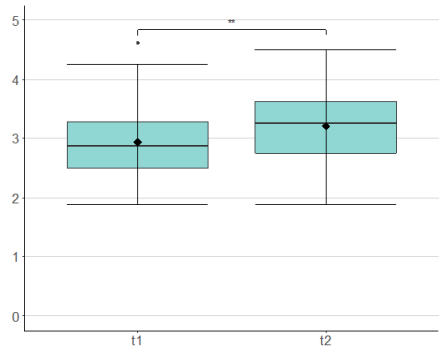


Figure 1 (left). Experimental group's ability to concentrate at time t_1 and t_2
Figure 2 (right). Experimental group's level of fear of missing out at time t_1 and t_2

Finally, at the beginning of the semester, 35% rated their *dependence on smartphones* as partly high to high, compared to 31% at the end of the semester. The mean difference between the experimental group at t_1 (M_{t1}=2.8, SD_{t1}=0.7) and at t_2 (M_{t2}=2.5, SD_{t2}=0.6) was shown to be significant using a t-test for dependent samples ($t(87)=5.2$, $p<0.001$) (see Figure 3).



Note: Scale: 1=doesn't apply to 5=applies, n=88



Note: Scale: 1=doesn't apply to 5=applies, n=88

Figure 3 (left). Experimental group's dependence on the smartphone at time t_1 and t_2
Figure 4 (right). Experimental group's level of self-control at time t_1 and t_2

At the beginning of the semester, 43% of the students rated their *self-control* as partly good to good, at the end of the semester the figure was 64%. The mean difference at t_1 (M_{t1}=2.9, SD_{t1}=0.6) and at t_2 (M_{t2}=3.2, SD_{t2}=0.6) is significant ($t(87)=4.9$, $p<0.01$) (see Figure 4).

The control group's results differ at t_1 compared to the experimental group's values. However, there was no significant difference between t_1 and t_2 for any of the scales of the control group. Also, there was no significant difference between experimental and control group at time t_2.

The experimental group's feedback provides reliable insight into the project's impact. At the end of the semester, 93% of students reported completing the playbook exercises regularly and conscientiously, and 91% would recommend what they learned to friends. Students reported for example: *'It has given me a lot of time and, above all, time to reflect on my own actions'*, *'It is a document that can be used over a long period of time. It also shows the struggles of using technology in effective ways to combat distractions'*, *'Because it is useful not only for my studies, but for my whole life [...]'*. The structured focus interviews provided deeper insights into these quantitatively assessed changes. They reveal a multifaceted impact of the program on participants' perceived productivity, focus, and attitudes toward technology and learning. One participant noted, *'I was able to significantly improve my attention span and concentration through the exercises'*. This was echoed by others, who highlighted the tangible benefits of adopting new strategies. For instance, another participant shared, *'I've been much more productive since I stopped multitasking'*. These reflections suggest that the program successfully facilitated a shift in cognitive habits, promoting a more focused and deliberate approach to tasks.

Moreover, the program appeared to influence participants' perceptions of technology in the context of learning. As one interviewee stated, *'The program has radically changed my attitude towards smartphones and learning'.* In addition to individual benefits, the social dimension of the program emerged as a significant factor. One participant remarked, *'It was good to see that the others in the learning group feel the same way as I do and that we can also make a difference together'.* This underscores the importance of peer support in reinforcing behavioural changes and fostering a sense of collective efficacy.

5. Discussion

Results of the experimental group showed significant improvements in students' concentration, reduced fear of missing out, and decreased smartphone dependence. Students reported increased self-awareness and perceived benefits to their academic and personal lives. The findings suggest approaches for discussing the future applicability of such learning content in higher education. The learning content provided guidance to students during a challenging period of flexibilisation and individualisation. By addressing the issue of focus and attention in the context of digitalisation and acceleration, students learned to be more self-directed and responsible. Many students demonstrated how deep work enhanced learning success, while shallow, distracting activities were reduced.

Qualitative findings highlight key questions for future research, such as sustaining positive change over time and identifying effective long-term interventions. In addition, the findings highlight the need for dialogue in higher education about two opposing trends: smartphone bans versus the promotion of self-regulation and media literacy. We hope that this research can make a meaningful contribution to this ongoing and multifaceted discussion.

Despite careful data cleansing, the quantitative survey covers a relatively small sample. The mean values were calculated without considering the individual differences between the students or classes. In addition, the focus and attention, based on self-assessments, could be enhanced by external evaluations. Nevertheless, the pretest-posttest control group design in a quasi-experiment provides a solid basis for analysis of key factors.

References

Doden, W., Morf, M., Arnold, A., Feierabend, A., Grote, G., & Staffelbach, B. (2014). *Schweizer HR-Barometer 2014. Schwerpunktthema Arbeitserleben und Job Crafting*. Universität Zürich und ETH Zürich. https://doi.org/10.5167/uzh-104343

Eyal, N. & Li, J. (2020). *Indistractable: How to Control Your Attention and Choose Your Life*. BenBella Books.

Fischer, J. A., Hüttermann, H., & Werther, S. (2021). *Employee Experience Questionnaire (EXQ): Fragebogen zur Messung von Zufriedenheit, Commitment und Engagement.* Gesis. https://doi.org/10.6102/zis304

Gazzaley, A., & Rosen, L. D. (2018). *Das überforderte Gehirn: Mit Steinzeitwerkzeug in der Hightech-Welt*. Redline.

Goleman, D. (2014). *Focus: The Hidden Driver of Excellence.* Bloomsbury.

Hari, J. (2022). *Abgelenkt: wie uns die Konzentration abhandenkam und wie wir sie zurückgewinnen.* Riva.

Judah, M. R., Grant, D. M., Mills, A. C., & Lechner, W. V. (2014). Factor structure and validation of the attentional control scale. *Cognition & Emotion, 28*(3), 433–451. http://dx.doi.org/10.1080/02699931.2013.835254

Krebs, M., Kuhn, C., & Sitte, M. (2023). Success factor focus and attention in study and in the work context - a call for action at institutes of higher education in a more and more digitalized world. *EPiC Series in Computing, 93*, 97–104. https://doi.org/10.29007/h3rc

Mark, G. (2023). *Attention Span: A Groundbreaking Way to Restore Balance, Happiness and Productivity.* Hanover Square Press.

Montag, C. (2018). *Homo Digitalis. Smartphones, soziale Netzwerke und das Gehirn.* Springer. https://doi.org/10.1007/978-3-658-20026-8

Newport, C. (2022). *Konzentriert arbeiten: Regeln für eine Welt voller Ablenkungen* (6th ed.). Redline.

Przybylski, A. K., Murayama, K., DeHaan, C. R., & Gladwell, V. (2013). Motivational, emotional, and behavioral correlates of fear of missing out. *Computers in Human Behavior, 29*(4), 1841–1848. http://dx.doi.org/10.1016/j.chb.2013.02.014

Schuler, D., Tuch, A., & Peter, C. (2020). *Psychische Gesundheit in der Schweiz. Monitoring 2020* (Report No. 15/2020). Obsan. https://www.obsan.admin.ch/sites/default/files/obsan_15_2020_bericht_2.pdf

Singh, R. K. (2022). Normierung und testtheoretische Überprüfung der deutschen Adaptation der Kurzform der Self-Control Scale (SCS-K-D). *Diagnostica, 68*(2), 76–87. https://doi.org/10.1026/0012-1924/a000284

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Student Perspectives on Improving Academic Integrity through Authentic Assessment Design

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Abstract

Authentic assessment has been proposed as a potential solution to deal with increasing concerns around academic integrity in higher education; however, empirical research on its effectiveness remains limited. Moreover, the ability of authentic assessment to improve academic integrity depends on students' perspectives and experiences, yet these remain underexplored in existing literature. To address this gap, a thematic analysis was conducted on the perspectives of final-year undergraduate business students (N = 128) in relation to their experiences with authentic assessment. The authentic assessment was structured using a framework and implementation plan developed by Lehane et al. (2024). The findings of this new study suggest that authentic assessment can play a significant role in enhancing academic integrity. Building on these findings, practical implications and recommendations for educators are discussed to promote the adoption and effective implementation of authentic assessment strategies, strengthening their impact on academic integrity.

Keywords: *Academic Integrity; Authentic Assessment; Student Perspectives.*

1. Introduction

Authentic assessment actively engages students by creating immersive, real-world experiences that enhance deep learning, self-reflection, and self-evaluation, empowering students to become autonomous learners and active participants in the assessment process (Jopp, 2020). In addition to enhanced learning, authentic assessments lead to the development of key employability skills such as critical thinking, communication, and creativity, addressing the growing 'global skills gap' emphasised by employers (Wake *et al.,* 2023). Despite the clear pedagogical benefits of authentic assessment, research explicitly exploring student experiences remains scarce, with much of the literature centred on lecturers' viewpoints. Understanding student perspectives is

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essential for improving learning outcomes, skill development, and the successful implementation of authentic assessment in higher education (Wake *et al.,* 2023). While research does suggest that students prefer innovative teaching methods over traditional approaches, limited studies have specifically explored their perceptions of authentic assessment. Addressing this gap, the present study aims to examine student perceptions of authentic assessment, offering empirical insights to enhance its implementation and impact on academic integrity.

2. Literature Review

2.1. Student Perspectives

Examining authentic assessments from a student perspective provides a critical lens for understanding this type of assessment, as student perceptions significantly influence both what and how they learn. Incorporating student perspectives when designing authentic assessments is imperative as authentic assessment shapes their learning approaches, fosters deeper engagement, and enhances overall motivation. The reflective process also provides valuable insights for lecturers on the enhancement of academic integrity through authentic assessment design, as student reflections highlight areas where students believe they benefited most, and where they thought they were supported or challenged (Sokhanvar *et al.,* 2021). Utilising student perceptions to inform the authentic assessment process ensures that the assessment not only aligns with educational objectives but also resonates with students' expectations, learning needs, and professional ambitions (Asgarova *et al.,* 2022). Furthermore, a well-designed authentic assessment experience can enhance students' satisfaction with their degree programme and the university, reinforcing their commitment to ethical academic practices. Although previous studies indicate that students value authentic assessments, there is a lack of in-depth research examining their perceptions, particularly in the context of academic integrity (Asgarova *et al.,* 2022). This study addresses that gap by providing an in-depth analysis of student's perceptions, while also considering broader pedagogical and policy implications for the design and implementation of authentic assessments in higher education business courses.

2.2. Authentic Assessment and Academic Integrity

Authentic assessment is defined as an assessment which evaluates student learning and skill development in ways that are relevant to the workplace and lifelong learning by requiring students to engage with tasks situated within real-world contexts (Jopp, 2020). Authentic assessments must be flexible, dynamic and inclusive, to reflect the diverse student population and the evolving nature of digital and globalised work. There is an urgent need for evidence-based authentic assessment frameworks to clarify lecturer expectations, enhance student understanding, reduce student stress, and facilitate effective implementation of authentic assessment. Furthermore, successful implementation requires faculty training and ongoing

collaboration between educators and industry to ensure that assessments align with current professional standards and industry expectations (Jopp, 2020). Embedding authentic assessment into the curriculum is crucial for its sustainability and long-term effectiveness. However, this integration must be supported by clearly defined institutional policies and guidelines to maintain academic integrity (Sokhanvar *et al.,* 2021). Academic misconduct, particularly the misuse of GenAI, has emerged as a significant global concern. The rapid expansion of the GenAI market presents an ongoing challenge for universities, necessitating strategic responses through assessment design. Authentic assessment design can promote academic integrity by requiring learners to construct original responses and generate personalised, novel ideas that cannot be easily replicated by AI tools (Sotiriadou *et al.,* 2020). Providing students with continuous support throughout the assessment is essential to build students' confidence in their ability to complete tasks independently, thus reducing the likelihood of academic misconduct. Moreover, a collaborative teaching approach involving students as partners in the assessment strengthens their commitment to ethical practices (Sotiriadou *et al.,* 2020). Further research and empirical evidence are required, however, to evaluate the extent to which authentic assessment effectively deters academic misconduct.

3. Methodology

This novel research aims to examine how the implementation of the Lehane *et al.* (2024) framework led to improvements in academic integrity, offering evidence-based analysis to inform authentic assessment design. A qualitative approach was adopted, and a structured methodological process was followed: [1] Students participated in an authentic assessment with a local industry partner, the Marina Market (MM) in Cork City, Ireland, and the student experience served as the case study for this research; [2] Students provided 600-word reflections on their experience post-assessment; [3] Reflections were analysed using Braun and Clarke's (2006) thematic analysis approach to identify new valuable findings; [4] These empirical findings contribute to the refinement of the Lehane *et al.* (2024) framework by offering recommendations for future iterations. A case study approach was employed to explore students' experiences with the MM authentic assessment. The study involved 128 final-year undergraduate Business students at Munster Technological University (MTU), an Irish university, enrolled in a mandatory Strategy module. Working in groups of four, students conducted a strategic analysis of MM and proposed event ideas based on their findings. Data collection took place in January 2024, following completion of the assessment and the submission of individual student reflections. All 128 students provided informed consent for their reflections to be used in this study, and full ethical approval was granted by the MTU Research Ethics Committee. Data was gathered from reflections addressing: [1] students' positive and negative experiences with the authentic assessment, [2] underlying reasons for their perspectives, [3] skills acquired and key learnings, [4] how and why they developed these skills,

and [5] potential improvements they would make. Students structured their reflections using Gibbs' Reflective Cycle (1998). A deductive, theoretical, thematic analysis was conducted, with academic integrity as the overarching theme. All student comments related to academic integrity were systematically coded under this theme, and specific sub-themes were identified.

4. Results

Students reflected on various stages of the authentic assessment process as outlined in the Lehane *et al.* (2024) framework and implementation plan including: the Initial Introduction to the authentic assessment, Marina Market Presentation, Rubric Co-Design, Visual Scrapbook Analysis document, Exemplar Workshop, Peer Feedback, Lecturer-Student Feedforward Sessions and Student Presentations. Under the overarching theme of academic integrity, 571 total student comments were received. The major sub-themes that emerged are shown in Table 1, along with the number of comments coded to each sub-theme, the percentage they represent out of the total 571 comments, and the main stages of the authentic assessment process that they relate to. Sub-themes shown in Table 1 represent the nature of 72% of the 571 comments.

Table 1. Number of Student Comments on Academic Integrity Categorised by Sub-Theme

Sub-Theme	Comments		Authentic Assessment Stage & No. of Comments per Stage*
Understanding	176	31%	Exemplar Workshop (55), Rubric Co-Design (51), Marina Market Presentation (45), Lecturer Feed-Forward (15), Initial Intro (6)
Lecturer Support	80	14%	Lecturer Feed-Forward (62), Rubric Co-Design (6)
Student Partnership	72	13%	Rubric Co-Design (69)
Assessment Type	41	7%	Scrapbook (30), Initial Intro (7)
Self-Regulation	39	7%	Rubric Co-Design (15), Lecturer Feed-Forward (5), Student Presentations (5)

*Authentic Assessment Stages which had less than 5 comments are not shown

The main academic integrity findings are discussed below under the sub-theme headings. Strong evidence is provided to support all findings in the form of student quote examples.

5. Discussion

5.1. Understanding

Exemplars provided students with meaningful learning experiences by clearly communicating assessment expectations and offering illustrative examples. Aligning the exemplars with the co-designed rubric further reinforced assessment clarity by ensuring students comprehended assignment guidelines and developed a clear understanding of the marking criteria. This

collaborative approach between the lecturer and students created a supportive, positive learning environment that engaged students and contextualised their learning. By providing clear guidance and meaningful context, the use of exemplars and rubric co-design helped reduce uncertainty around the authentic assessment, thus minimising the likelihood of academic misconduct. Furthermore, the rubric co-design empowered students to engage more deeply with the assessment criteria, enabling them to clearly connect their learning with assessment outcomes and the standards for success. In addition to the rubric co-design process and exemplar workshops, lecturer feedforward sessions built trust between students and the lecturer, and guided student efforts. This approach increased students' confidence in completing the assessment, leading to improved performance. The presentation from Marina Market representatives enhanced student understanding by providing real-world context and practical insights which bridged the gap for students between theoretical knowledge and its application. The presentation also highlighted industry-specific challenges and goals which clarified industry expectations and enabled students to align their work with professional standards:

"Workshops gave me a very good understanding of how to gain as much marks as possible in sections"
"I really found that I was able to further my understanding of what was required for the project"
"Gaining a thorough grasp of the assessment criteria was made possible through the rubric co-design"
"Feedforward sessions deepened my understanding and refined my approach to the project"
"The MM presentation was informative, providing a fantastic insight into what the company expected"

5.2. Lecturer Support and Student Partnership

Students highly valued timely and constructive lecturer support and feedback, recognising its role in reinforcing learning, enhancing self-reflection, and guiding improvement. Feedforward sessions provided students with clear expectations and personalised support, particularly for challenging tasks, which enhanced student confidence and engagement. The individualised nature of these sessions not only strengthened intrinsic motivation but also reduced the perceived need to engage in academic dishonesty. The strong student-lecturer relationships that emerged through the rubric co-design process was also a key aspect of the authentic assessment experience, reinforcing students' roles as active partners and valued contributors in their learning. By collaborating on the development of assessment criteria, students developed a sense of ownership, empowerment, and autonomy over their learning. This process also introduced flexibility and inclusivity, allowing students to align the marking scheme with their individual learning preferences and needs. An open dialogue about academic challenges developed, enabling the lecturer to provide personalised support and address students' concerns directly. As a result, students felt more supported and were less likely to resort to misconduct. Furthermore, despite the large student cohort, the co-design process facilitated a more personalised approach to teaching by ensuring that every student's voice was heard. Close collaboration also allowed lecturers to become familiar with students' skills and learning styles early in the assessment process. This familiarity not only enabled earlier detection of potential

academic integrity breaches but also allowed lecturers to identify and support struggling students at an early stage, potentially preventing future instances of academic misconduct:

"It was a great opportunity to get to show our lecturer our work and get one to one feedback"
"Gave us a clear path to our end goal and made the process a lot easier"
"I had never taken a module with so much student interaction before, and it was really valuable"
"Felt inclusive, each student was able to voice their opinions, with all accommodated by the lecturer"
"Made me feel important because my input was valued, and I had a say in the marking scheme"

5.3. Assessment Type and Self-Regulation

The introduction of a scrapbook, which was a challenging and unfamiliar assessment type, had both positive and negative implications for students. On the positive side, the novelty and complexity of the scrapbook minimised opportunities for academic misconduct by requiring unique, personalised responses that could not be easily outsourced or replicated, particularly in the era of GenAI tools. The creative and reflective nature of the scrapbook format ensured that each submission was highly individualised, reinforcing academic integrity through authentic student engagement. The unfamiliarity of the assessment also heightened student anxiety and uncertainty about expectations and assessment criteria, however, particularly as this student cohort was the first to complete the new format. Despite these initial concerns, incorporating a visual scrapbook instead of a traditional report ultimately enhanced student engagement by offering greater creative freedom and fostering a sense of ownership over their work. By enabling students to experiment with design, layout, and visual elements, the scrapbook aligned with diverse learning styles and encouraged deeper interaction with course content. The integration of authentic assessment tasks, such as rubric co-design, lecturer feedforward sessions, and student presentations, played a crucial role in developing students' self-regulation skills, which in turn reinforced academic integrity. The reflective nature of these tasks enhanced students' ability to self-evaluate, increasing their self-awareness and self-monitoring – students critically analysed their performance, identified their strengths, and recognized gaps in their knowledge or skills. This deeper understanding enabled them to develop targeted strategies for improvement and personal growth. This emphasis on self-regulation not only improved academic performance but also reduced the likelihood of misconduct, as students became more confident in their abilities and more invested in their personal and academic growth:

"Use of a scrapbook rather than a traditional report was a good choice due to the rise of Chat GPT"
"I found the scrapbook quite interesting as we had not done one before, but this also made it difficult"
"I didn't like the idea of the scrapbook in the beginning as I was confused as to what to put inside it"
"Empowered to design our own rubric, gave me responsibility around my project and its direction"
"In the future, I would practice the presentation further in advance to ensure I was prepared"

6. Implications and Recommendations

This study highlights the importance of integrating rubric co-design, lecturer feedforward sessions, exemplar workshops, industry involvement, and personalised assessment types into authentic assessment practices. Students highly value these elements as they create a partnership, enhance support, and clarify expectations leading to greater student engagement and intrinsic motivation, and reducing the likelihood of academic misconduct. To maximize the benefits of authentic assessment, universities should prioritise co-designing assessments with students, incorporating student feedback, and encouraging open communication. Professional development for lecturers should focus on equipping them with the skills needed to facilitate student partnerships effectively. Moreover, implementing feedforward strategies will encourage self-directed learning by enhancing students' self-regulation skills. Allocating time for personalised feedback and support is essential. Universities should explore innovative delivery methods, such as flipped classrooms, online resources, and in-class co-design and exemplar workshops. Providing students with a range of exemplars of varying quality will encourage critical analysis, self-assessment, and a deeper understanding of assessment criteria. Industry collaboration should also be embedded into authentic assessment practices. Universities should support lecturers in developing industry partnerships and integrating industry perspectives into authentic assessment design. Clear instructions and ongoing feedback are particularly important for students encountering unfamiliar assessment formats, to prevent confusion and potential academic integrity breaches. Finally, as the Lehane *et al.* (2024) authentic assessment framework evolves, future cohorts will benefit from additional exemplars and insights from past students. Providing structured scaffolding and reassurance about ongoing support can help mitigate student anxiety. Clarifying from the outset that students will have input in the assessment design and receive personalised feedback will further encourage engagement and ensure the successful implementation of authentic assessment.

7. Conclusion and Future Research

Future research should explore the generalisability of this study's novel and significant findings to different authentic assessment types, disciplines, and universities. Evaluating the impact of student demographics and academic performance on the authentic assessment experience would provide further insights. Further in-depth analysis of student anxiety in relation to unfamiliar assessment types should be carried out. Comparative studies examining student perspectives at various academic stages, as well as evaluations of traditional versus authentic assessments, would also be valuable. Additionally, engaging recent graduates would assess the long-term impact of authentic assessment on employability and workforce transitions. The role of industry partnerships in authentic assessment warrants further exploration, particularly in cases where direct student access to industry premises is limited. Research into industry partners' perspectives, alongside lecturer and graduate experiences, could provide a more in-depth

understanding of how authentic assessment aligns with professional expectations. This study strengthens empirical support for integrating authentic assessment into higher education curriculum design, teaching strategies, and academic integrity policies. By implementing Lehane et al.'s (2024) framework, institutions can enhance academic integrity while improving student engagement and learning outcomes. Given the global relevance of these challenges, sharing best practices in authentic assessment is essential for advancing higher education. This study serves as a foundation for further research, encouraging policymakers and educators to adopt student-centred approaches that align with the evolving needs of 21st-century learners.

References

Asgarova, R., Macaskill, A. and Abrahamse, W. (2023). Authentic assessment targeting sustainability outcomes: a case study exploring student perceptions. *International Journal of Sustainability in Higher Education*, 24(1), 28-45. https://doi.org/10.1108/IJSHE-07-2021-0266

Braun, V. and Clarke, V. (2006) Using Thematic Analysis in Psychology. *Qualitative Research in Psychology*, 3, 77-101. http://dx.doi.org/10.1191/1478088706qp063oa

Gibbs, G. (1988). *Learning by Doing: A Guide to Teaching and Learning Methods,* Further Education Unit, Oxford: Oxford Polytechnic.

Jopp, R. (2020). A case study of a technology enhanced learning initiative that supports authentic assessment. *Teaching in Higher Education*, 25(8), 942–958. https://doi.org/10.1080/13562517.2019.1613637

Lehane, S., Wright, A., & Fenton, P. (2024). Improving academic integrity through authentic assessment design. *Irish Educational Studies*, 1–23. https://doi.org/10.1080/03323315.2024.2441164

Sokhanvar, Z., Salehi, K., & Sokhanvar, F. (2021). Advantages of authentic assessment for improving the learning experience and employability skills of higher education students: A systematic literature review. *Studies in Educational Evaluation*, 70, 101030. https:// doi. org/ 10. 1016/j. stued uc. 2021. 101030

Sotiriadou, P., Logan, D., Daly, A. and Guest, R. (2020). The role of authentic assessment to preserve academic integrity and promote skill development and employability. *Studies in Higher Education*, 45(11), 2132-2148. doi:10.1080/03075079.2019.1582015

Wake, S., Pownall, M., Harris, R., & Birtill, P. (2023). Balancing pedagogical innovation with psychological safety? Student perceptions of authentic assessment. *Assessment & Evaluation in Higher Education*, 49(4), 511–522. https://doi.org/10.1080/02602938.2023.2275519

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Implementing Reflections in Student's Project Work to Enhance Study Performance – Lessons Learnt

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Abstract

In today's fast-paced and interconnected work environments, higher education institutions are turning to project-based courses to cultivate collaborative learning. While effective, this approach may overwhelm students, potentially affecting their motivation and group performance. To address these challenges, two undergraduate courses incorporated mandatory reflective practices grounded in Kolb's Learning Cycle. These reflections were designed to boost individual engagement and critical thinking, mitigating problems related to group dynamics and motivation. The study focused on how students responded to these reflective exercises, investigating their impact on teamwork, communication, and overall project results. It highlighted the importance of instructor involvement and customized support. Insights are provided for educators aiming to integrate reflection into their teaching, as it proved to be a powerful tool for fostering student autonomy and improving project-based learning outcomes in higher education.

Keywords: *reflection, group work, projects work, self-reflection.*

1. Introduction

As project-based learning becomes more widespread in higher education, it has sparked a reconsideration of traditional student assessment strategies: (Cuseo, 1992; Siegeris and Pfennig, 2022) prioritizing student-centered experiences, fostering collaboration and problem-solving within real-world scenarios: (Sjølie, Espenes, & Buø, 2022). Self-reflection has emerged as a promising criterion for evaluation: (Bohd, 2015; Goel, 2017). Within this framework, group processes are vital for fostering collaboration, with team members participating in critical dialogue and operating as self-organized units: (Sjølie, Espenes and Buø, 2022; Johnson & Johnson, 2009). Regular team reflections enable participants to assess their performance, refine their methods, and proactively address potential challenges (Kneisel, 2020; Edmondson, 1999).

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This practice proves especially beneficial in online project settings, where it aids in adapting to virtual learning environments: (Sjølie, Espenes and Buø, 2022).

Reflective practices, such as regular team reflections and pre- and post-project evaluations, enhance collaboration and adaptability in project-based learning. Team reflections allow members to assess goals, refine workflows, and adapt to changing conditions, while pre- and post-project reflections emphasize social interdependence over individual skills: (Sjølie, Espenes and Buø, 2022; Kneisel 2020). High-achieving students use self-reflection for both formative and summative assessments, aligning well with agile methodologies through retrospective evaluations to improve team efficiency and enabling them to align better with educators' expectations: (Bohd, 2015). Evidence suggests that reflective training enhances test scores: (Schneider, 1986). In engineering education, combining team-based efforts with portfolio assessments provides valuable insights into student learning (Knipfer, Kump, Wessel, Cress, 2013). Similarly, reflective practices in fields like arts and reading education contribute significantly to personal growth and professional development: (Carpe, 2019). While self-reflection delivers rich feedback, it may demand additional time and effort: (Coertjens, 2021).

Despite their potential, research on the impact of self-reflection on individual performance in group projects is limited. A study employing Kolb's Reflective Learning Cycle: (Kolb, 1984) and a blind review process found that reflective practices can improve teamwork and final product quality. However, insufficient attention has been given to students' perspectives, well-being, and personal learning outcomes. The here addressed findings underline the importance of supportive conditions for effectively integrating reflections into engineering education.

2. Method: The reflection process in IT and mechanical engineering courses

Reflection levels vary in depth and are delineated by various reflective models, e.g. descriptive, simple, value based, evaluative, analytical and concluding as outlined by: (Moon, 2004) and expanded upon by: Dowling, 2019) (summarized by: (Pfennig and Siegeris, 2024).

It's crucial to recognize that a comprehensive reflection often integrates elements from these diverse levels. However, achieving a truly "insightful" reflection necessitates reaching an "analytical" or "conclusive" level of depth, as emphasized by: (Dowling, 2019). Connecting reflective practice to the learning process, Kolb's Learning Cycle: (Kolb, 1984), as previously discussed by: (Siegeris and Pfennig, 2024), posits reflection as one of the four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Figure 1 refers to the reflective tasks and main observation during the reflection cycles.

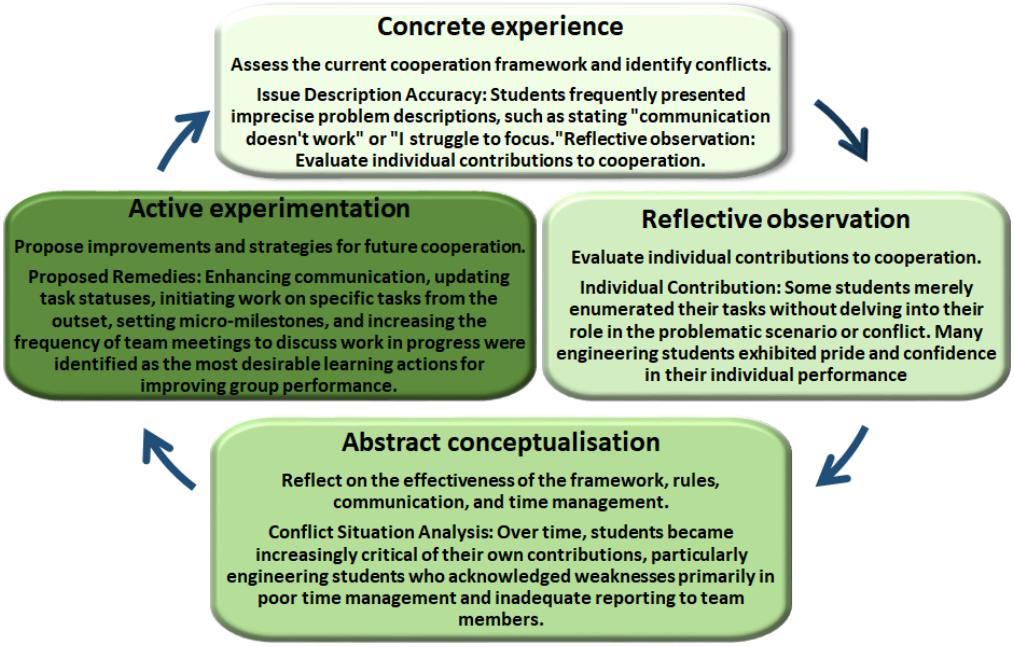


Figure 1: Kolb's Learning Cycle delineates four stages within the learning process: It begins with a concrete experience, proceeds to reflective observation of what transpired, moves on to an attempt to comprehend the occurrences and their underlying reasons, and culminates in testing the comprehension through experimentation. Source: Adapted from: (Kolb, 1984 p. 42) in: Dowling (2019) modified from: (Siegeris and Pfennig, 2024).

Communication challenges emerged as a predominant issue in both projects. Initially, students found reflections to be time-consuming and did not perceive them as beneficial for project outcomes. However, subsequent reflection cycles revealed their positive impact on communication and task clarification (Pfennig and Siegeris, 2024). In the IT course, project results could not be directly linked to reflective statements due to multiple stakeholders involved. Conversely, in the Materials Science course, lecturers outlined main issues addressed in student reflections post-course and assigned weighted scores based on wording, emotional involvement, and rational statements (Figure 2). Notably, there was no correlation between rules, micro tasks, communication, cooperation, scientific performance, individual time management, and individual project assessment. Groups demonstrating superior time management skills, including meeting deadlines, achieving milestones, and holding informal meetings, tend to receive higher grades compared to those with poor time management. Figure 2 allows to estimate a modest correlation between improved group and time management and higher grades.

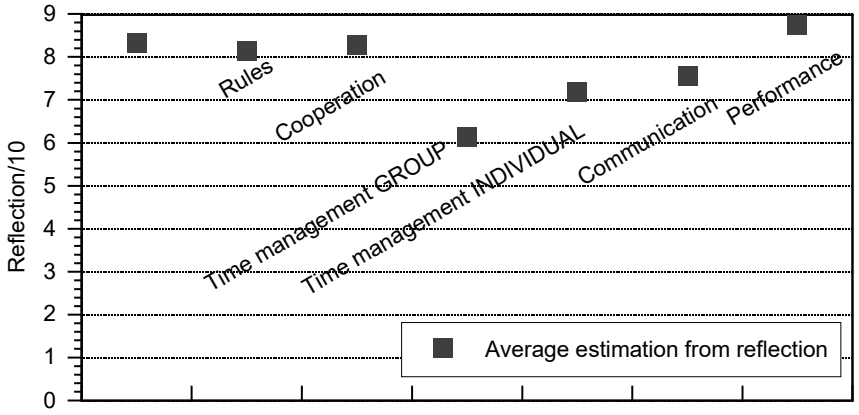


Figure 2. Weighting of the main topics issued within students` reflection with regard to influence on the project outcome (0 poor, 10 outstanding).

In the following, the authors focus on lessons learnt from students` feedback and implementing the reflection method for 5 semesters. First findings were presented at ICERI 2024: (Pfennig and Siegeris, 2024).

3. Results: Student`s feedback

MB students' reflections on the scientific task offer valuable insights into their experiences with research and collaboration. They highlight key challenges, including unfamiliar topics, distractions, frustration, and demotivation. Students recognize the importance of a structured research approach and suggest strategies for future improvement, such as acknowledging the often-overlooked role of research. Furthermore, their reflections address group communication challenges and propose actionable steps to enhance communication in future projects.

The IT course focused on product development implementing agile methods. However, the remote setting of the course was found to add extra challenges to mastering the project. As key issues from the Summer School IT Students in mixed team (German/Australian) agile projects students remind of the importance of clear communication, adherence to guidelines, technological support for data management, addressing time-related challenges, ensuring adequate subject knowledge, enhancing agile skills, resolving specific issues promptly, and addressing language barriers to foster effective collaboration and project success.

Students prioritized the frequency and timing of reflections, feedback and engagement of instructors along with structure and guidance as most critical to their personal study success (Figure 3). The relationship and regular meetings were not rated important. Team dynamics, authenticity and team practical as well as emotional support is rated with medium priority to IT students.

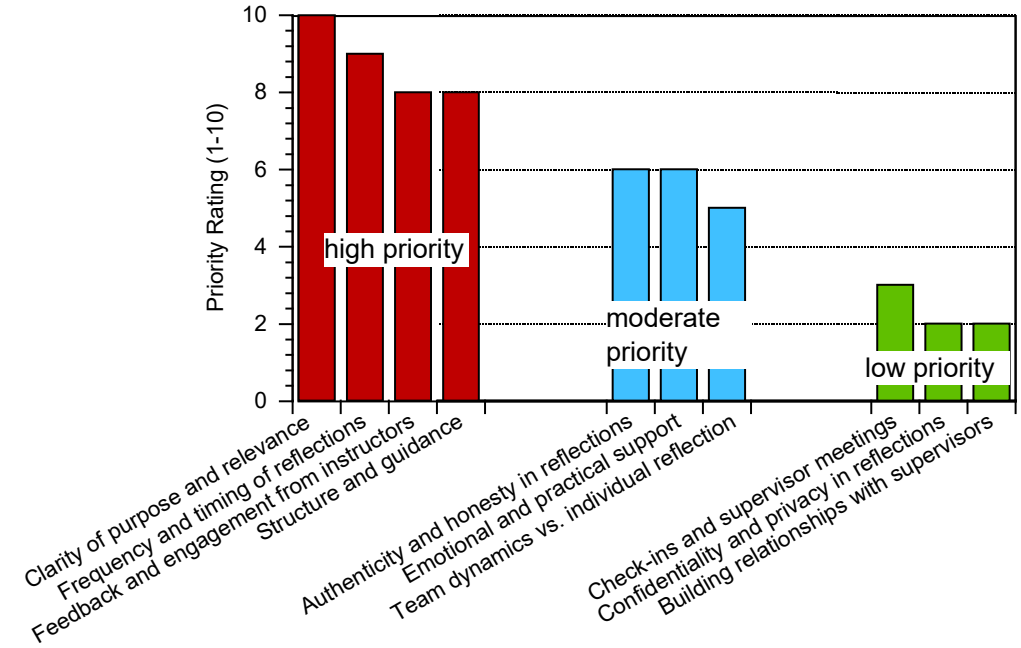


Figure 3. Key issues related to reflection grouped by students` priority rating. Data was obtained anonymously 2022-2023 during 3 months summer school. An external counselor regularly discussed issues with students finalizing the given results from multiple student inputs, findings and feedback.

4. Discussion: Lessons learnt

Reflections in higher education have both benefits and drawbacks. On the positive side, they provide a structured way for students to engage in metacognition, fostering deeper understanding, critical thinking, and self-directed learning. They also empower students to take ownership of their education, making them more active participants: (Kolb, 1984; Moon, 2004; Kneisel, 2020; Pfennig and Siegeris, 2024). However, reflections can be time-consuming, overly subjective, and disconnected from students' academic or career goals, particularly when clear guidelines or grading criteria are absent.

Students prioritize structured and consistent elements of their education, such as timely reflections, feedback, instructor engagement, and clear guidance, as critical to their study success. Personal relationships and regular meetings are considered less important, suggesting a preference for efficiency and autonomy in learning. Team dynamics, authenticity, and emotional support hold medium priority, indicating that while collaboration and a supportive environment are valued, they are secondary to instructor-led support. For IT students, these findings highlight the whish for programs that emphasize clear instructions and practical feedback while placing less focus on fostering personal connections. This suggests a broader

preference for individualized and task-oriented learning processes, but is not in agreement with the aim of higher education where students take over responsibility for their learning progress and. Moreover, students it shows, that students do not realize that personal connection is the key issue to successful collaboration and team progress.

Many students complete reflections purely for grades, lacking intrinsic motivation. To address this, instructors should integrate reflections meaningfully into the curriculum, align them with course objectives, and provide clear directions. Additionally, factors such as students' prior experience, learning preferences, and cultural context (e.g., international summer school settings) influence the effectiveness of reflections.

First-year engineering students often overestimate their abilities due to limited project experience or past inflated praise, necessitating lecturers to bridge the gap between self-evaluation and actual outcomes in group projects. Despite strong individual time management skills, students rate group coordination poorly, highlighting the need for strategies and preparatory workshops in cross-cultural training, language adaptation, team building, and agile skills. To enhance reflection activities, educators should provide clear guidelines, link reflections to learning objectives, integrate them into assessments, and offer examples and feedback for authentic self-reflection (Pfennig and Siegeris, 2024). Continuous review and adjustment of reflection strategies can further optimize learning outcomes and support student success.

In general, from incorporation of reflection as learning and assessment practice in mechanical engineering and IT the most important lesson is that students relate their study success mostly upon external criteria, such as guidance, deadlines, engagement and support offered by lecturers and feedback. Therefore, comprised lessons learnt are: (Pfennig and Siegeris, 2024).

Structured research/project guidance:

- emphasize research as a critical aspect of academic work, not just a task.
- provide clear guidelines, resources, and workshops on research methods, academic databases, and source evaluation. Clear mile-stones need to be respected.
- highlight that research and organization contribute over 70% to project success.

Managing distractions:

- encourage creating dedicated study spaces and setting time blocks for focused work.
- suggest using techniques like the Pomodoro Technique for concentration.

Addressing frustration and demotivation:

- offer regular check-ins to monitor progress and provide encouragement.
- facilitate peer support networks and provide constructive feedback.

Preparatory workshops for international IT groups:

- cross-cultural training: cultural awareness and sensitivity for better team dynamics.
- language adaptation: strategies for clear communication among multiple backgrounds.
- team building: trust, rapport, and a sense of shared responsibility among the team.
- agile skills: agile principles and practices for effective project management.

However, the authors want to note, that higher education trains young adults to be responsible for their own career and learning progress and the need to find a suitable balance between the request for strong guidance and demands of their future professional environment that will rely upon self-management, critical thinking and creative goal-driven project outcomes.

5. Conclusion

Reflection cycles in project-based IT and material science courses revealed challenges such as: insufficient guidance, miscommunication, poor time management, navigating unfamiliar topics, and dealing with frustration and distractions. Reflections helped improve team dynamics, task clarity, and collaboration.

The lessons learnt from implementing reflection cycles in undergraduate project-based IT and material science courses highlight several key insights: Students emphasized the need for external criteria as viable to their study success, such as: structure, engagement of lecturers, feedback clear communication, agile skills, and addressing language barriers. Instructors are encouraged to provide structured research guidance, foster a supportive learning environment, and incorporate preparatory workshops on team building, cross-cultural training, and agile skills. Key recommendations for instructors include:

1. clarity: clearly defining expectations, offer clear guidelines
2. lecturer engagement: supporting self-reflection and authenticity.
3. communication: promoting effective communication and structured research.
4. feedback: addressing frustration, distraction, and time management challenges.
5. skills: provide team-building and agile skills training.

Reflections demonstrate student's self-awareness and willingness to learn from their experiences, suggesting opportunities for growth and development in their academic progress. When implemented thoughtfully, reflections can enhance learning, collaboration, and personal growth, preparing students for academic and professional success. The authors emphasize that higher education must balance providing guidance with preparing students for professional environments that demand self-management, critical thinking, and goal-oriented creativity.

References

Bohd, J.D. (2006). Reflective Assessment: Including Students in the Assessment Process. *Form of the Public Policy*, 1-17.

Carpe, D. (2019). Tool: Self reflection / assessment as didactic tools. Project: Teaching Interdiscipl. Artistic Research. DOI:10.13140/RG.2.2.11230.18244.

Coertjens, L., Lesterhuis, M., De Winter, B. Y.c, Goossens, M., De Maeyer, S., Michels, N.R.M. (2021). Improving Self-Reflection Assessment Practices: Comparative Judgment as an Alternative to Rubrics, *Teaching and Learning in Medicine*, 33(5), 525-535, DOI: 10.1080/10401334.2021.1877709.

Cuseo, J. B. (1992). Tips for students when forming learning teams: How to collaborate with peers to improve acad. performance. *Coop. Learning and College Teaching* 7(3), 11-16.

Dowling Carew Hadgraft (2010). Engineering your future, Chapter 3 Learning to be an Engineer. Retrieved from: https://e.pdfpremiumfree.com/downloads/dowling-carew-hadgraft-engineering-your-future/ January 2023

Edmondson, A. (1999). Psychological safety and learning behavior in work teams. *Administrative Science Quarterly*, 44(2), 350–383.

Goel, Sanjay (2017). Reflection in Action Information. Retrieved from: Engin. & Comp. Ed. Reflections and Ideation. http://goelsan.wordpress.com/2010/08/20/design-is-a-reflective-practice-a-summary-of-schons-views/.

Johnson, D. W., & Johnson, R. T. (2009). An educational psychology success story: Social interdependence theory and cooperative learning. *Educational Researcher*, 38 (5), 365–379. https://doi.org/10.3102/0013189x09339057.

Kneisel, E. (2020). Team reflections, team mental models and team performance over time. *Team Performance Management*, 26(1–2), 143–168. DOI: 10.1108/TPM-09-2018-0061.

Knipfer, K.; Kump, B.; Wessel, D.; Cress, U. (2013). Reflection as a catalyst for organizational learning. *Studies in Continuing Education*, 35(1), 30–48, 2013.

Kolb, D. (1984), Experiential Learning: Experience as The Source of Learning and Development. Prentice Hall, New Jersey.

Moon, J. (2004), A Handbook of Reflective and Experimental Learning: Theory and Praxis, Routledge Falmer, London.

Pfennig, A., Siegeris, J. (2024). Reflections from a student perspective – response to action. In: *Proceedings 2024 of the ICERI 17th annual International Conference of Education*, 1260-1269. doi: 10.21125/iceri.2024.0389.

Schneider, W., J. G. Borkowski, B. Kurtz, and K. Kerwin. (1986). Metamemory and motivation: A comparison of strategy use and performance in German and American children. *Journal of Cross-Cultural Psychology* 17(3), 315-336.

Siegeris, J.; Pfennig, A. (2022). Team Formation and Project Assignment − the dilemma of assigning students to project groups. In: *Proceedings of the HEAd'22*, 1313-1320, 2022.

Sjølie E., Espenes T.C., Buø R. (2022). Social interaction and agency in self-organizing student teams during their transition from face-to-face to online learning. *Computers & Education* 189, 104580. https://doi.org/10.1016/j.compedu.2022.104580.

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Design principles for generating real-time explanations to learners' questions in a virtual reality learning environment using natural language generation: Practice based lessons learned from creating multiple agents in Unreal Engine 5 using ConvAI

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Abstract

The effectiveness of a virtual reality learning environment (VRLE) can be enhanced through adaptive instruction where pedagogical agents adjust their instruction to the learner's actions. Despite advances in natural language processing, the lack of natural communication of pedagogical agents in a VRLE is reducing its effectiveness. Furthermore, there is a lack of design principles for developing pedagogical agents that respond intelligently to learners and can converse naturally. This paper is part of a larger study that investigates the design principles for effective pedagogical agents in VRLEs that provide real-time explanations using natural language generation. It reports on the lessons learned while developing a pedagogical agent using Unreal Engine and ConvAI. Two key design principles were identified, namely the importance of multiple pedagogical agents with distinct roles and well-rounded personas. A pedagogical agent was developed, and initial tests show that the agent responded intelligently in an appropriate context.

Keywords: *Virtual reality; Education; Pedagogical agent; Natural language generation*

1. Introduction

Pedagogical support tools are imperative to enhance learning and form a part of the adaptive learning system in the virtual reality learning environment (VRLE) (Steynberg, 2021; Steynberg et al., 2023). Pedagogical tools can be implemented through the environment or a pedagogical agent. A pedagogical agent is a digital, lifelike character in a digital learning environment that can provide guidance, model desired behaviour and skills, assist, and support the learner emotionally and cognitively as well as metacognitively (Dai & Ke, 2022; Grivokostopoulou et

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al., 2020; Tao et al., 2022). The problem investigated in this study is that despite the advancement of technology regarding natural language processing and real-time text-to-speech conversion, the lack of fluent and natural communication of pedagogical agents in virtual reality is reducing the effectiveness and usability in electronic learning environments (Sikström et al., 2022). This inadequacy in pedagogical agents' communication implies challenges to adaptive, adequate, relational, and logical communication (Sikström et al., 2022).

The larger study attempts to answer the following question:

What are the design principles of effective and efficient pedagogical agents in immersive virtual reality learning environments that can respond to learners' questions and provide explanations in real-time using natural language generation?

This paper reports on a sub-part of the prototype development, namely lessons learned for creating pedagogical persona generated by an artificial intelligence character engine that can respond intelligently and efficiently to learner's questions and provide suitable and relevant explanations in real-time.

2. Methodology

This study adopts the Systems Development Research Methodology (SDRM) from Design Science Research (DSR), introduced by Nunamaker et al.(Nunamaker & Chen, 1990), which comprises of six key phases: problem and objective definition, design and development of a prototype, demonstration, evaluation, and communication. This paper focuses on a sub-section of the prototype development, namely using Unreal Engine 5 and ConvAI to create a persona and intelligent conversation engine for the pedagogical agent and do an initial review of the responses achieved by conversing with the agent. Unreal Engine 5 is a 3D creation tool used to build various immersive experiences. ConvAI is a character development engine that allows the creator to craft personalities, backstories and facilitate real-time, responsive conversations.

2.1. Developing the pedagogical agents and non-player characters for the VRLE

Following the guidelines proposed by Steynberg et. al. (2021), a storyboard was created to define the overall flow of the learning experience. Thereafter the non-player characters and pedagogical agent for each scene were specified. At the commencement of this study, it was envisioned that there will be a group of villagers who carry on with their daily lives but will not communicate with the character with only one pedagogical agent - a sage that will provide the learning. This was due to the perceived complexity of implementing the natural language integration into the VRLE for a specific character. As the development proceeded and testing was continuously done through the process by the authors, it became apparent that communication and interaction with the other characters could also contribute to the authenticity

and level of immersion of the learner, as a non-player character that does not communicate with the player feels unnatural. During a previous study (Steynberg, 2023), one of the participants stated that she 'felt very alone and isolated' as there were no other characters or players in the prototype that was built, only a voice that provided instructions.

Initial work done by Baylor and Ebbers (2003) found that multiple agents with separate roles have a significant positive impact on learning as well as the perceived value of the agents. They coined this principle as the split persona effect, where two distinct agent roles such as an expert and a motivator in two separate personalities is preferable to one agent with one role such as a mentor and further determined that it was simpler for learners to split or compartmentalize the information delivered by the two different agents, and this led to improved learning (Baylor & Ebbers, 2003). Baylor and Kim (2016) identified three primary roles that an agent can assume in an educational setting, namely a motivator, an expert, and a mentor. This list has been expanded to include additional roles, such as tutor, assistant, learning partner, competitor, and even troublemaker (Kim & Baylor, 2016; Tao et al., 2022; Waldner et al., 2022).

2.2. Pedagogical agent personas

The definition of a pedagogical agent states that it is a lifelike digital character, therefore it has human traits, emotions, and a persona (Alfaro et al., 2020; Alimamy & Kuhail, 2023). A well-defined, likable persona improves the learner's perceived anthropomorphism which helps to create an emotional connection with the agent, as well as enhances the trust which is crucial for learner engagement (Alfaro et al., 2020; Baylor & Ebbers, 2003; Castro-Alonso et al., 2021). By designing the agent's appearance, voice, nonverbal communication and personality to reflect and support the role its playing in the learning environment could impact specific learning and motivational outcomes (Kim & Baylor, 2016)

Referring to these guidelines derived from literature, the development of the VRLE continued with the design and development of multiple non-player characters and a sage who can all converse in natural language and respond efficiently and effectively to learners' questions, as well as guide the learner through the learning tasks. A character engine is typically used to develop characters in a game - it is a set of tools that help developers to create generative artificial intelligent characters for games. The requirements for such a character engine were derived from the literature-based guidelines as noted in Table 1.

Table 1. Requirements of a character engine to create a pedagogical agent in virtual reality

Personality aspect	Characteristics	Character engine capabilities	Source
Agent role	The role of the agent must be distinct and easily recognisable	The agent must have a specific personality with a backstory that fits in with the role of the agent	Baylor & Ebbers, 2003; Kim & Baylor, 2016; Tao et al., 2022; Waldner et al., 2022
Agent knowledge	The agent must have appropriate knowledge to be able to fulfill the pedagogical role identified	A knowledge base should be accessible for each specific agent that forms the base of their knowledge	Baylor & Ebbers, 2003; Kim & Baylor, 2016; Waldner et al., 2022
Appearance	The agent's appearance should be likable without distracting the learner	The agent's gender, race, age and clothing should be easily configurable and changeable if needed	Alfaro et al., 2020; Baylor & Ebbers, 2003; Castro-Alonso et al., 2021; Kim & Baylor, 2016
Emotions	The agent's emotional state should be apparent by the type of language it uses, as well as body language	The agent's emotional state should be configurable	Alfaro et al., 2020; Alimamy & Kuhail, 2023
Actions	The agent's body language and movements in the VRLE must be believable and appropriate	Body language and animation should be configurable, and lip syncing should be appropriate	Kim & Baylor, 2016
Narrative flow	The agents as a collective entity should be able to guide the learner through the tasks	The narration and communication with the learner should follow a decision tree, depending on the actions and responses of the learner	Chen, 2006; Clarebout & Elen 2007; Minocha & Hardy 2016

Different character engines for creation of characters in Unreal Engine were considered. An internet search was done on 15 November 2024 with the following search criteria: "character engine for NPC AI unreal engine 5" where NPC is a non-player character. There are not many character engines currently available, and only three suitable engines were identified, namely InworldAI, ConvAI, and Replica. The support of the character engine towards the personality aspects from Table 1 were considered, and ConvAI was selected because it provides the

capability to create an agent persona that is fully rounded, its appearance can be custom built, narrative design can be done and it is affordable with a low learning curve.

2.3. Creating a pedagogical agent as a non-player character in ConvAI

To develop a character in ConvAI, there are different aspects that feed into the creation of the persona. To define the personality and style of the character, the character's name, personality traits, and distinctive features must be defined. The engine has the capability to set the character's personality in terms of openness, meticulousness, extraversion, agreeableness, and sensitivity visually with sliders. Specific speaking patterns and sample dialogues can be entered, such as favourite phrases or exclamations used by the character. A specific voice can be selected, and multiple languages are supported. Special pronunciation can be added for specific words and words that can be hard to recognise such as names can be listed explicitly.

A backstory in the form of a brief background on the character's story should be created and added to the engine. A knowledge base can be uploaded as books of information to create your character's conceptual framework and can elevate its knowledge to any level you choose. The state of mind of the character can be set by choosing a specific state on an emotions wheel. Considering long term memory, all dialogues that the pedagogical agent has completed are stored in a memory bank. This is an important consideration for developing a VRLE that will be used by various learners. Names and places should not be part of long-term memory, as confusion can arise if the agent uses the wrong name.

Narrative design allows the developer to define certain dialogue responses depending on the conversation between the agent and the learner. Dialogue sections are added to the narrative design which define the objective of the section or a set script and has a specific decision point. A decision point is when the agent asks a question and the learner responds in a certain way, or something specific is addressed in the conversation. Lastly, safety restrictions can be defined as on or off - the engine allows for moderation to form part of the narrative response. This prevents the agents from using profanities, hate speech or inappropriate content.

2.4. Prototype development

ConvAI was used to develop the first character. A backstory for the character was created through ChatGPT and uploaded to the ConvAI platform, but no specific narrative design was done. The emotion defined for the character was being "sad" and "desperate" since he is a survivor of an apocalyptic fiasco and is struggling to find a means of living. The Metahuman platform was used to create the visual appearance of the character and Unreal Engine 5 was used to implement realistic animations.

A conversation between the learner and pedagogical agent then takes place by using the learner's microphone and speakers in the virtual reality head-mounted display. The character engine captures the voice input from the microphone, translates it to text and uses a large language model, incorporating the persona definition created by the developer to generate an appropriate response. This is then converted to speech which the learner hears through their headset.

Initial testing done by a volunteer produced an example of a conversation that took place as shown in Table 2.

Table 2. Extract of a conversation between a learner and the pedagogical agent

Learner	In what town are we right now?
Pete	We're in a small, run-down village. It's not much, but it's home for a handful of survivors. Everyone's trying to make it work in this new reality. If you decide to stay a bit, you might find some interesting stories and maybe learn a few survival skills from the folks here.
Learner	What happened? Why are they survivors?
Pete	It's a long story. The world went through a huge upheaval—systems we relied on collapsed, and chaos followed. Climate disasters, power outages, and food shortages hit hard. The people here managed to survive through sheer will and resourcefulness, holding onto whatever they could from the past while adapting to the new world. It's been a struggle, but they're determined to keep going.
Learner	What methods of survival are they implementing?
Pete	The villagers have turned to some traditional methods for survival. They've been foraging for edible plants and trying to cultivate small gardens, despite the challenges with soil and climate. Some have taken up fishing or hunting, using whatever tools they can manage to find or make. They're also relying on skills passed down from older generations, like preserving food and basic craftsmanship. It's a mix of ingenuity and adaptation to make it through each day.

3. Conclusion

This paper reports on lessons learned during the design and implementation of a virtual reality learning environment reality with pedagogical agents using natural language processing and generative artificial intelligence. Lessons learned in this study include firstly the significance of implementing multiple pedagogical agents with multiple, different roles such as a motivator,

expert or mentor to improve the trust, engagement and immersion that could lead to improved learning outcomes of the learner in the VRLE. Secondly, agents with well-rounded personalities that are believable, authentic and likable personalities lead to improved engagement, higher trust and motivation. Combining these two design principles of creating multiple agents with unique, authentic personalities lead to a challenge to develop agents in a simple, clear and efficient way and tools to simplify, streamline and accelerate the development of these characters were researched. From these design principles requirements for such a character engine has been derived and include that the character engine should facilitate specifying and customising an agent's persona, role, background knowledge, appearance, state of mind, animations and the narrative flow for each agent. Another finding pertains to the selection of character engines where three different character engines were evaluated, and ConvAI was selected because of its capabilities and features, ease of use and low cost. It was used to create the first pedagogical agent for the VRLE, and initial tests show that the pedagogical agent conversed intelligently, responding with contextually appropriate responses. Future work includes the completion of the prototype by adding multiple pedagogical agents and narrative flow, where after the theoretical contribution of the study will follow. This will be a set of practice evaluated design principles that are founded in literature to guide developers of immersive virtual reality learning environments with effective and efficient pedagogical agents that can converse naturally using generative artificial intelligence and natural language processing.

References

Akoka, J., Comyn-Wattiau, I., Prat, N., & Storey, V. C. (2023). Knowledge contributions in design science research: Paths of knowledge types. *Decision Support Systems*, *166*, 113898. https://doi.org/10.1016/j.dss.2022.113898

Alfaro, L., Rivera, C., Luna-Urquizo, J., Castaneda, E., Zuniga-Cueva, J., & Rivera-Chavez, M. (2020). New Trends in Pedagogical Agents in Education. *2020 International Conference on Computational Science and Computational Intelligence (CSCI)*, 923–928. https://doi.org/10.1109/CSCI51800.2020.00172

Alimamy, S., & Kuhail, M. A. (2023). I will be with you Alexa! The impact of intelligent virtual assistant's authenticity and personalization on user reusage intentions. *Computers in Human Behavior*, *143*, 107711. https://doi.org/10.1016/j.chb.2023.107711

Baylor, A. L., & Ebbers, S. J. (2003). The Pedagogical Agent Split-Persona Effect: When Two Agents are Better than One. *World Conference on Educational Multimedia, Hypermedia & Telecommunications*, 459–462.

Castro-Alonso, J. C., Wong, R. M., Adesope, O. O., & Paas, F. (2021). Effectiveness of Multimedia Pedagogical Agents Predicted by Diverse Theories: A Meta-Analysis. *Educational Psychology Review*, *33*(3), 989–1015. https://doi.org/10.1007/s10648-020-09587-1

Chen, C. J. (2006). The design, development and evaluation of a virtual reality based learning environment. *Australasian Journal of Educational Technology*, *22*(1). https://doi.org/10.14742/ajet.1306

Clarebout, G., & Elen, J. (2007). In search of pedagogical agents' modality and dialogue effects in open learning environments. *E-JIST*, *10*(1).

Dai, C.-P., & Ke, F. (2022). Educational applications of artificial intelligence in simulation-based learning: A systematic mapping review. *Computers and Education: Artificial Intelligence*, *3*, 100087. https://doi.org/10.1016/j.caeai.2022.100087

Grivokostopoulou, F., Kovas, K., & Perikos, I. (2020). The Effectiveness of Embodied Pedagogical Agents and Their Impact on Students Learning in Virtual Worlds. *Applied Sciences*, *10*(5), 1739. https://doi.org/10.3390/app10051739

Haj-Bolouri, A. (2019). Design Principles for E-Learning that Support Integration Work: A Case of Action Design Research. In B. Tulu, S. Djamasbi, & G. Leroy (Eds.), *Extending the Boundaries of Design Science Theory and Practice* (Vol. 11491, pp. 300–316). Springer International Publishing. https://doi.org/10.1007/978-3-030-19504-5_20

Kim, Y., & Baylor, A. L. (2016). Research-Based Design of Pedagogical Agent Roles: A Review, Progress, and Recommendations. *International Journal of Artificial Intelligence in Education*, *26*(1), 160–169. https://doi.org/10.1007/s40593-015-0055-y

Minocha, S., & Hardy, C. (2016). Navigation and Wayfinding in Learning Spaces in 3D Virtual Worlds. In *Learning in Virtual Worlds: Research and Applications* (pp. 5–41).

Nunamaker, J. F., & Chen, M. (1990). Systems Development in Information Systems Research. *Journal of Management Information Systems*, *7*(3), 631–640.

Peffers, K., Tuunanen, T., Gengler, C. E., Rossi, M., & Hui, W. (2020). The design science research process: A model for producing and presenting information systems research. *Systems Research*.

Schroeder, N. L. (2016). Pedagogical Agents. In D. H. Choi (Ed.), *Emerging Tools and Applications of Virtual Reality in Education:* (pp. 216–238). IGI Global. https://doi.org/10.4018/978-1-4666-9837-6

Sikström, P., Valentini, C., Sivunen, A., & Kärkkäinen, T. (2022). How pedagogical agents communicate with students: A two-phase systematic review. *Computers & Education*, *188*, 104564. https://doi.org/10.1016/j.compedu.2022.104564

Steynberg, J. C. (2021). *The development of a virtual reality learning environment to assess knowledge transfer in science education: A design science approach focusing on magnetism*. University of South Africa.

Steynberg, J. C., van Biljon, J., & Pilkington, C. (2023). *Virtual learner experience (VLX): A new dimension of virtual reality environments for the assessment of knowledge transfer*.

Tao, Y., Zhang, G., Zhang, D., Wang, F., Zhou, Y., & Xu, T. (2022). Exploring Persona Characteristics in Learning: A Review Study of Pedagogical Agents. *Procedia Computer Science*, *201*, 87–94. https://doi.org/10.1016/j.procs.2022.03.014

UNESCO. (2022). *Where are we on education recovery?* Unicef.

Waldner, S., Seeber, I., Waizenegger, L., & Maier, R. (2022). *How do Pedagogical Conversational Agents affect Learning Outcomes among High School Pupils: Insights from*

a Field Experiment. Hawaii International Conference on System Sciences. https://doi.org/10.24251/HICSS.2022.049

Zahabi, M., & Abdul Razak, A. M. (2020). Adaptive virtual reality-based training: A systematic literature review and framework. *Virtual Reality*, *24*(4), 725–752. https://doi.org/10.1007/s10055-020-00434-w

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Focusing on Improved Construction Quality through Augmented Reality Training

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Abstract

This research examines augmented reality (AR) technologies for improving construction quality control, focusing on material placement accuracy and workforce skill gaps. The industry struggles with labor shortages and outdated practices. AR enhances visualization, training, and inspection, aiding design interpretation and precision. This study assesses four AR devices—iPhone, iPad, HoloLens 2, and SiteVision—in a simulated construction task. The HoloLens showed the highest accuracy with the other devices exhibiting lower performance. While none of the devices met industry precision standards, the AR tool proved valuable for training and participants found them useful for learning. These findings highlight AR's potential in construction education and quality control, warranting further research.

Keywords: *Augmented Reality, Workforce Training, Quality, Construction Education*

1. Introduction and Background

The construction industry faces significant challenges in maintaining quality and productivity due to a shrinking skilled labor force and outdated inspection practices (Allen, 1985; Welfare, Sherratt, & Hallowell, 2021). Traditionally, industry professionals have relied on visual assessments of two-dimensional (2D) documents for three-dimensional (3D) construction tasks, a skill developed over years of experience. However, the retirement of seasoned professionals and the inexperience of newer practitioners contribute to inefficiencies, errors, and declining industry standards (Arditi & Gunaydin, 1997).

Addressing this skills gap requires innovative solutions, such as Augmented Reality (AR), which overlays digital information onto real-world environments, improving material placement and inspections (Sawhney et al., 2020). Unlike Virtual Reality (VR), AR enhances real-world tasks by providing contextual information, making it particularly valuable for construction. Research in many industries highlights AR's potential to enhance training, improve safety, and support quality control (Li et al., 2018; Harikrishnan et al., 2021).

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However, AR's practical effectiveness in quality control for construction remains underexplored. For instance, the precise placement of underslab utilities is critical, as errors can lead to costly rework and project delays – there is a desire to improve this process. AR has been shown to facilitate inspectors in various industries and with numerous work tasks (Sawhney, 2020). Yet AR's ability to provide accurate overlays must be rigorously tested to determine its reliability and dependability (Hajirasouli et al., 2022; Adebowale & Agumba, 2022). Initially, this study aimed to evaluate different AR modalities in a simulated construction environment, but as it evolved, its impact as an educational tool was discovered and warranted testing. Therefore, by incorporating AR into construction education, this research aims to equip students with foundational skills that can enhance industry practices that focus on improving quality. As AR technology advances, its widespread adoption could modernize training, improve quality control, and boost overall industry productivity (Sawhney et al., 2020).

2. Methodology

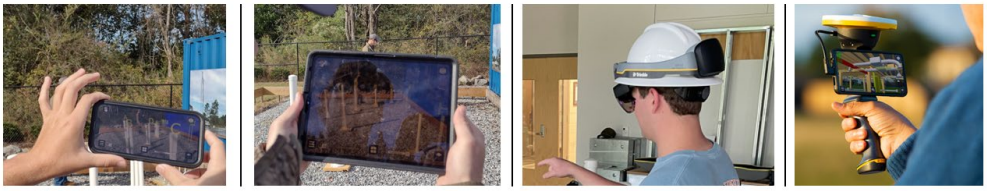
This study employs an action research methodology, integrating findings from previous interdisciplinary research that has evaluated the effectiveness of augmented reality (AR) tools in various contexts (Kahn et al., 2021; Scherl et al., 2021). The foundational premise is that superimposing virtual overlays onto real-world construction environments can enhance student preparedness for professional roles by bridging the gap between theoretical classroom concepts and practical construction quality inspections while instilling a sense of work experience to enhance the student's learning. While the primary objective was to evaluate the precision and accuracy of an AR-based quality inspection tool, the broader aim is to establish an innovative approach to training future quality inspectors. Additionally, the study will provide a nuanced context as to whether this AR tool can provide tangible benefits for industry professionals, particularly in enhancing quality control processes within real-world construction settings.

2.1. Participants

The participant cohort (N=32) comprised undergraduate students enrolled in a four-year construction management program at a university in the southeastern United States. Participation was voluntary, and the experiment was conducted during a regularly scheduled class session. These students were selected to represent an unskilled workforce in training, preparing for future roles as project managers or superintendents in commercial construction. Aged between 20 and 24 years, the participants had varying levels of hands-on construction experience, primarily gained through internships. These prior experiences provided a foundational understanding of construction practices and quality control procedures. The selection of this participant group was intended to enhance the credibility and reliability of the study by ensuring that the findings accurately reflected the learning process of emerging professionals in the construction industry.

2.2. The AR Learning Tools

To examine how different AR interactions influence learning outcomes, this study employed four AR devices, offering students a diverse AR experience. The selected devices included the Apple iPhone 13 Pro Max (iPhone), the Apple iPad Pro 12.9-inch 5th Generation (iPad), the Trimble XR10 HoloLens 2 (HoloLens), and the Trimble SiteVision GPS receiver with its HPS2-integrated handle (SiteVision) see Figure 1. The inclusion of the iPhone and iPad was based on their widespread familiarity and daily use among students, although no specific data were collected to assess the impact of this familiarity on learning outcomes. The HoloLens and SiteVision were incorporated for their advanced AR capabilities, allowing students to engage with innovative tools that hold potential for real-world construction applications. By integrating these devices, the study aimed to provide insights into the effectiveness of different AR technologies in construction quality control training and learning.



a. b. c. d.

Figure 1. AR Tools (a.) iPhone, (b.) iPad, (c.) HoloLens, and (d.) SiteVision

2.3. The Simulated Learning Environment

The AR experience was developed using Autodesk Revit, creating a *digital twin* virtual model of a simulated construction project site as the basis for a plumbing pipe layout experiment. The model replicated an actual construction project site, which consisted of wooden edge forms measuring 20 feet by 15 feet (6.1 m × 4.6 m), simulating a flat surface representative of the pre-stage for a concrete slab-on-grade (Figure 2a). This setup mirrored real-world construction conditions, where accurate plumbing pipe placement is critical to prevent costly rework and schedule disruptions after concrete placement.



a. b.

Figure 2. (a.) Simulation Construction Site and (b.) Proxy Plumbing Pipe

The simulation site was outdoors in a partially shaded area to replicate typical construction conditions, enhancing the study's external validity (Figure 2a). This setting aimed to improve student learning and retention by mimicking real-world scenarios. While AR functionality challenges in outdoor conditions were anticipated, no data were collected on their impact, assuming they would not significantly affect learning outcomes. After model development, the digital twin was integrated into the Trimble FieldLink MR platform, ensuring consistent AR experiences across all four devices and minimizing data variability.

2.4. Learning Activity Workflow

Before the study with student participants, a control point was established by aligning the digital twin model with the physical construction site. This alignment ensured accurate overlay of the virtual model onto the real-world environment, enabling students using AR devices to position proxy plumbing pipes correctly. Researchers later assessed placement accuracy by comparing student placements to predetermined control positions in the digital twin. The study aimed to evaluate the feasibility of AR devices for real-world construction quality inspections while also improving students' inspection skills through a competitive element.

Participants were randomly assigned to one of four AR device types and received brief training based on their familiarity. Each student used their assigned AR device to position plumbing penetration proxies within a simulated slab-on-grade area, adjusting placements to match virtual representations.

Researchers measured the accuracy of each student's placement using a robotic total station, comparing it with control data. Upon completing the task, participants filled out a perception survey evaluating their experience with the AR tool, its impact on learning, cognitive load, and effectiveness in construction education. The NASA Task Load Index (NASA-TLX) was also used to assess the cognitive demands of the AR tool, as excessive load can hinder learning effectiveness (Sweller, 2020).

3. Results and Discussion

Students positioned proxy pipes independently during the experiment. While accuracy and precision data were collected, this paper focuses on the learning experience. Results showed the highest accuracy and precision with the HoloLens, followed by the iPad and SiteVision, with the iPhone performing the worst. However, all measured errors exceeded industry tolerance standards, indicating that while AR enhances learning, it is not yet a viable replacement for industry tools in precise material placement. Further improvements are needed before AR can meet construction accuracy and precision requirements.

3.1. Student Perceptions Survey

At the conclusion of the experiment, students provided feedback on their learning experience with the AR tool. The assessment focused on four key parameters, measured using a 5-point Likert scale:

1. The AR tool **HELPED** my learning.
2. The AR tool **DISTRACTED** me from learning.
3. The AR tool was **EASY** to use.
4. I would **RECOMMEND** this AR tool to others.

Table 2 summarizes students' perceptions regarding their learning experience with the AR tool, offering insights into its perceived effectiveness, usability, and overall impact on the educational process.

Table 2. Student Perceptions of the AR Learning Tool (N=32)

CATEGORY	SD	D	Neither	A	SA
1.HELPED	-	-	6%	17%	78%
2.DISTRACTED	67%	17%	6%	-	11%
3.EASY	-	-	6%	22%	72%
4.RECOMMEND	-	-	3%	17%	81%

The survey results support the effectiveness of the AR tool as a valuable educational aid in construction management training. Overall, students reported that the tool enhanced their learning experience, with minimal reports of distraction. However, 11% of participants indicated that they experienced some level of distraction, which may be attributed to the novelty of AR technology in a traditional learning environment. Since no additional data were collected

to investigate this discrepancy, future research should explore the potential impact of cognitive overload or technological unfamiliarity on learning outcomes.

Given that students in this demographic are generally proficient in using digital tools, it is unsurprising that they found the AR interface intuitive and easy to use. Moreover, their strong willingness to recommend the AR tool for future learning applications further reinforces its perceived value as an educational resource. These findings suggest that AR technology holds significant potential for enhancing construction management education by integrating innovative, interactive learning methodologies.

3.2. Task Load Index

The NASA-TLX is a widely used subjective workload assessment tool designed to measure cognitive and physical demands imposed by tasks. Its use in this study evaluates six dimensions: mental demand, physical demand, temporal demand, effort, performance, and frustration. As this is educational research, NASA-TLX is an effective instrument for assessing students' cognitive load and effort when interacting with technology in the classroom. By quantifying workload perceptions of the student's experience in this study, it can be determined whether a technology-enhanced learning tool facilitates or hinders student engagement. Applying NASA-TLX as a part of the exit survey enables the researchers to identify usability challenges, optimize instructional design, and enhance the effectiveness of digital learning environments. Table 2 enumerates the NASA-TLX data results for this study.

Table 2. NASA-TLX Survey Results

DIMENSION	MEAN	SD
MENTAL	-4.31	4.54
PHYSICAL	-5.78	3.70
TEMPORAL	-5.64	3.25
PERFORMANCE	7.17	2.83
EFFORT	-3.00	5.17
FRUSTRATION	-6.75	3.58

The mean MENTAL effort score (-4.31, SD = 4.54) suggests that students perceived the cognitive demands of the AR tool as relatively low. Similarly, PHYSICAL effort (-5.78, SD = 3.70) and TEMPORAL effort (-5.64, SD = 3.25) were also rated low, indicating minimal strain in terms of physical exertion and time constraints. The PERFORMANCE metric (7.17, SD =

2.83) reflects a strong perception of task success, suggesting that students felt confident in their ability to complete tasks effectively using the AR tool in this experiment. The overall EFFORT score (-3.00, SD = 5.17) aligns with the low mental, physical, and temporal effort ratings, reinforcing that students did not find the AR tool overly demanding. Lastly, the general FRUSTRATION score (-6.75, SD = 3.58) suggests a low level of frustration, indicating that the AR interface did not significantly impede the learning experience. These findings suggest that the AR tool was well received by students, imposing minimal workload while facilitating effective learning. This is a significant finding and one that positively aligns with Sweller's (2020) concerns when incorporating technology into the educational experience. The low frustration and effort levels, combined with the high-performance rating, highlight the AR tool's potential as a user-friendly and efficient educational resource for construction management training. However, further research may be needed to assess individual differences in cognitive load and long-term retention effects associated with AR-based learning.

4. Conclusion

The findings of this study underscore the significant potential of AR technology as a powerful and efficient educational tool for construction management training. Results from the NASA-TLX assessment reveal that students reported minimal cognitive, physical, and temporal demands, coupled with high perceived performance and low levels of frustration. These outcomes strongly indicate that AR can enrich learning experiences without introducing undue mental or physical burden. Moreover, student feedback demonstrated a high degree of acceptance and ease of use, reinforcing AR's practical viability as an instructional resource within academic settings.

However, the study's limited sample size (N=32) restricts the generalizability of these results. To substantiate these findings, future research should incorporate a more diverse participant base, encompassing a range of educational backgrounds, experience levels, and institutional contexts. Additionally, further investigation is warranted into the long-term retention benefits of AR-based learning and its effectiveness in enhancing real-world construction competencies. Examining factors such as cognitive overload and user familiarity with technology will also be critical in refining AR instructional design to maximize educational outcomes.

Broadening the application of AR across various construction disciplines and project scenarios could yield deeper insights into its adaptability and value in professional training environments. Comparative studies assessing AR-assisted learning versus traditional training methods would provide stronger empirical support for its role in addressing the skills gap within construction management education. As AR technology continues to advance, sustained research efforts will be vital to optimize its integration and ensure it aligns with the evolving needs of the construction industry.

References

Adebowale, O., & Agumba, J., 2022. Applications of augmented reality for construction productivity improvement: a systematic review. Smart and Sustainable Built Environment. https://doi.org/10.1108/sasbe-06-2022-0128.Allen, S., 1985. Why Construction Industry Productivity is Declining. Macroeconomics eJournal. https://doi.org/10.2307/1924811.

Allen, S., 1985. Why Construction Industry Productivity is Declining. Macroeconomics eJournal. https://doi.org/10.2307/1924811.

Arditi, D., & Gunaydin, H., 1997. Total quality management in the construction pro-cess. International Journal of Project Management, 15, pp. 235-243. https://doi.org/10.1016/S0263-7863(96)00076-2.

Hajirasouli, A., Banihashemi, S., Drogemuller, R., Fazeli, A., & Mohandes, S., 2022. Augmented reality in design and construction: thematic analysis and conceptual frameworks. Construction Innovation. https://doi.org/10.1108/ci-01-2022-0007.

Harikrishnan, A., Abdallah, A., Ayer, S., Asmar, M., & Tang, P., 2021. Feasibility of augmented reality technology for communication in the construction industry. Adv. Eng. Informatics, 50, pp. 101363. https://doi.org/10.1016/J.AEI.2021.101363.

Khan, F., Muvva, V., Wu, D., Arefin, M., Phillips, N., & Swan, J., 2021. Measuring the Perceived Three-Dimensional Location of Virtual Objects in Optical See-Through Augmented Reality. 2021 IEEE International Symposium on Mixed and Augmented Reality (ISMAR), pp. 109-117. https://doi.org/10.1109/ismar52148.2021.00025.

Li, X., Yi, W., Chi, H., Wang, X., & Chan, A., 2018. A critical review of virtual and augmented reality (VR/AR) applications in construction safety. Automation in Con-struction, 86, pp. 150-162. https://doi.org/10.1016/J.AUTCON.2017.11.003.

Sawhney, A., Riley, M. and Irizarry, J., 2020. Construction 4.0: Introduction and overview. In Construction 4.0 (pp. 3-22). Routledge.

Scherl, C., Stratemeier, J., Karle, C., Rotter, N., Hesser, J., Huber, L., Dias, A., Hoff-mann, O., Riffel, P., Schönberg, S., Schell, A., Lammert, A., Affolter, A., & Männle, D., 2020. Augmented reality with HoloLens in parotid surgery: how to assess and to improve accuracy. European Archives of Oto-Rhino-Laryngology, 278, pp. 2473 - 2483. https://doi.org/10.1007/s00405-020-06351-7.

Sweller, J., 2020. Cognitive load theory and educational technology. Educational Tech-nology Research and Development, 68(1), pp.1-16.

Welfare, K., Sherratt, F., & Hallowell, M., 2021. Perceptions of Construction Work: Views to Consider to Improve Employee Recruitment and Retention. Journal of Con-struction Engineering and Management. https://doi.org/10.1061/(ASCE)CO.1943-7862.0002057.

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Preparing Creative Arts and Design Students for the New World of Generative Artificial Intelligence in the Workplace

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Abstract

Generative Artificial Intelligence (AI) is transforming the Creative Industries, influencing fields such as Design, Film, and Advertising by bridging machine-generated content and human creativity. This paper explores the necessity for design educators to prepare students for these new workplace realities, where Generative AI tools are reshaping creativity, intellectual property, and ethical discussions. Through a survey of postgraduate design students, this research examines their perspectives on integrating Generative AI into their future careers. Findings indicate a strong interest in learning how to use these tools across age and experience levels.

Keywords: *Generative Artificial Intelligence (AI), Creative Industries, Creative Arts education; Design education; Curriculum development, Career readiness.*

1. Introduction

Creative arts and design students aiming for careers in the Creative Industries must begin bridging the gap between human creativity and machine-generated content, a growing presence in creative businesses. Design educators are now tasked with helping students integrate Generative AI into their creative processes without sacrificing the core principles of design education. The rise of tools like ChatGPT and DALL-E since 2022 has redefined creativity, talent, and intellectual property, leading to ongoing ethical and legal discussions about AI's role (Yogesh et al., 2024; Auernhammer, 2020; Anantrasirichai & Bull, 2022). Generative AI, a subset of AI that creates new content (Marr, 2023), is reshaping Creative Industries areas like Music, Film, Design, and Advertising by generating novel outputs from data. Although Generative AI can increase productivity by quickly iterating ideas, concerns about job displacement and a flood of low quality automated content persist (Matthews et al., 2023; Meron, 2022). Given the growing integration of AI in the Creative Industries, this study explores postgraduate design students' perspectives on the realities of working with Generative AI in the creative workplace.

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2. Generative AI's Impact on the Creative Industries

The use of Generative AI in the Creative Industries is rapidly expanding. Anantrasirichai and Bull (2022) highlight AI's impact across various fields: Generative AI produces scripts, aids journalism through natural language processing, supports music production, creates new art forms in image generation, automates animation, and enhances immersive experiences in AR/VR.

However, creative professionals have raised concerns about AI's impact on creativity, ethics, and copyright (Black et al., 2024), with some feeling they operate in a legal grey zone (Erickson, 2024). Various reports argue that there will be job losses amongst creative and design professionals (e.g. Black, et al. 2024). Erickson (2024) explains that the implementation of Generative AI will lead to "further deskilling of creative labour, and displacement of ancillary production jobs due to increased efficiency and changing production practices" (p. 3).

A survey of 113 Creative Industries professionals showed a majority use Generative AI tools like ChatGPT and DALL-E, with 62% agreeing that failure to adopt AI could mean missing career opportunities (Engine Creative, 2023). While AI's role in other sectors focuses on automation, in creative fields, it is seen as a tool to enhance creativity though co-creation (Cremer et al., 2023; Fleischmann, 2024a). The acceptance of Generative AI in the creative workplace is happening despite an inherent uneasiness about its use: "AI presents a fascinating paradox in the creative world. It disrupts traditional industries while simultaneously empowering individual creativity" (Hutchins, 2024, p. 1).

3. Design Education and Generative AI Integration

Design education is based on studio pedagogy, which prompts students to learn through the critiquing process, collaborative dialogue and critical thinking, prototyping and iteration of design ideas (McLain, 2022). Generative AI's rapid development has made it difficult for higher education creative arts and design educators to find a way to integrate a technology that enables students to shortcut the creative process (Fleischmann, 2024b). Previous examples of groundbreaking technological advancements show that universities had to play catch-up because of new technology's rapid emergence. Examples include the digitalisation of the creation and production process through the introduction of desktop computers and the emergence of the Internet and digital media (Meron, 2022). This latency between adoption of new technology in higher education concerns Creative Industries professionals who worry about "… training, funding and otherwise engaging with AI technologies" (Black, et al. 2024, p. 3).

The limited literature on the use of Generative AI in creative arts and design education highlights both its potential and concerns for the future. Fleischmann (2023) found that some educators in Germany worry Generative AI could threaten graphic and communication design programs

within the next decade—a sentiment echoed by Matthews et al. (2023). Early adopters like Figoli et al. (2022), Noguera (2022) and Huang, et al. (2023) highlight both the potential for speeding up design processes but also the need to emphasize critical thinking around AI's biases and ethics. Creative arts and design educators now need to create frameworks that allow students to ethically collaborate with Generative AI tools while preserving their agency in the creative process, a core aspect of design education (Fleischmann, 2024b).

To be prepared to enter the Creative Industries job market, creative arts and design graduates need a variety of skills, including creativity, problem-solving, communication, and proficiency with design software (Barnes, et al., 2022). Graduates should also understand business strategies, have cultural skills and be able to work effectively in a team (Barnes et al., 2022; Matthews et al., 2023). Proficiency in design software goes beyond managing illustration, photo or video software and must now include a basic familiarity with using Generative AI tools and understanding new creation and production processes Generative AI engenders.

While some design educators have already started integrating Generative AI into their creative arts and design curriculum (e.g., Huang et al., 2023; Noguera, 2023), the uncertainty around ethics, copyright and originality is holding many back. Fleischmann (2024b, p. 1) provides "recommendations for a structured pedagogic approach for implementing Generative AI as a building block for the design creative process into the curriculum" while also considering the ethical frameworks and copyright challenges.

4. Measuring Graduate Student Attitudes Toward Generative AI: Methods

This study followed a pragmatic research paradigm, recognizing that knowledge is socially constructed and rooted in interconnected experiences (Kelly & Cordeiro, 2020). To explore student views about the impact of Generative AI, their experiences in using AI tools and interest in learning about it, the author surveyed thirty-three postgraduate design students (Master of Design) in their first year of study.

The survey was conducted using the online survey tool SurveyMonkey. The researcher developed the survey questions (multiple choice and open-ended questions) to gather a broad overview or trend on the topics. The survey tool delivered basic statistical data for the analysis of the quantitative data, including the tally of response totals, percentages, and response counts. Answers to open ended questions such as career aspirations were manually counted and grouped using Microsoft Excel.

The researcher acknowledges that the small sample size restricts the ability to generalize the findings but instead offers immediate insights that capture student experiences and perspectives (Meterko et al., 2015).

5. Findings

To better contextualize the feedback given by the postgraduate design students, they were asked to provide their age, previous degree studies, career aspirations and existing experience with using Generative AI tools. Table 1 shows the age of student participants.

Table 1. Age range of postgraduate design students.

Answer Choices	**Participants percentage / number**	
18-22	18%	6
23-25	27%	9
26-28	15%	5
29-35	30%	10
over 35	9%	3
I'd rather not say	0%	0
Answered	**100%**	**33**

When exploring students' previous education, it was revealed that twenty-three students (70%) had completed Creative Industries undergraduate degrees such as Graphic Design, Product Design or Interior Design. Ten students (30%) had completed undergraduate degrees in non-creative areas such as Business and Management, Law and Social Sciences, and Education. Three students had completed both, a Creative Industries degree and a non-creative degree. All students were seeking careers in the Creative Industries within 5 years' time. Table 2 shows the creative profession they envision as their future career.

Table 2. Envisioned careers by postgraduate design students.

Answers	**Participants percentage / number**	
UI/UX Designer	33%	11
Graphic Designer	18%	6
Creative Director/Senior Design Role	15%	5
Own Design Studio or Freelance	18%	6
Other Creative Fields	12%	4
Uncertain or Flexible Career	3%	1
Answered	**100%**	**33**

Students who had completed creative arts and design degrees beforehand would have been exposed to the constantly evolving field, shaped by technological shifts, changing cultural trends, market demands and sustainability concerns. The careers envisioned by these students will most certainly intersect with Generative AI soon. Given that 54% of this student cohort are 26 years old or older, there is an assumption that a number of these postgraduate students have

worked in jobs, participated in internships or experienced work-integrated learning before enrolling in the master's degree. The survey explored the experience these postgraduate design students have had in using Generative AI in the professional field. Table 3 overviews the results.

Table 3. Experience of postgraduate design students using Generative AI in the professional field.

Have you ever used AI-powered design tools in your professional work?		
Answer Choices	**Participants percentage / number**	
Yes, frequently	6%	2
Yes, occasionally	13%	4
No, but I am interested in using them	47%	15
No, and I am not interested in using them	9%	3
No, I did not work in a job where AI could be applied	25%	8
Answered (1 skipped)	**100%**	**32**

Table 3 findings show that a small number (19%) of postgraduate design students had used Generative AI on the job. However, nearly half were interested in using AI tools despite not having used them before. Interestingly, three students (9%) were not interested in using Generative AI in their professional work. The rapid development of Generative AI applications in the Creative Industries reflects in survey participant acceptance of this technology as a fact of life in the future creative workplace. Table 4 clearly shows that most students have a realistic view about the impact of Generative AI on their future careers. Only one student sees traditional design work being unaffected and remaining unchanged.

Table 4. Postgraduate design students' view on the impact of Generative AI on the design process.

Do you think Generative AI will replace some traditional design tasks?		
Answer Choices	**Participants percentage / number**	
Yes, to a large extent	21%	7
Yes, to some extent	64%	21
Yes, to some extent	12%	4
No, they will not replace traditional design work	3%	1
Total	**100%**	**33**

Of the thirty-three students, twenty-eight students (85%) see Generative AI 'replacing' tasks that they would perform on the job. This finding reflects previous research from professionals that those who do not adapt to AI and learn how to use it are risking their relevance in the workplace. This idea that AI replaces certain tasks also contributes to critics who see it as a job threat.

When exploring the openness of students to engage with Generative AI as part of their study program, the majority of students expressed an interest, with three quarters of the group (75%) being 'definitely' interested and the rest of students being 'somewhat' interested or would 'need more information'. No student expressed that they are not interested in AI tools, as demonstrated in Table 5.

Table 5. Postgraduate design students' motivation to explore Generative AI design tools

Would you be interested in learning about how to effectively use AI tools in design?		
Answer Choices	Participants percentage / number	
Yes, definitely	75%	24
Yes, I'm somewhat interested	16%	5
Maybe, I need more information	9%	3
No, I'm not interested	0%	0
No, I prefer traditional design methods only	0%	0
Answered (1 skipped)	**100%**	**32**

It is clear from the survey data that students have had limited experience using Generative AI in the workplace but the majority are interested in learning more about it and feel that it will replace some of their future tasks.

6. Conclusion

The growing presence of Generative Artificial Intelligence in the Creative Industries is undeniable. From Film to Graphic Design, Generative AI has swiftly carved out a niche in areas traditionally dominated by human creativity, challenging the notion that these fields are the sole domain of creative individuals, not algorithms.

Over the next decade and immediate future, Generative AI will have a profound impact on creative professions. While practitioners in the Creative Industries express concerns about Generative AI's rapid advancements, particularly regarding ethical frameworks and copyright issues, they also acknowledge that failing to embrace AI may result in falling behind or missing significant opportunities.

Despite its limitations, it is essential for creative arts and design educators to bridge the gap between industry demands and the need for graduates to be prepared for the evolving workplace. Survey results show a clear desire among postgraduate design students to learn how to use Generative AI tools to better equip themselves for the creative job market. This enthusiasm spans across different ages and levels of experience.

Unlike many other industries where AI's value lies in automating tasks, in the creative sector, Generative AI has the potential to act as a collaborative tool. It enhances creativity, optimizes workflows, and accelerates processes, rather than merely automating tasks.

The challenge for creative arts and design educators is to teach students to strike a balance between AI as a co-creator in the design process and original human work. This can be achieved through experimentation and a staged approach to curriculum development that not only integrates Generative AI but also addresses its limitations and explores the ethical concerns surrounding originality and copyright laws.

References

Anantrasirichai, N., & Bull, D. (2022). Artificial intelligence in the creative industries: a review. Artificial Intelligence Review, 55, 589–656. https://doi.org/https://doi.org/10.1007/s10462-021-10039-7

Auernhammer, J. (2020, 11-14 August). Human-centered AI: The role of Human-centered Design Research in the development of AI Synergy - DRS International Conference 2020, Brisbane.

Barnes, C., Nicole Wragg, Fisher, E., Tyagi, S., & Kruiff, A. d. (2022). Portfolio Literacy and the Transition to Work for Graphic Design Graduates. International Journal of Art & Design Education (iJADE), 41(2). https://doi.org/DOI: 10.1111/jade.12407

Black, S. R., Bilbao, S., Moruzzi, C., Osborne, N., Terras, M., & Zeller, F. (2024). The Future of Creativity and AI: Views from the Scottish Creative Industries. A Report from Creative Informatics. https://www.researchgate.net/publication/380760645_The_Future_of_Creativity_and_AI_Views_from_the_Scottish_Creative_Industries_A_Report_from_Creative_Informatics

Cremer, D. D., Bianzino, N. M., & Falk, B. (2023). How Generative AI Could Disrupt Creative Work. Harvard Bussines Review, 1-10. https://hbr.org/2023/04/how-generative-ai-could-disrupt-creative-work

Engine Creative (2023). We Asked 113 Creatives Their Opinion on the Impact of AI in the Creative Industry: Here Are the Results. https://www.enginecreative.co.uk/blog/artificial-intelligence-in-the-creative-industry/

Erickson, K. (2024). AI and work in the creative industries: digital continuity or discontinuity? Creative Industries Journal, 1-22. https://doi.org/10.1080/17510694.2024.2421135

Fleischmann, K. (2023). German Design Educators' Post-Covid Challenges: Online, Artificial Intelligence (AI) and Government Data Restrictions. Design and Technology Education: An International Journal 28(1), 135–153. https://openjournals.ljmu.ac.uk/DATE/article/view/1176

Fleischmann, K. (2024a). Making the case for introducing generative artificial intelligence (AI) into design curricula. Art, Design & Communication in Higher Education, 1-21. https://doi.org/10.1386/adch_00088_1

Fleischmann, K. (2024b). The commodification of creativity: Integrating Generative Artificial Intelligence in higher education design curriculum. Innovations in Education and Teaching International, 1-16. https://doi.org/10.1080/14703297.2024.2427039

Figoli, F. A., Rampino, L., & Mattioli, F. (2022, 25 June - 3 July). AI in design idea development: A workshop on creativity and human-AI collaboration DRS2022, Bilbao, Spain.

Huang, Y.-C. J., Wensveen, S., & Funk, M. (2023). Experiential Speculation in Vision-Based AI Design Education: Designing Conventional and Progressive AI Futures. International Journal of Design (2), 1-17.

Hutchins, B. (2024). AI and the Creative Industry: A Paradox of Disruption and Empowerment. Medium, 16 January 2025. https://bobhutchins.medium.com/ai-and-the-creative-industry-a-paradox-of-disruption-and-empowerment-9a0c69b2a1e1

Kelly, L. M., & Cordeiro, M. (2020). Three principles of pragmatism for research on organizational processes. Methodological Innovations, 13(2), 1–10. https://doi.org/10.1177/2059799120937242

Marr, B. (2023). The difference between generative AI and traditional AI: An easy explanation for anyone, Forbes, 24 July, https://www.forbes.com/sites/ bernardmarr/2023/07/24/the-difference-between-generative-ai-and-traditional-ai-an-easy-explanation-for-anyone/?sh=1213914b508a. Accessed 17 January 2025.

Matthews, B., Shannon, B., & Roxburgh, M. (2023). Destroy All Humans: The Dematerialisation of the Designer in an Age of Automation and its Impact on Graphic Design—A Literature Review. International Journal of Art & Design Education (iJADE), 1-17. https://doi.org/10.1111/jade.12460

McLain, M. (2022). Towards a signature pedagogy for design and technology education: a literature review. International Journal of Technology and Design Education, 32, 1629–1648. https://doi.org/10.1007/s10798-021-09667-5]

Meron, Y. (2022, 25 June - 3 July). Graphic design and artificial intelligence: Interdisciplinary challenges for designers in the search for research collaboration DRS2022, Bilbao, Spain.

Meterko, M., Restuccia, J. d., Stolzmann, K., Mohr, D., Brennan, C., Glasgow, J., & Kaboli, P. (2015). Response rates, nonresponse bias, and data quality. Public Opinion Quarterly, 79(1), 130–144. https://doi.org/10.1093/poq/nfu052

Noguera, J. C. (2023). Industrial Design Takes on AI. Retrieved 27 November 2023, from https://www.noguera.design/industrial-design-takes-on-ai

Yogesh, D., Emmanuel, M., Amany, E., Joseph, A.-A., & Samar, A. (2024). The impending disruption of creative industries by generative AI: Opportunities, challenges, and research agenda. International Journal of Information Management, 79, 1-11. 10.1016/j.ijinfomgt.2024.102759

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Integration of VR in Landscape Architecture Education: Insights from Case Studies

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Abstract

Keywords: *Virtual reality; landscape architecture education; immersive learning; spatial perception; design communication.*

1. Introduction

The integration of digital technologies into higher education has revolutionized the way students and researchers engage with complex spatial, social, and environmental issues. Among these technologies, VR has emerged as a particularly transformative tool, offering immersive and interactive experiences that challenge traditional pedagogical approaches (Radianti et al., 2020). One of the key drivers of VR's recent increasing adoption in education is its growing accessibility and affordability. The cost of VR hardware and software has significantly decreased in recent years, making it feasible for educational institutions to integrate VR-based learning into their curricula (MATSH, 2023). Advances in standalone VR headsets, cloud-based platforms, and open-source development tools have further reduced barriers to entry, enabling

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more universities and research institutions to incorporate immersive technologies into teaching and research (Liu et al., 2017). Moreover, in today's digital age, young generations of students are growing up in a world flooded with digital technologies, and they are highly adept at using these technologies for a variety of purposes, including learning and entertainment. By integrating the latest technological development solutions into teaching, we can leverage students' existing skills and interests to engage them in the subject matter in new and innovative ways.

Since its establishment in 2007, the VR-Lab at NMBU has played a major role in testing visual solutions and advancing the integration of VR technology within higher education. By harnessing VR technology capabilities, the lab facilitates the transformation of teaching methodologies, learning environments, interdisciplinary collaboration, and knowledge accessibility across disciplines, specifically in landscape architecture, urban planning, and social sciences education. A major argument for incorporating VR into these disciplines is the inherently visual nature of landscape architecture and urban planning, where effective communication of design and planning scenarios is essential. Traditionally, these fields have relied on maps, 2D drawings, physical models, and static renderings to convey spatial concepts and design proposals. While these methods remain valuable, they often fail to fully communicate the scale, depth, and experiential qualities of a landscape or urban environment. VR, in contrast, provides an immersive and interactive medium that allows students, designers, and stakeholders to experience and engage with proposed designs at a human scale, facilitating greater spatial understanding and more effective decision-making (Ghadirian & Bishop, 2008).

This paper presents a series of case studies conducted at the VR-Lab, illustrating the diverse applications and benefits of VR in these disciplines. The first study investigates how immersive VR can be used to compare public perceptions of traditional versus contemporary architectural styles in urban spaces. The second study examines perceived safety in urban parks through immersive simulations, providing insights into design strategies that enhance user comfort and security. The third study explores the use of VR as a mediator in teaching landscape architecture history, demonstrating how digital reconstructions can bridge the gap between past and present. Finally, the fourth study explores the use of VR technology in contested landscapes, emphasizing its potential to empower communities and raise awareness about cultural heritage sites.

2. Case Studies

2.1. Architectural Style Perception in Public Spaces

This case study examined how architectural styles influence public perception and emotional responses using immersive VR. It involved students who assessed traditional and contemporary

architectural designs through 360-degree videos. The study employed 360-degree video technology to capture visual representations of eight public spaces in Oslo, Norway, categorized by traditional and contemporary design elements (figure 1). Traditional styles featured symmetry, ornamentation, and connections to local history, while contemporary styles emphasized minimalism, asymmetry, and industrial materials. The findings indicated a preference for traditional styles, associated with relaxation and aesthetic appeal, while contemporary styles evoked mixed reactions. VR facilitated experiential learning, enabling students to critically analyze architectural elements beyond static images or theoretical descriptions. To extend their learning, students engaged in design critique sessions where they applied theoretical frameworks from architectural history and urban planning. These discussions provided insights into how spatial aesthetics influence public behavior and place identity. In addition, the study introduced VR as a comparative tool, allowing students to alternate between different urban scenarios dynamically and refine their understanding of spatial composition (Mouratidis & Hassan, 2020).



Figure 1. Snapshots from 360-degree videos showing public spaces in Oslo that were used in this study. Source: author (2019).

2.2. Perceived Safety in Urban Parks

This case study investigated how hedge height impacts perceived safety in an urban park in Oslo. A mixed-methods approach combined field surveys and VR simulations to assess safety perceptions before and after a hedge-cutting intervention. Female participants reported increased safety following the reduction in hedge height, while male participants exhibited no significant changes. The VR component provided a controlled environment for students to analyze spatial factors influencing safety, reinforcing the importance of empirical testing in landscape planning. The VR-based approach allowed students to assess different hedge height scenarios dynamically, promoting engagement in risk analysis and urban safety measures. By experiencing the spatial effects of enclosure and openness through VR simulations, students developed an understanding of how vegetation influences perceived security. This hands-on methodology helped bridge theoretical concepts in environmental psychology and practical urban design applications. Furthermore, this case study emphasized the importance of gender-

sensitive urban design, encouraging discussions on inclusivity and how environmental modifications can impact different user groups (Evensen et al., 2021).

2.3. Teaching Landscape Architecture History through VR

Historical landscape education often struggles with student engagement due to its abstract nature. This case study introduced VR-based reconstructions of historical gardens and sites, allowing students to explore past landscapes in an interactive format. The integration of VR into coursework improved comprehension, accessibility, and critical analysis, demonstrating the effectiveness of digital tools in bridging historical theoretical knowledge with visual and spatial understanding. By enabling students to virtually immerse themselves in historical sites, VR facilitated an experiential learning process that traditional lectures and textbooks could not offer. Students analyzed reconstructed environments in comparison with historical documentation, helping them build critical evaluation skills and appreciate the evolution of design styles over time (Figure 2). This approach also introduced discussions on the challenges of digital reconstruction and the ethics of recreating historical landscapes, adding a reflective dimension to their learning. Group projects further encouraged collaboration, where students worked on digital reconstructions, reinforcing interdisciplinary skills spanning history, technology, and design (Hassan & Dietze-Schirdewahn, 2024).



Figure 2. Snapshot of an interactive virtual model showing the reconstruction of the historical garden of Barony Rosendal that was used in this study. Source: author (2020).

2.4. VR for Cultural Heritage Documentation in Contested Landscapes

This case study focused on documenting and preserving cultural heritage sites in Palestine using VR. Due to political and physical restrictions, many historical sites are inaccessible. VR

facilitated remote access to these sites, allowing students and researchers to engage with them virtually. The project also incorporated digital storytelling and community involvement, broadening public awareness and educational outreach. The study underscored the role of VR in safeguarding and interpreting heritage sites in conflict-affected areas. Students in this project engaged with historical documentation, GIS mapping, and 3D modeling techniques to develop comprehensive digital heritage archives. The inclusion of virtual storytelling elements made historical narratives more compelling, reinforcing the importance of preserving cultural identity through immersive technology (Figure 3). VR also enabled cross-disciplinary collaboration, incorporating perspectives from archaeology, history, and digital media. The ethical dimension of heritage reconstruction was a key discussion point, prompting students to reflect on issues related to authenticity, representation, and historical accuracy in digital heritage preservation. The VR component further allowed community stakeholders to participate in heritage documentation efforts, raising inclusivity in cultural preservation initiatives (Hassan, 2021).



Figure 3. Pupils at a school in Ramallah, Palestine, are experiencing a heritage site with VR. Source: author (2019).

3. Navigating the Challenges of VR Integration in Education

Despite the significant benefits of VR technologies in education, several challenges and limitations must be addressed for their successful implementation and adoption. Insights from the presented case studies highlight practical obstacles encountered during the integration of VR into teaching and the need for a structured framework.

3.1. Practical Constraints

One of the primary challenges is the cost of implementing VR technology. While the cost of VR hardware and software has declined in recent years, it still represents a considerable investment for educational institutions. The case study on teaching landscape architecture history underscored the necessity of securing access to VR equipment before course implementation. To mitigate costs, collaboration with the VR-Lab at NMBU was established, allowing students access to VR technology without requiring independent institutional investments.

Another significant challenge is the requirement for specialized skills and training to effectively utilize VR technology. Instructors and students must learn not only how to operate VR hardware but also how to create, navigate, and interact with VR content. The case studies demonstrated that integrating VR required additional time investment, both in preparing educators to incorporate VR effectively into curricula and in training students to use immersive environments as analytical and design tools.

A third limitation is the risk of student disengagement or distraction in VR environments. While VR offers captivating experiences, it can also be overwhelming for some learners, potentially leading to disorientation or motion sickness. The case studies revealed that balancing immersive learning with structured guidance was crucial in preventing sensory overload. Designing well-structured VR lessons with clear objectives and intermittent breaks helped maintain student focus and engagement.

Another critical limitation is the effectiveness of VR in teaching abstract concepts such as social and cultural contexts. While VR excels in simulating physical environments, it may not fully capture complex socio-cultural values embedded in historical landscapes. The case study on teaching landscape architecture history demonstrated that, although students could interact with historical reconstructions, discussions and supplementary materials were necessary to convey cultural significance beyond the visual experience. Future improvements in VR educational applications should explore methods to integrate more nuanced cultural narratives.

3.2. The Need for a Pedagogical Framework

Incorporating VR and other digital technologies into teaching without a pedagogical framework risks diminishing their potential impact on student learning. As Zhao and Frank (2003) noted, "the most effective uses of technology in schools are those that are aligned with pedagogical goals, support student-centered learning, and provide opportunities for collaboration and interaction". To maximize the effectiveness of VR-based education, it is crucial to align its integration with well-established pedagogical theories that guide educators in facilitating purposeful and meaningful learning experiences. A study by Otchie and Pedaste (2020) found that constructivism is the most commonly used theory for integrating digital media into

teaching. Constructivism is the learning theory that underlines the importance of active engagement and the construction of knowledge by students. In addition, constructivism offers the benefit in that it highlights the significance of social interaction and cooperation during learning. In the history of landscape architecture case study, for example, students using VR were able to reconstruct historical sites, analyze spatial relationships, and develop their own interpretations of cultural heritage. This interactive approach aligns with constructivist principles by enabling learners to construct meaning based on their experiences.

Beyond constructivism, experiential learning theory also plays a critical role in VR-based education. Experiential learning emphasizes learning through direct experience and reflection (Kolb, 2014). In VR applications, students engage with immersive simulations, where they can interact with different design scenarios, test spatial configurations, and reflect on their observations. This approach enhances spatial cognition and decision-making skills, as evidenced in the study on perceived safety in urban parks. By navigating through virtual environments with varying hedge heights, students gained a stronger understanding of how spatial design influences public perceptions of safety.

4. Conclusion

The integration of VR in landscape architecture, urban planning, and social sciences has demonstrated its value as an educational tool. The case studies presented in this paper illustrate VR's ability to enhance spatial understanding, critical thinking, and collaborative decision-making. By providing immersive learning environments, VR bridges theoretical knowledge with practical applications, reinforcing complex spatial relationships in ways traditional methods cannot. While VR offers significant benefits, challenges such as technological limitations, and the need for tailored pedagogical strategies remain. Addressing these issues requires further research into the development of scalable VR curricula, affordable solutions for institutions, and training programs to equip educators with the necessary technical skills.

To ensure that VR is effectively integrated into curricula, educators must adopt a structured pedagogical framework that includes clear learning objectives, assessment strategies, and scaffolded learning activities. Faculty training is also necessary to equip educators with the skills to design and facilitate VR-based learning experiences. As institutions continue to explore the use of VR, future research should focus on developing models that integrate constructivist and experiential learning approaches with immersive technologies to optimize student engagement and learning outcomes.

The case studies presented here show that expanding VR's use in interdisciplinary settings can encourage broader collaborations across fields, helping students develop holistic problem-solving skills applicable to real-world challenges. As immersive technology continues to evolve, its potential in reshaping education remains vast, requiring continuous adaptation and

innovation in pedagogical methodologies. Building on the insights from these case studies, the VR-Lab is developing new projects on AI-assisted landscape design and multi-user immersive environments for collaborative studio teaching. These initiatives aim to further explore the intersection of emerging technologies and design pedagogy, strengthening innovation in landscape architecture education.

References

Evensen, K. H., Nordh, H., Hassan, R., & Fyhri, A. (2021). Testing the effect of hedge height on perceived safety—A landscape design intervention. *Sustainability, 13(9)*, 1–15. https://doi.org/10.3390/su13095063

Ghadirian, P., & Bishop, I. D. (2008). Integration of augmented reality and GIS: A new approach to realistic landscape visualization. *Landscape and Urban Planning, 86(3–4)*, 226–232. https://doi.org/10.1016/j.landurbplan.2008.03.004

Hassan, R. (2021). VR as a tool for preserving architectural heritage in conflict zones: The case of Palestine. In S. Eloy, A. Kreutzberg, & I. Symeonidou (Eds.), *Virtual aesthetics in architecture: Designing in mixed realities* (pp. 49–90). Routledge. https://doi.org/10.4324/9781003183105

Hassan, R., & Dietze-Schirdewahn, A. (2024). Virtual reality as mediator in teaching landscape architecture history. *Journal of Digital Landscape Architecture, 2024(9),* 958–965. https://doi.org/10.14627/537752090

Kolb, D. (2014). *Experiential learning: Experience as the source of learning and development.* FT Press.

Liu, D., Dede, C., Huang, R., & Richards, J. (2017). *Virtual, augmented, and mixed realities in education.* Springer Singapore. https://doi.org/10.1007/978-981-10-5490-7

MATSH. (2023). Emerging technologies in education: Statistics on AI and VR adoption. *MATSH.* https://www.matsh.co/en/statistics-on-ai-vr-adoption-in-education/

Mouratidis, K., & Hassan, R. (2020). Contemporary versus traditional styles in architecture and public space: A virtual reality study with 360-degree videos. *Cities, 97,* 102491. https://doi.org/10.1016/j.cities.2019.102499

Otchie, W. O., & Pedaste, M. (2020). Using social media for learning in high schools: A systematic literature review. *European Journal of Educational Research, 9(2),* 889–903. https://doi.org/10.12973/eu-jer.9.2.889

Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Computers & Education, 147,* 103778. https://doi.org/10.1016/j.compedu.2019.103778

Zhao, Y., & Frank, K. A. (2003). Factors affecting technology uses in schools: An ecological perspective. *American Educational Research Journal, 40(4),* 807–840. https://doi.org/10.3102/00028312040004807

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Case Study of Improving Educational Chatbots with Customized Information Retrieval

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Abstract

Generic chatbots can function as virtual tutors, assessing responses and providing feedback. However, trained on generalized data limits them to act as subject-specialist tutors, resulting in weak or inaccurate responses and feedback, particularly for complex queries. We aimed to develop and evaluate whether a specialised information retrieval system can enhance a generic chatbot's capabilities. The customized chatbot was integrated into a teaching session and evaluated by the students. Our approach enabled the chatbot to access relevant information and provide tailored feedback, resulting in 75% of students finding the teaching session engaging and helpful. Students also expressed a preference for the customized chatbot over a generic one. However, occasional inaccuracies in responses to highly complex queries occurred and were attributed to incomplete optimization of the retrieval system. To address this, we recommend developing a comprehensive knowledge database and fully optimising the retrieval system to ensure consistently accurate and contextually relevant responses.

Keywords: *AI; chatbots; customization; specialised; feedback; RAG*

1. Introduction

Studies on the use of AI chatbots are growing at an ever-increasing rate. For instance, a search on Google Scholar returned 102,000 results for 2024 alone, representing a significant increase of over 110% from the 48,400 results for 2023. These numbers highlight the growing interest in using chatbots, such as ChatGPT, Gemini, and Copilot, commercially available from OpenAI, Google and Microsoft respectively, for a wide range of applications including teaching and learning practices. While many educational institutions encourage the use of chatbots to enhance learning, concerns related to inaccurate responses and data privacy are persistently flagged by studies (Ansari *et al.,* 2024; Labadze *et al.,* 2023). These concerns emphasize the critical need

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for solutions that prioritize accuracy in chatbot responses and ensure robust data security measures to foster student trust and engagement.

Despite the widespread adoption of chatbots, there is a critical gap in research on practical strategies to address these issues, as well as limited understanding of students' perspectives on these concerns and how they impact their engagement with these tools for learning. In this study, we address these issues by investigating whether we can enhance the capability of a generic chatbot to access our own specific knowledge base to provide contextually accurate responses.

2. Approaches to enhance chatbot capabilities

Chatbot development typically begins with the use of a foundation model (FM). Foundation models are pre-trained on a vast body of generalized data, equipping them with a broad knowledge base and the ability to generate coherent responses. To further enhance the capabilities of these models, Reinforcement Learning (RL) is often employed. In this process, human evaluators review the chatbot's responses, providing feedback on critical factors such as accuracy, relevance, and fairness. The chatbot incorporates this feedback into its learning process, enabling it to adjust its parameters and prioritize outputs that better align with the desired criteria. This iterative feedback loop allows the chatbot to continuously evolve and has been reported to improve its ability to deliver accurate and user-aligned responses (Izadi and Forouzanfar 2024). However, retraining foundation models through RL for domain-specific or organizational applications is computationally and financially intensive. An alternative approach is the Retrieval-Augmented Generation (RAG) model, which bypasses the need for extensive retraining. Instead, RAG combines a generic LLM with a retrieval system, enabling it to access a specifically developed database containing domain-specific information (Gao *et al.,* 2023). We reason that the technique could be applied in teaching and learning to empower chatbots to handle complex tasks and provide contextually relevant responses on specific subjects. Several recent studies have explored the application of RAG in different contexts. Saha et al. (2024) showed that standard RAG configurations outperform traditional LLM outputs in terms of factual precision and contextual alignment in question-answering tasks. Modran et al. (2024) developed a RAG-based tutoring system and highlighted the anticipated benefits of the architecture in supporting domain-specific learning. However, as their work remains in preliminary stages, insights from the learner’s perspective are yet to be published. Recognising the importance of student-centred evaluation, this study presents a practical implementation of a RAG-enhanced chatbot in a live educational setting. The system was embedded with curriculum-specific content and its effectiveness assessed through student feedback and comparative analysis.

3. Methodology

3.1. Development of a local chatbot with RAG capabilities and its workflow

Building on previous work demonstrating that chatbots can deliver feedback aligned with predefined assessment criteria, this study introduced a teaching session where students received tailored feedback from a RAG-enhanced chatbot. For the chatbot a small LLM called discolm-mfto-7b-german-v0.1 was chosen due to it needing reduced computing power while providing robust performance in German. (discolm-mfto-german, 2024). The chatbot was integrated with RAG, allowing it to retrieve task-specific data such as student tasks, sample solutions, and relevant datapoints. Supplemented by a tailored prompt describing assessment criteria, this setup enabled the chatbot to deliver a more reliable, targeted feedback aligned to specific exercises (Woo et al., 2024). The chatbot followed a multi-step workflow: first, it received the input, then it queried the retrieval system for relevant context and finally generated feedback by combining this retrieved information with the instructional prompt.

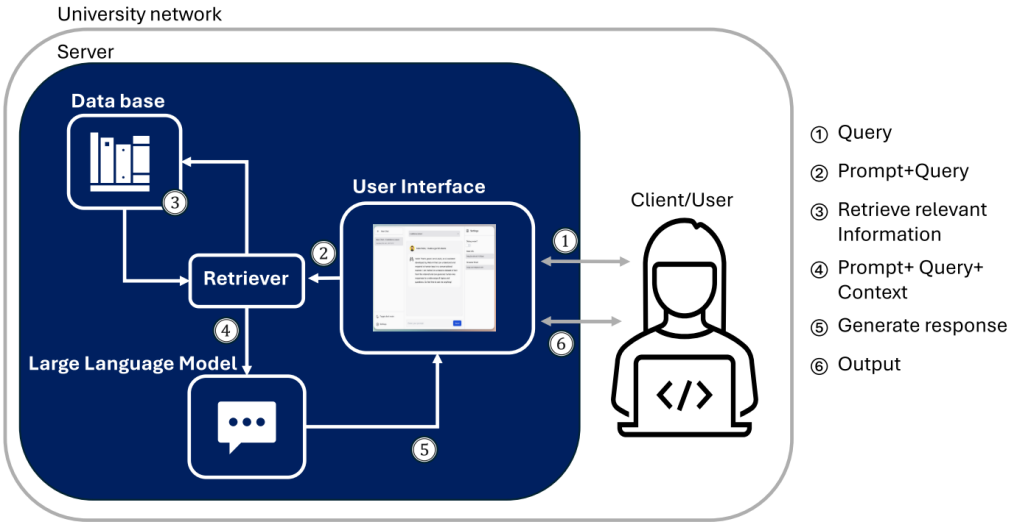


Figure 1. The implementation of the RAG model. A locally situated chatbot was combined with a retrieval system enabling it to access a highly selective database to provide domain specific responses.

To enhance accuracy and contextual relevance, the temperature was set to 0 to reduce variability, and the Top-K parameter was lowered to 5 to limit retrieved text sections (Chang et al., 2023; Yu, 2022). Further details on the setup, hardware, and software can be found on the Bochum University's Sustainable Technologies Laboratory 's documentation website.

3.2. Design of the teaching session integrated with the RAG powered chatbot

To evaluate the performance of the custom-built chatbot as a virtual tutor, it was integrated into a 90-minute trial teaching session on Ecodesign, delivered in December 2024 at Bochum University to undergraduate students enrolled in the Sustainable Development bachelor's degree. The design of the session involved students completing a practical exercise drawn from the Ecodesign lecture. The exercise required them to calculate which life cycle phase: production, transport, or use had the highest global warming potential (GWP), using data provided on an e-scooter and reference values for the GWP of various materials and processes. Based on their calculations, students were then asked to make practical design recommendations to reduce environmental impact in line with Ecodesign principles. Run as a cohort-wide activity, providing individualized support and feedback to each group's recommendations during the session has previously been impractical due to time constraints and the scale of the class. The integration of a local chatbot tutor powered by RAG was proposed as a solution to address these challenges as students would be able to complete the tasks while receiving real-time, constructive feedback tailored to their specific input.

3.3. Evaluation instrument and analysis

We developed a structured questionnaire designed to systematically collect both quantitative and qualitative data. The instrument was informed by established principles of educational evaluation (Kelley *et al,* 2003) and reviewed by academic staff to ensure validity and reliability. A mix of Likert-scale, ranking, and open-ended questions allowed for a well-rounded and triangulated analysis of user experience. The questionnaire covered key areas relevant to chatbot effectiveness, including performance metrics and student preferences as shown in Table 1.

Table 1. Survey insights: Areas of interest and examples of metrics which were evaluated

Area of interest	**Examples**
Ranking of requirements	accuracy, speed, data security
Evaluation of the trail session	helpfulness, personal impressions
Comparison with other feedback methods	commercial offers, sample solutions

The study was designed and conducted in accordance with the university's Educational Research standards. All students were fully informed of the study's purpose and assured that participation was voluntary, thereby enabling informed consent. To protect student confidentiality, no personal data was collected during the evaluation. Although all students (n = 30) were invited to complete the questionnaire, 12 responses were received. While this number does not support statistical significance, a 40% response rate exceeds the widely accepted

minimum threshold of 30% for online surveys in educational settings (Nulty, 2008) and was therefore considered acceptable for analysing the results and identifying trends.

4. Results and discussion

4.1. Identifying students' requirements for engagement with a learning chatbot

One of the first findings of this study focused on identifying students' expectations and priorities regarding AI-driven educational tools. Research shows that students may hold ethical concerns or skepticism about the reliability of AI-generated feedback, which can impact their engagement (Schei et al., 2024). To inform the design of a locally situated chatbot, students were asked to rate the importance of three key functionalities: accuracy, response speed, and data security.

Findings showed that accuracy was the highest priority, with all students rating it as "very important." Speed was also valued, with 75% rating it as "important" or "very important." In contrast, opinions on data security were split evenly. These findings are consistent with broader research (Schei et al., 2024).

4.2. Evaluation of chatbot functionality and impact on student learning

The chatbot, customized with RAG-enabled parameters, was integrated into the Ecodesign session to assess students' solutions and provide feedback. This evaluation followed an Exploratory Testing approach as defined within the international software testing standard (ISTQB, n.d.). Its accuracy was evaluated by comparing its responses to the worked model solutions, and it was found to correctly identify and report errors in students' submissions. As part of the test session it was observed that the chatbot hallucinated content—particularly in its explanations of errors when responding to incorrect student submissions—and that its mathematical calculations were unreliable. While our setup ensured data security, as all information entered into the chatbot was stored within the local server, its relatively slow processing speed in comparison to commercially available chatbot like ChatGPT was noted by students which may have impacted their overall user experience. Table 2 provides a summary of the chatbot's performance across these key functionalities mapped against their priority as perceived by students.

We then sought to understand students' perceptions of the chatbot's feedback compared to other forms of support, including sample solutions, tutorial sessions, and commercially available chatbots. While we acknowledge the limitations of retrospective evaluations, the responses clearly indicated a preference for using the chatbot over receiving no feedback, suggesting it added value to the learning process. However, traditional methods such as written feedback with opportunities for clarification and tutor-led tutorials remained the most preferred. This suggests

that while chatbot feedback is beneficial, it is best positioned as a complement rather than a replacement for human-guided support (Figure 2).

Table 2. Summary of the evaluation of the chatbot tutor based on the student requirements

Functionality	Relevance	Result	Further details of result
Accuracy	very important	partly achieved	+ Feedback finds relevant mistakes within the students' solution. - Feedback contains hallucinated content. - Mathematical operations within the feedback are not reliable.
Speed	important	not achieved	- Response time of more than 5 seconds, sometimes up to several minutes - Unable to process several requests in parallel
Data Security	partly important	achieved	+ Entered data is stored on the local server and can only be viewed by the application administrator.

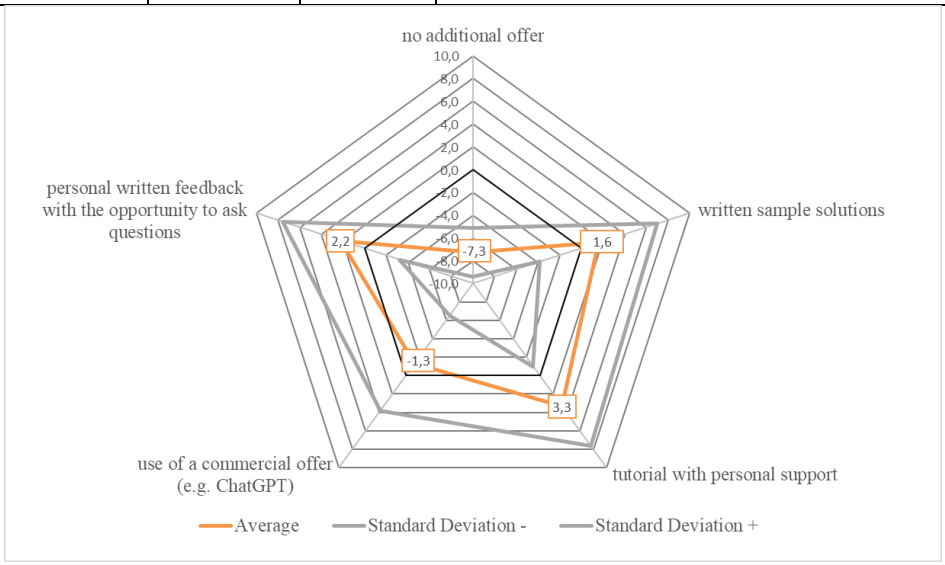


Figure 2. Students' perception of the bespoke chatbot in comparison to other feedback methods. Figure shows how the students ranked their preference on average on a scale from -10 (preferred chatbot) to 10 (preferred alternative method).

5. Summary and Outlook

This study developed and evaluated a German-language chatbot tutor using open-source frameworks Ollama and OpenWebUI, tailored to help students identify weaknesses in their learning and provide domain-specific feedback in an Ecodesign course. By integrating RAG, the chatbot effectively helped students identify errors in their submitted work.

Pedagogically, we believe there are several implications of this approach on student learning. Firstly, this approach fosters self-regulated learning, which can enhance student engagement. By enabling students to assess their own understanding, they gain greater ownership over their learning leading to increased academic performance. Research indicates that self-regulated learning helps students gain confidence and develop critical thinking skills which contribute to improved academic outcomes (Broadbent *et al.,* 2021). This approach also helps to make learning an active process. The provision of immediate, context-specific feedback supports learners in actively constructing their understanding, aligning with principles of constructivist learning theory. The approach of providing instant assessment and feedback aims to help students identify knowledge gaps and adapt their strategies accordingly. This form of metacognitive regulation is associated with increased motivation and deeper learning engagement (Nicol & Macfarlane-Dick, 2006). However, we acknowledge that our current implementation did not fully meet these objectives. The chatbot's delayed response time and hallucinated content limited the overall effectiveness of the feedback. We attribute this to two main factors: insufficient curation of domain-specific content and the limited computational optimization of our deployment environment.

To address these limitations and enhance reliability, we propose the following improvements:

1. Improved Accuracy: Enhancing RAG capabilities through curated domain-specific materials and refining both the retriever and the language model.
2. Performance Optimization: Upgrading to a GPU with at least 28GB and implementing parallel model instances or efficient request handling to support multiple users simultaneously.
3. Comprehensive Evaluation: Conducting additional tests, including functional and stress testing, and collaborative evaluations with students to ensure usability and performance.

In summary, the proposed improvements in performance, accuracy, and evaluation will help to refine the development of GenAI-driven educational tools.

References

All-MiniLM-L6-v2 (Version all-minilm-l6-v2-f32:latest). (2024). [Software]. https://huggingface.co/sentence-transformers/all-MiniLM-L6-v2

Ansari, A.N., Ahmad, S. & Bhutta, S.M. (2024). Mapping the global evidence around the use of ChatGPT in higher education. A systematic scoping review. *Educ Inf Technol* 29, 11281–11321. https://doi.org/10.1007/s10639-023-12223-4

Broadbent, J., Sharman, S., Panadero, E., Fuller-Tyszkiewicz, M. (2021). How does self-regulated learning influence formative assessment and summative grade? Comparing online and blended learners, The Internet and Higher Education, 50. https://doi.org/10.1016/j.iheduc.2021.100805

Chang, C.-C., Reitter, D., Aksitov, R., & Sung, Y.-H. (2023). KL-Divergence Guided Temperature Sampling (arXiv:2306.01286). https://doi.org/10.48550/arXiv.2306.01286

Discolm-mfto-german. (2024). [Software]. https://ollama.com/cas/discolm-mfto-german

Gao, Y., Xiong, Y., Gao, X., Jia, K., Pan, J., Bi, Y., Dai, Y., Sun, J. and Wang, H. (2023). Retrieval-augmented generation for large language models: A survey. *arXiv preprint arXiv:23*

International Software Testing Qualifications Board (ISTQB). (n.d.). *Glossary*. Retrieved April 22, 2025, from https://istqb-glossary.page/exploratory-testing/

Izadi, S., & Forouzanfar, M. (2024). Error Correction and Adaptation in Conversational AI: A Review of Techniques and Applications in Chatbots. *AI*, 5(2), 803-841. https://doi.org/10.3390/ai5020041

Kelley, K., Clark, B., Brown, V. and Sitzia, J. (2003) 'Good practice in the conduct and reporting of survey research.' International Journal for Quality in Health Care. 15(3), 261-266. Available at: https://doi.org/10.1093/intqhc/mzg031

Labadze, L., Grigolia, M. & Machaidze, L. (2023). Role of AI chatbots in education: systematic literature review. *Int J Educ Technol High Educ* 20, 56. https://doi.org/10.1186/s41239-023-00426-1

Modran, H. A., Ursuțiu, D., Samoilă, C., & Gherman-Dolhăscu, E.-C. (2024). Developing a GPT Chatbot Model for Students Programming Education. In M. E. Auer, R. Langmann, D. May, & K. Roos (Eds.), Smart Technologies for a Sustainable Future (pp. 72–82). Springer. https://doi.org/10.1007/978-3-031-61905-2_8

Nulty, D. D. (2008). The adequacy of response rates to online and paper surveys: what can be done? *Assessment & Evaluation in Higher Education*, *33*(3), 301–314

Saha, B., Saha, U., Zubair Malik, M. (2025). QuIM-RAG: Advancing Retrieval-Augmented Generation with Inverted Question Matching for Enhanced QA Performance. *arXiv e-prints*. doi:10.48550/arXiv.2501.02702

Schei, O. M., Møgelvang, A., & Ludvigsen, K. (2024). Perceptions and Use of AI Chatbots among Students in Higher Education: A Scoping Review of Empirical Studies. *Education Sciences*,*14*(8), 922. https://doi.org/10.3390/educsci14080922

Woo, J., Yang, A., Olsen, R., Hasan, S., Nawabi, D., Nwachukwu, B., Williams, R and . Ramkumar, P. (2024). Custom Large Language Models Improve Accuracy: Comparing Retrieval Augmented Generation and Artificial Intelligence Agents to Noncustom Models for Evidence-Based Medicine. *Arthroscopy: The Journal of Arthroscopic & Related Surgery.* https://doi.org/10.1016

Yu, W. (2022). *Retrieval-augmented Generation across Heterogeneous Knowledge.* Proceedings of the 2022 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies: Student Research Workshop, 52–58. https://doi.org/10.18653/v1/2022.naacl-srw.7

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ChatGPT Applications in Active Learning in Higher Education: A Restricted Systematic Review

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Abstract

The active learning approach is promising in increasing students' engagement and providing opportunities for practising higher-order thinking skills. However, its application in higher education is associated with some challenges, including institutional, pedagogical, and technological. The applications of Artificial Intelligence can mitigate some of these challenges. The paper at hand reports a restricted systematic review that aims to revise the current experiences of integrating AI applications into higher education, focusing on ChatGPT. Exploring the Scopus database using the keywords (ChatGPT) AND (Active) AND (Learning) AND (Higher) AND (Education) resulted in 13 publications. The review highlights the advantages of integrating ChatGPT with active learning but points out a lack of knowledge regarding how to quantify the effectiveness of this integration. The findings highlight ChatGPT's potential to enhance active learning by addressing pedagogical challenges and the need for standardised frameworks to measure effectiveness. The study also stresses the importance of ethical governance and interdisciplinary collaboration for the fair integration of AI in higher education.

Keywords: *ChatGPT; Active Learning; Higher Education.*

1. Introduction

In traditional teaching and learning approaches in higher education, students are passive receivers of knowledge as they primarily watch and listen to their instructors and lecturers. This contrasts with active learning, a student-centred learning approach that empowers students to take responsibility for their learning through active engagement, reflection, and the practice of

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higher-order thinking skills such as analysis, synthesis, evaluation, and creation. In this approach, instructors facilitate the students' construction of knowledge by designing learning scenarios. Such scenarios encourage the students to learn actively and incorporate a wide range of active learning techniques such as group discussions, flipped classrooms, problem-based learning, project-based learning, and case-based learning, among other techniques.

Despite the widespread interest in the active learning approach, the lack of consensus on its definition is noteworthy, as revealed by a recent restricted systematic review. The review, which examined 547 out of 1571 journal articles, aimed to explore how active learning is defined in the literature (Doolittle et al., 2023). Definitions for the active learning approach were found in 161 journal articles, reflecting the noticeable interest in this approach. Furthermore, the review identified the five top-cited definitions of active learning that highlight its roots in the constructive learning theory and its emphasis on reflective learning. Examples of these definitions are "any instructional method that engages students in the learning process" (Prince, 2004, p. 223) and "Active learning engages students in the process of learning through activities and/or discussion in class, as opposed to passively listening to an expert. It emphasises higher-order thinking and often involves group work." (Freeman et al., 2014, p.8413).

As highlighted by previous research, the broad interest in active learning stems from its benefits to the educational process. For instance, it was revealed that implementing active learning techniques enhances the students' writing and thinking skills (Bonwell & Eison, 1991), promotes life-long learning, and improves students' retention of knowledge (Prince, 2004). The link between the application of an active learning approach in engineering courses and the increase in students' academic performance was revealed in a recent study that collected objective measures for 2.5 years (Guimarães et al., 2023). Moreover, a meta-analysis of 225 studies pointed out the connection between traditional lecturing and high failure rates and the positive link between active learning and high examination scores (Freeman et al., 2014).

Applying the active learning approach is accompanied by challenges, such as transitioning from traditional teaching and learning methods to active learning (Fields et al., 2021) and assessing its effectiveness (Prince, 2004). An extensive review study identified six barriers to student active learning: physical, institutional, pedagogical, technological, teacher-related, and student-related barriers. The instructors' lack of time is classified under the institutional barriers, whereas the lack of personalised learning experiences and assessment falls under the pedagogical barriers. Such barriers can be mitigated by integrating Artificial Intelligence (AI) (Børte et al., 2023).

Indeed, AI's opportunities can enhance active learning's efforts directly and indirectly. Direct enhancements involve offering students with individualised learning experiences. Using AI as a learning assistant can identify knowledge gaps for each student, enabling the adaptation of the learning experience accordingly. The indirect enhancements reduce the time and effort

instructors spend on administrative tasks, which frees them to dedicate more time to students. This strengthens the instructor-student relationship, improving learning experiences (Akinwalere & Ivanov, 2022). Moreover, integrating AI into assessment methods customizes them to align with each student's learning experience, leading to an accurate and efficient evaluation of students' performance. Automatic grading saves the instructors time and effort while operating educational laboratories powered by AI, which is appealing for distance learning and for conducting experiments that are either dangerous or expensive (Jianzheng & Xuwei, 2023).

The paper aims to review the current experiences of integrating AI applications into higher education, with a special focus on ChatGPT. In particular, it investigates the strategies of active learning in which ChatGPT is widely integrated and how the effectiveness of this integration is evaluated. The following section details the methodology applied.

The first section starts after the abstract. Paper length must be between 4 and 8 pages, including the abstract page and all text, references, figures, and tables. Manuscripts that deviate from the guidelines, such as exceeding eight pages, adjusting margins incorrectly, or not conforming to the provided template, will be promptly rejected without evaluation of their content.

2. Methodology

To achieve the aim of this paper, a rapid review, also called a restricted systematic review, was conducted. A single database, namely Scopus, was searched, and each of the returned papers was examined by one researcher. Accordingly, the data for each record were extracted by one researcher. This approach is appropriate to the paper's aim of providing an overview of how AI applications are integrated into active learning in higher education. The search was conducted using the keywords (ChatGPT) AND (Active) AND (Learning) AND (Higher) AND (Education). A total of 13 results were returned, and they were all examined, considering their limited number.

3. Results and Discussion

ChatGPT is a chatbot developed by OpenAI and was released to the public in November 2022 (AlAfnan et al., 2023). This justified the publication of all examined studies in this review in 2023 and 2024. Out of the 24 examined publications, only three studies reported the direct integration of ChatGPT in active learning. In the first study, a flipped classroom strategy was applied in an engineering programming course, and ChatGPT was used as a virtual tutor to assist students with pre-class materials through guided questions. This application supported students' conceptual understanding and problem-solving, replacing traditional video-based content and enabling more interactive and tailored learning experiences. A total of 356 students

were divided into two groups: (flipped learning with ChatGPT) and (flipped learning with traditional videos). Students in the first group exhibited a higher normalised learning gain, averaging 52.9%, compared to the other group, which averaged 41.29% (Huesca et al., 2024).

Similarly, ChatGPT was a virtual tutor that provided real-time feedback and enhanced students' engagement with coding, mathematical modelling, and numerical methods in a mathematical course. In particular, the students selected real-world phenomena to model with differential equations and used ChatGPT to generate and modify codes for numerical methods like Euler's or Runge-Kutta. The findings indicated improvements in coding skills and numerical methods understanding for 91% and 72% of the students, respectively (Gouia-Zarrad & Gunn, 2024).

Additionally, a questionnaire was distributed among undergraduate business students to quantify the advantages of integrating ChatGPT. The questionnaire was designed considering the Interactive Constructive Active Passive (ICAP) framework and Self Determination Theory. Accordingly, four engagement modes were examined. In the interactive mode, the students created educational material collaboratively with their peers. In the constructive mode, they develop new knowledge in addition to the original content of the course. In the active mode, they link the newly obtained information to their previous knowledge. In the passive mode, they receive the information from ChatGPT. The results positively impacted the students' desire for learning, self-efficacy, and beliefs about the future. However, it should be mentioned that some students reported imposter syndrome, which requires further research. Moreover, it is not mentioned which active learning strategy was applied in the course (Gao et al., 2024).

ChatGPT application in biomedical education was explored considering the levels of the Structure of Observed Learning Outcomes (SOLO) taxonomy. In addition, design strategies for creating challenging assessment tools were proposed along with a rubric system for accurately evaluating the students' performance even when using AI models. The researcher highlighted the valuable opportunity that AI applications provide to enhance student engagement and promote active learning in the biomedical field. By understanding how to use these technologies effectively, educators can create tailored learning experiences that meet their students' needs, fostering intellectual curiosity and a deeper comprehension of complex subjects. Implementing these tools will be essential in providing more effective and engaging learning experiences for students in the future. This ultimately ensures the achievement of the Student Learning Outcomes (Moulin, 2024).

Despite its promising applications, ChatGPT should be carefully integrated into higher education as recommended by (Williams & Fadda, 2023). In this study, the robustness of ChatGPT was used to investigate its capability of passing the Glycobiology (science of studying carbohydrates) knowledge test. Specifically, ChatGPT was asked to solve Multiple Choice Questions (MCQs) and generate abstracts based on given keywords. It was found that ChatGPT

passed 70% of the MCQs and generated sound abstracts for basic knowledge in Glycobiology. However, it started hallucination once the required information was more specialised.

While most studies reported the impact of integrating ChatGPT in specific courses, the study conducted by (Chang et al., 2023) proposed an educational model for using ChatGPT to support Self-Regulated Learning (SRL). The model focuses on teaching the students effective prompting techniques, enabling reverse prompting for guided feedback, and providing personalised learning analytics to facilitate metacognitive skills development. Another conceptual framework, Promoting Assignment Integrity using Generative AI in Education (PAIGE), was proposed to emphasise the ethical integration of generative AI, encourage active student participation, and foster peer learning opportunities (Shanto et al., 2023).

In another study, the acceptance of ChatGPT and the student's willingness to use it in active learning were explored among undergraduates in Hong Kong. Four significant dimensions were investigated: intrinsic motivation, behavioural intention, perceived ease of use, and perceived usefulness. The study reported the positive impact of intrinsic motivation and perceived use on behavioural intention and, therefore, the use of ChatGPT. Improving ChatGPT to reduce fabricated and inaccurate information will positively reflect the student's acceptance (Lai et al., 2023).

A scoping review investigated the use of ChatGPT in academia with a special focus on academic writing and administrative uses. The review revealed an increased contribution of ChatGPT in higher education owing to its contribution towards personalising the learning experience despite the lack of ethical use regulations (Mahrishi et al., 2024). Another scoping review explored the pros and cons of integrating ChatGPT in healthcare education and research. To ensure the comprehension of the search, seven databases were consulted, namely PubMed, Medline, CINAHL, Embase, PsycINFO, Scopus, Web of Science, ProQuest Dissertations and Theses Global. Two main themes emerged from revising the returned publications: enhancing healthcare education, research, and writing with ChatGPT and controversies and concerns of ChatGPT in healthcare. The review highlighted issues accompanying the use of ChatGPT, such as hallucinations, limited understanding of specialised knowledge, security and confidentiality, and unquantified effects on students' learning and assessment. In addition, the review emphasised the necessity of governing the use of AI applications (Shorey et al., 2024).

Similarly, a systematic review, where the surveyed articles were analysed using reflexive thematic analysis, was conducted to assess the impact of ChatGPT on students' learning and assessment results. While it improves resource access, overreliance on ChatGPT without validating the generated information can threaten learning (Zirar, 2023). Another systematic review employed a bibliometric analysis and advanced data mining techniques to analyse trends and patterns using generative AI in education. The research areas related to the implementation of generative AI in educational practice include (1) interaction and communication with

chatbots powered by generative AI, (2) the impact of Large Language Models (LLMs) and generative AI on teaching and learning processes, (3) the opportunities, challenges, and implications of using conversational educational agents, (4) Utilizing generative AI to enhance social and cognitive learning processes, (5) promoting AI literacy to unlock future opportunities for learners, (6) harnessing generative AI to expand academic capabilities, and (7) improving educational experiences through human-AI interaction (Bozkurt, 2023).

Aiming to improve the students' learning experience, a bibliometric analysis of AI applications in education was conducted. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed in revising a total of 18,741 documents extracted from two databases, namely Scopus and Web of Science, using (Artificial Intelligence) AND (Teaching) as the query keywords. The researchers attempted to identify the related research trends by analysing the keywords of the reviewed papers. It was revealed that (active learning) was the fourth most frequent used keyword among authors reflecting its strong relation with artificial intelligence. It is noteworthy that the two most cited articles were about the application of ChatGPT in higher education. Moreover, the researchers predicted that ChatGPT will be among the research topics that will be deeply investigated in different fields including education and pedagogy (Ivanova et al., 2024).

Regardless of the increasing use of AI applications in active learning in higher education, some areas require the researchers' attention, such as accurate quantification of the impact of AI and the governance of its use. Considering the reviewed papers, not all reported the effectiveness of integrating AI applications in active learning. Besides, the few studies that did that employed different self-reporting methods, which made it difficult to compare the findings. For instance, the effectiveness of integrating ChatGPT in an engineering programming undergraduate course was quantified through normalised learning gains. These, in turn, were quantified using the students' scores in pre-testing and post-testing questions (Huesca et al., 2024). Another study that integrated ChatGPT in an undergraduate mathematical course utilised a questionnaire with quantitative and qualitative components to collect the students' perceptions about the effectiveness of this integration (Gouia-Zarrad & Gunn, 2024). Furthermore, the statistical tools represented in the Partial Least Squares Structural Equation Modelling (PLS-SEM) were utilised to measure the effectiveness of integrating ChatGPT into an undergraduate business course (Gao et al., 2024).

4. Research Implications

The results of this study offer important insights into the integration of AI applications, particularly ChatGPT, in higher education. They emphasise its potential to tackle key active learning challenges while pinpointing critical areas needing further exploration and development. Integrating ChatGPT into active learning environments enhances student

engagement and higher-order thinking. Educators can utilise AI for personalised feedback, collaborative learning, and adaptive content, transforming higher education teaching methods.

5. Conclusion

This review highlights the growing potential of generative AI in enhancing active learning in higher education institutions. Evidence from reviewed works reveals its positive impact on student engagement, customised follow up, and the development of advanced thinking skills.

On the other hand, the limited number of empirical studies and diverse assessment methods underscore the need for standardised assessment frameworks. Ethical concerns, data accuracy, and student overreliance call forth cautious consideration when adopting these technologies in education. To ensure solid integration and responsible use of these technologies, interdisciplinary collaboration and governance structures are essential. ChatGPT, for example, offers valuable opportunities, but its adoption must be guided by pedagogical intent. Future research should focus on quantifying its effectiveness, addressing the emerging challenges, and suggesting suitable solutions.

References

Akinwalere, S. N., & Ivanov, V. (2022). Artificial intelligence in higher education: Challenges and opportunities. *Border Crossing*, 12(1), 1–15. https://doi.org/10.33182/bc.v12i1.2015

AlAfnan, M. A., Dishari, S., Jovic, M., & Lomidze, K. (2023). ChatGPT as an educational tool: Opportunities, challenges, and recommendations for communication, business writing, and composition courses. *Journal of Artificial Intelligence and Technology*, 3(2). https://doi.org/10.37965/jait.2023.0184

Bonwell, C. C., & Eison, J. A. (1991). *Academic advising for student success: A system of shared responsibility*. Washington, D.C.: School of Education, George Washington University.

Bozkurt, A. (2023). Unleashing the potential of generative AI, conversational agents and chatbots in educational praxis: A systematic review and bibliometric analysis of GenAI in education. *Open Praxis*, 15(4), 261–270. https://doi.org/10.55982/openpraxis.15.4.609

Børte, K., Nesje, K., & Lillejord, S. (2023). Barriers to student active learning in higher education. *Teaching in Higher Education*, 28(3), 597–615. https://doi.org/10.1080/13562517.2020.1839746

Chang, D. H., Lin, M. P.-C., Hajian, S., & Wang, Q. Q. (2023). Educational design principles of using AI chatbot that supports self-regulated learning in education: Goal setting, feedback, and personalization. *Sustainability*, 15(17), 12921. https://doi.org/10.3390/su151712921

Doolittle, P., Wojdak, K., & Walters, A. (2023). Defining active learning: A restricted systemic review. *Teaching and Learning Inquiry,* 11. https://doi.org/10.20343/teachlearninqu.11.25

Fields, L., Trostian, B., Moroney, T., & Dean, B. A. (2021). Active learning pedagogy transformation: A whole-of-school approach to person-centred teaching and nursing graduates. *Nurse Education in Practice*, 53, 103051. https://doi.org/10.1016/j.nepr.2021.103051

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, 111(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

Gao, Z., Cheah, J.-H., Lim, X.-J., & Luo, X. (2024). Enhancing academic performance of business students using generative AI: An interactive-constructive-active-passive (ICAP) self-determination perspective. *International Journal of Management Education*, 22(2), 100958. https://doi.org/10.1016/j.ijme.2024.100958

Gouia-Zarrad, R., & Gunn, C. (2024). Enhancing students' learning experience in mathematics class through ChatGPT. *International Electronic Journal of Mathematics Education,* 19(3), em0781. https://doi.org/10.29333/iejme/14614

Guimarães, L. M., & Da Silva Lima, R. (2023). Structural modeling and measuring impact of active learning methods in engineering education. *IEEE Transactions on Education*, 66(6), 543–552. https://doi.org/10.1109/TE.2023.3259882

Huesca, G., Zhang, X., Sun, P., Wang, J., & Ahmed, S. (2024). Effectiveness of using ChatGPT as a tool to strengthen the benefits of the flipped learning strategy. *Education Sciences,* 14(660), 1–21. https://doi.org/10.3390/educsci14060660

Ivanova, M., Grosseck, G., Holotescu, C., 2024. Unveiling Insights: A Bibliometric Analysis of Artificial Intelligence in Teaching. Informatics 11, 10. https://doi.org/10.3390/informatics11010010

Jianzheng, S., & Xuwei, Z. (2023). Integration of AI with higher education innovation: Reforming future educational directions. *International Journal of Science Research (IJSR),* 12(10), 1727–1731. https://doi.org/10.21275/SR231023183401

Lai, C. Y., Cheung, K. Y., & Chan, C. S. (2023). Exploring the role of intrinsic motivation in ChatGPT adoption to support active learning: An extension of the technology acceptance model. Computers and Education: *Artificial Intelligence*, 5, 100178. https://doi.org/10.1016/j.caeai.2023.100178

Mahrishi, M., Abbas, A., Radovanović, D., & Hosseini, S. (2024). Emerging dynamics of ChatGPT in academia: A scoping review. *Journal of University Teaching & Learning Practice,* 21(1), 1–31. https://doi.org/10.53761/b182ws13

Moulin, T. C. (2024). Learning with AI language models: Guidelines for the development and scoring of medical questions for higher education. *Journal of Medical Systems*, 48(1), 45. https://doi.org/10.1007/s10916-024-02069-9

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education,* 93(3), 223–231. https://doi.org/10.1002/j.2168-9830.2004.tb00809.x

Shanto, S. S., Ahmed, Z., & Jony, A. I. (2023). PAIGE: A generative AI-based framework for promoting assignment integrity in higher education. *STEM Education*, 3(4), 288–305. https://doi.org/10.3934/steme.2023018

Shorey, S., Mattar, C., Pereira, T. L.-B., & Choolani, M. (2024). A scoping review of ChatGPT's role in healthcare education and research. *Nurse Education Today*, 135, 106121. https://doi.org/10.1016/j.nedt.2024.106121

Williams, D. O., & Fadda, E. (2023). Can ChatGPT pass glycobiology?. *Glycobiology*, 33(8), 606–614. https://doi.org/10.1093/glycob/cwad064

Zirar, A. (2023). Exploring the impact of language models, such as ChatGPT, on student learning and assessment. *Review of Education*, 11(3), e3433. https://doi.org/10.1002/rev3.3433

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The contribution of chatbots to student engagement: A case study from a Business School in Mexico

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Abstract

The implementation of artificial intelligence tools, in a context of higher education and specifically in a Business School, promotes the opportunity to strengthen iterative evaluation and; consequently, it has an impact on student motivation and commitment. Under this premise, the research analyses how the application of artificial intelligence through a programmed chatbot affects the level of student engagement of a sample of a Business School in Mexico. To this end, an exploratory study of 14 students and a confirmatory study of 62 students who used the Noodle Factory Platform and whose impact was measured on engagement was carried out. The results suggest that the implementation of educational chatbots has a significant positive impact on student learning and engagement. Along with this, the potential for application or scaling in similar contexts for careers related to international business is highlighted.

Keywords: *Higher education, artificial intelligence, teaching methodologies, chatbot, educational innovation*

1. Introduction

The use of artificial intelligence (AI) in higher education has gained prominence for its ability to enhance personalized learning and improve the efficiency of academic processes (Timms, 2016). Among AI applications, chatbots stand out as promising tools to support teaching, learning, and particularly assessment, by enabling ongoing, personalized interaction with students (Abbas et al., 2022; Okonkwo & Ade-Ibijola, 2021). This is especially relevant in disciplines such as international business, where mastering complex regulatory frameworks requires not only theoretical knowledge but also applied practice (García-Rodríguez et al., 2024).

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This study examines the effectiveness of chatbot-based iterative assessments in fostering student engagement and topic mastery within a business school in Mexico. Through an exploratory and a confirmatory study, it analyzes how repeated interactions with an AI-driven chatbot influence students' learning experiences and motivation. We hypothesize that the use of chatbots for formative assessment enhances student engagement, facilitates deeper understanding, and contributes to the development of applied competencies.

This study begins with a review of the literature on chatbots and iterative assessment in higher education, followed by the theoretical framework and methodology. The results are then presented and discussed, concluding with implications for educational practice and suggestions for future research.

2. Theoretical framework

Artificial intelligence (AI) in higher education is defined as a computerized system that interacts with human learning processes such as adaptation, synthesis, and decision-making (Popenici & Kerr, 2017). In this context, chatbots are AI-based tools designed to communicate through natural language and support educational functions such as tutoring, assessment, and feedback (Winkler & Söllner, 2018; Hobert, 2019). Their ability to simulate conversation enables personalized interaction, while their adaptive capabilities position them as valuable tools for active learning (Pérez et al., 2020). These applications are grounded in constructivist theories by Piaget and Vygotsky, who view learning as an active process of building knowledge through experience (Ertmer & Newby, 2013).

In turn, Davis's (1989) technology acceptance model (TAM) postulates that the acceptance and use of a new technology is mainly determined by two key factors: perceived usefulness (PU) and perceived ease of use (PFU). In relation to PU, it refers to the extent to which students believe that using the chatbot will improve their academic performance and facilitate mastery of the subjects; and PFU, refers to the extent to which students believe that using the technology will be effortless (Szajna, 1996). Chung et al. (2020) found that when students perceive that a technological tool can help them achieve their learning goals more efficiently, they are more likely to adopt and use it regularly. Li and Wong (2023) suggest that the intuitive interface and the ability of chatbots to provide clear instructions and immediate feedback contribute significantly to high PFU. According to García-Rodríguez et al. (2024), one of the main uses of chatbots in education is to support evaluation processes, adding this to the research of Zhang and Brown (2021) who highlight the potential of this tool to provide adaptive assessments, adjusting the difficulty of the questions according to the student's performance.

Hence, iterative assessments and the feedback that they entail align with Bloom's (1968) mastery learning theory and are supported by Taylor et al. (2022) who argue that repeated practice with immediate feedback is crucial for mastery of complex skills. Hernandez and Kim

(2024) argue that chatbots offer an ideal platform to implement this approach, allowing students to practice until they reach the desired level of competence required in their training process. Nguyen et al. (2023) suggest that the use of chatbots for iterative assessment can foster deeper and more applied learning.

3. Methodology

It was developed in two sequential phases: an initial exploratory study and a subsequent confirmatory study with a larger sample. We used a quantitative research design with a descriptive approach in both phases. For the confirmatory study, a pre-test-posttest design was carried out with a sample for convenience and informed consent and acceptance of the participants. In both phases, the study was developed during a full academic semester consisting of 16 weeks.

Due to institutional and ethical constraints regarding student assessment, it was not feasible to establish a separate control group not exposed to the chatbot. Instead, a within-subjects design was implemented, comparing students' results before and after using the chatbot in the same cohort. This approach allowed us to measure progress while controlling for individual variation.

3.1. Instruments

1. *Questionnaire*: measure engagement by evaluating, on a scale of 1 to 100.

Table 1. Dimensions of engagement

Vigor	**High willingness to exert effort and persist in the face of adversity.**
Dedication	It refers to being strongly involved and experiencing a sense of excitement, inspiration, pride, challenge, and meaning.
Absorption	It is characterized by being totally concentrated and happily immersed, in such a way that time passes quickly and you experience unpleasantness for having to stop activities.

Cronbach's alpha for the entire measurement instrument was 0.93, and for the dimensions: vigor (0.82), dedication (0.90) and absorption (0.84). The validation was carried out using a sample of 116 professional students from Tecnológico de Monterrey, which was provided by the Institute for the Future of Education. It is worth mentioning that the original tool was developed by Shaufeli, Bakker and Salanova called the Ultrech Work Engagement Scale.

2. *Knowledge exam*: a specific exam was designed to evaluate student learning. The same exam was administered at the beginning and at the end of the course. The instrument was designed with a consistent structure, scope and difficulty level, allowing for valid comparisons of learning outcomes.

3. *Experience questionnaire*: The experience questionnaire included items on perceived fairness of evaluation, usefulness of feedback, reflection on learning, and the perceived applicability of the course. Each item was rated on a scale from 0 to 100, and the instrument was developed based on existing scales used in digital learning environments.

3.2. Phase 1: Exploratory study

The initial sample consisted of 14 undergraduate students (N = 14) enrolled in the fourth semester of the International Business (LIN) career at the Saltillo Campus Business School, with a demographic distribution of 9 women (64.3%) and 5 men (35.7%), and an average age of 20.35 years. The study measured learning gains using a pre-test and post-test instrument. To measure engagement and user experience with technology, only a post-test instrument was applied. The exploratory study yielded positive results regarding the use of chatbots both in the area of engagement and in the user experience and learning. However, standard deviations greater than 30 were observed in all dimensions, so it was decided to conduct a second experiment with a larger sample.

3.3. Phase 2: Confirmatory study

The sample was expanded to 62 students, with 40 women (64.5%) and 22 men (35.5%) participating, maintaining similar characteristics in terms of age (20.5 years), academic level, and area of study.

Before using the chatbot, students completed a pre-test that included both an engagement questionnaire and a knowledge exam, to establish their baseline scores. The engagement instrument was administered again as a post-test at the end of the course, using the same items to ensure comparability and consistency in measurement.

The chatbot used in this study was implemented through the Noodle Factory platform, which enables automated formative assessment through natural language interactions. The chatbot provided immediate, personalized feedback on open-ended responses and guided students through repeated practice cycles. This iterative process is aligned with mastery learning principles and intended to enhance knowledge retention and engagement.

At the end of the course, students were again given the knowledge test (same structure and difficulty as the initial one), the engagement instrument, and a questionnaire on their experience with the educational technology. This final instrument included items on perceived fairness, usefulness of feedback, learning reflection, and the practical applicability of course activities.

3.4. Data analysis

Descriptive statistical analyses were performed including: measures of central tendency, analysis of variability, pre-test and post-test comparisons.

4. Results

The comparative pre-test/post-test analysis showed improvements in the items analyzed.

4.1. Engagement

The comparative analysis of pretest and posttest results showed a consistent increase across all three dimensions of engagement. The mean score in vigor rose from 79.3 to 82.9, in dedication from 82.0 to 85.2, and in absorption from 81.4 to 83.9. Although these increases were not statistically significant ($p > 0.29$), the trend is positive. The effect sizes (Cohen's $d \approx 0.16–0.17$) suggest small but consistent improvements in student engagement after using the chatbot-based feedback. The results by dimension are shown below:

Table 2. Results by dimensions.

Dimension: Vigor		**+15.8 Gain Points**	**With the largest increase**
Energy	My coursework made me feel energized	+18.0 points	Item with the highest increase
Vigor	I felt strong and vigorous when I am studying or going to the course	+16.1 points	
Motivation	When I got up in the morning, I wanted to go to my course	+13.3 points	
Dimension: Dedication		**+11.5 Win Points**	**With the smallest of increases**
Enthusiasm	I was excited about my course	+7.4 points	Item with the lowest increase
Inspiration	My course inspired me with new things	+15.7	
Pride	I was proud to do this course	+11.5	
Dimension: Absorption		**+13.8 points**	**It registered an increase**
Happiness	I was happy to do my homework related to my course	+17.1	
Immersion	I felt immersed in my course	+11.8	
Commitment	I got carried away when I was doing my coursework as a student	+12.7	

When disaggregating the engagement data by gender, we observed a distinct pattern. Female students showed statistically significant improvements in the dimension of vigor ($p = 0.022$), with a moderate effect size (Cohen's $d = 0.59$). Smaller, non-significant improvements were also noted in dedication ($d = 0.28$) and absorption ($d = 0.36$).

In contrast, male students showed a slight decrease or no improvement in their engagement scores across dimensions, with no statistically significant changes observed. These results

suggest that chatbot-based feedback may have a more positive impact on female students, potentially due to differences in learning styles, interaction preferences, or receptivity to automated feedback. Further research is needed to explore these factors in depth.

4.2. Knowledge

The difference between the scores in the knowledge test showed an improvement of 24%, going from an average pre-test score of 57.8 points to an average post-test score of 76 points. Although the rating improvement cannot be attributed solely to the use of chatbots, the results are encouraging.

4.3. Experience with educational technology

The study revealed improvements in key indicators in the areas of feedback and evaluation
- My rating was fair: 82.0
- The feedback helped me identify the difficult topics in my course: 84.6
- The feedback provided made me reflect on my way of working in the course.: 84.6
- My course activities helped me learn better.: 86.3
- Educational technology helped me apply the knowledge I gained in this course in a real-world context: 83.8
- Educational technology was difficult for me to use: 60.6%

5. Discussion

The results of this study provide valuable insights into the use of chatbots, specifically Noodle Factory, for iterative assessment in higher education, particularly in the context of learning international business regulatory frameworks. The results reveal an overall positive level of engagement among students. This finding aligns with previous studies such as that of Anderson et al. (2024), which found high levels of satisfaction among students using educational chatbots.

The high score in the user experience dimension (81.4) suggests a positive perception among students. This is aligned with Davis' (1989) Technology Acceptance Model, which posits the importance of the perception of ease of use in the adoption of new technologies. However, the lowest score in the learning experience dimension was difficulty of use (60.6), indicating that the perception of usefulness could be improved by training users in the use of the tool and making the connection between the tool and the learning objectives of the courses more explicit.

While students' perceptions were generally positive, it is important to note that this study did not include a control group, which limits the ability to isolate the specific contribution of the chatbot to the learning outcomes. This decision was based on ethical and logistical constraints related to instructional design within a single course. Instead, we used a within-subjects pre-post design, allowing for comparisons over time within the same cohort. Similarly, the need to

adjust the design of the activities and the feedback provided by the chatbot to increase its perception of usefulness was observed, preferably through the personalization of the evaluations, as suggested by Hernández and Kim (2024).

Although the overall increase in engagement was not statistically significant, the gender-based analysis revealed that female students benefited more strongly from the use of chatbot feedback. This aligns with previous studies that suggest differentiated responses to educational technologies based on gender. These findings highlight the need for future research to explore adaptive feedback mechanisms that can be customized according to student profiles.

The results of the knowledge test provide direct and quantifiable evidence of students' mastery of topics. The 18.2 points improvement suggests that the use of chatbots has allowed students to practice and refine their knowledge effectively throughout the course, which could be attributed to both the dosage of the learner's cognitive load, and repeated practice with immediate feedback for the mastery of complex skills (Taylor et al., 2022). In addition, these quantitative results support the high overall satisfaction reported by students. Their perception that Noodle Factory helps them connect knowledge is validated by the objective improvement in their academic performance.

These findings indicate that the tool is not only perceived as useful, but that it is effectively facilitating deep and applied learning, which is particularly relevant in the context of learning normative frameworks, where accuracy and practical application of knowledge are crucial. In addition, although the chatbot provided rapid and iterative feedback, it is not intended to replace human feedback, but rather to complement it. Students still benefit from the teacher’s perspective, particularly in complex or subjective areas. Future research should explore how both sources of feedback interact and whether personalization of AI feedback can be enhanced to better support deep learning.

5.1. Theoretical and practical implications

Theoretically, this study contributes to the literature on the use of chatbots in higher education by providing empirical evidence on their effectiveness. The results support the idea that chatbots can facilitate deeper, more applied learning, as suggested by Nguyen et al. (2023), but they also reveal the complexity of this process and the need to consider additional factors such as gender differences and the need for tool customization. In practical terms, the findings suggest that implementing chatbots like Noodle Factory can improve the learning experience for students, but they also indicate areas for improvement. Educators and ed-tech designers should consider: Improving the connection between chatbot activities and learning objectives, developing methods to directly assess how iterative chatbot use contributes to mastery of complex topics such as international business regulatory frameworks, adapting chatbot design to address gender differences in perception and use of the tool.

5.2. Limitations

It is important to recognize the following: the study was carried out in a single semester, which does not allow evaluating the long-term effects of the use of chatbots, the lack of a control group makes it difficult to directly attribute the results to the use of the chatbot. The study focused on students' perception and did not directly measure academic performance or mastery of topics. Additionally, despite the advances in research on educational chatbots, there are several significant gaps in relation to the current literature, such as: scarcity of longitudinal studies on the long-term impact of chatbot use on learning, limited research on the effectiveness of chatbots in different disciplines and educational levels, lack of studies examining how iterative assessment using chatbots affects long-term knowledge retention and transfer, need for more research on how to optimize chatbot design for different learning styles and student preferences.

Furthermore, the results indicate possible gender-related variations in engagement outcomes. While not the primary focus of this study, these differences suggest a need for more targeted investigations into how students of different genders perceive and respond to chatbot-based feedback in educational settings.

6. Conclusions

This study provides promising evidence on the potential of chatbots as iterative assessment tools in higher education having a significant positive impact on student learning and engagement, particularly in the field of international business. However, it also reveals the complexity of implementing these technologies effectively and equitably.

Further research and refinement of these tools is needed to ensure that they truly enhance the learning experience and contribute to the mastery of critical knowledge in higher education students. In line with what has been studied, we suggest for future research: to conduct longitudinal studies to evaluate the long-term impact of chatbot use on knowledge learning and retention, to further investigate the reasons for gender differences in the perception and use of educational chatbots, to develop and validate methods to directly measure how the iterative use of chatbots contributes to the mastery of complex topics in international business.

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References

Abbas, M., Smith, J., & Brown, K. (2022). Using chatbots to build student communities in online learning: A case study at the University of Leeds. *Journal of Educational Technology*, 19(3), 245-260.

Anderson, E., Wilson, T., & Lee, J. (2024) The role of chatbots in providing teacher support in higher education. *International Journal of Educational Technology in Higher Education*, 21(1), 15

Bloom, B. S. (1968). Learning for mastery. *Evaluation Comment*, 1(2), 1-12.

Chung, M., Ko, E., Joung, H., & Kim, S. J. (2020). Chatbot e-service and customer satisfaction regarding luxury brands. *Journal of Business Research*, 117, 587-595.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319-340.

Ertmer, P.A., & Newby, T.J. (2013) Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly*, 26(2), 43-71.

García-Rodríguez, J., López, M., & Fernández, A. (2024). Enhancing meaningful learning through chatbot assessments in higher education. *IEEE Transactions on Education*, 67(1), 45-60.

Hernández, C., & Kim, J. (2024). The influence of chatbots on critical thinking skills in business education. *Thinking Skills and Creativity*, 47, 101080.

Hobert, S. (2019). How are you, chatbot? Evaluating chatbots in educational settings – Results of a literature review. In: *Proceedings of the 17th International Conference on Wirtschaftsinformatik*.

Li, W., & Wong, S. (2023). Comparing traditional and chatbot-based assessments in business schools. *Assessment & Evaluation in Higher Education*, 48(3), 456-470.

Nguyen, T., Park, H., & Lee, Y. (2023). Personalized learning experiences through AI-powered chatbots in higher education. *IEEE Transactions on Learning Technologies*, 16(2), 180-195.

Okonkwo, C. W., & Ade-Ibijola, A. (2021). Chatbots applications in education: A systematic review. *Computers and Education: Artificial Intelligence*, 2, 100033. https://doi.org/10.1016/j.caeai.2021.100033

Pérez, J. Q., Daradoumis, T., & Puig, J. M. M. (2020). Rediscovering the use of chatbots in education: A systematic literature review. *Computer Applications in Engineering Education*, 28(6), 1549-1565.

Popenici, S. A. D., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning*, 12, Article 22. https://doi.org/10.1186/s41039-017-0062-8

Szajna, B. (1996) Empirical Evaluation of the Revised Technology Acceptance Model. *Management Science* 42(1):85-92. https://doi.org/10.1287/mnsc.42.1.85

Taylor, M., Brown, K., & Smith, L. (2022). Chatbots and learner comfort: A study on anxiety reduction in higher education. *Journal of Educational Technology & Society*, 25(4), 78-90.

Timms, M. J. (2016.) ‘‘Letting artificial intelligence in education out of the box: Educational cobots and smart classrooms” *Int. J. Artif. Intell. Edu*., vol. 26, no. 2, pp. 701–712.

Winkler, R., & Söllner, M. (2018). Unleashing the potential of chatbots in education: A state-of-the-art analysis. In: *Academy of Management Annual Meeting Proceedings*.

Zhang, L., & Brown, R. (2021). The impact of chatbots on student engagement in online business courses. *Journal of Online Learning*, 18(4), 210-225.

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Creating personalised learning through the use of AI powered teaching assistants: perceptions of higher education educators

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Abstract

This study aims to evaluate university lecturers' perceptions of AI technology and its use in education, as well the extent to which advanced AI teaching assistants can offer an effective means for more personalised learning opportunities. The study interviewed 10 lecturers from a UK Business School and found that whilst overall most saw potential uses and benefits of using AI, the majority of lecturers have significant concerns. These concerns related to the reliability and accuracy of AI, a removal of personal connection between lecturer and student, AI being seen to represent them and their views/knowledge and concerns related to the necessary resources needed to understand and embed AI into their teaching. If AI is to be used to create more personalised learning, then universities need to support staff to understand, explore and embed these tools, whilst also addressing the concerns they have.

Keywords: *artificial intelligence; personalised learning; higher education.*

1. Introduction

Higher education in the UK, and many other countries, has changed significantly in recent years, with larger and more diverse student groups. Standardised learning approaches that treat all students the same have proven ineffective for these diverse learners (Aggarwal, 2023; Shemshack and Spector, 2020). Instead, personalised learning is increasingly being seen as a more effective way to help prepare students for their careers by allowing them to tailor their studies to changing job markets (Kinash et al., 2014).

However, implementing this approach faces several challenges, including limited resources and a lack of necessary technology (Xu, 2024; Baskara, 2023). One possible solution is the adoption of Artificial Intelligence (AI).

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With the development of AI tools, there has been a growing body of research into their use in education. However, innovations in this area mean that AI and the tools it can support, are evolving at a significant rate and creating increasingly sophisticated means to teach, support and assess students. There is a need for research into the potential use of more advanced and specific AI tools by educators.

One such use is the creation of human-like avatars, which can interact with students. These advanced tools have been used in a small number of education settings to provide more human-like interactions with users (Fink et al., 2024). This study aims to evaluate university lecturers' perceptions of advanced AI technology and its use in education to provide personalised learning opportunities for students.

2. Literature Review

This literature review will explore the concept of personalised learning, challenges of delivering this and the extent to which advanced AI tools may offer a solution to these challenges.

2.1. Need for personalisation in education

Personalisation in education involves tailoring the learning experience to individual learners, such as providing resources based on factors such as students' abilities, prior knowledge, or personal relevance, or by offering adaptive assessments that adjust difficulty based on performance (Keppell, 2014; FitzGerald et al., 2017). However, critics like Selwyn (2016) argue that in practice, personalised learning has often been oversimplified to merely present the same content in different sequences for different students.

2.2. Challenges for Universities to provide personalised learning

Educators often face challenges in designing and delivering personalised learning experiences that cater to the diverse needs of their students (Aggarwal, 2023; Grubaugh and Levitt, 2023). Prowse, et al., (2020) found that while universities increasingly emphasize personalised learning to attract students, the reality of personal tutoring, a common form of support, often falls short.

Assessing and addressing individual learning needs can be time-consuming and resource-intensive (Rudolphet et al., 2024), with universities often not having the necessary infrastructure to support personalised and interactive learning experiences (Xu, 2024). A study by Liu et al., (2024) emphasises how increases in the size and diversity of cohorts, is putting increasing strain on educators, resulting in them struggling to provide the necessary educational and pastoral support.

2.3. Growing use of advanced AI tools in education

There have been a growing number of AI-enabled personalisation platforms such as Realizeit, AutoTutor, and the Adaptive Mobile Learning System (AMLS). These systems can adapt content delivery, provide personalised feedback, and adjust learning pathways based on students' performance and engagement, addressing the crucial challenge of personalisation in education. However, as Kabudi et al., (2021) points out, there remains a significant gap between the potential of AI-enabled learning interventions and their practical application. Their study highlights that while these systems can address some challenges, they often fall short in overcoming complex educational issues and in being fully utilised by educators and students.

2.4. Self-regulated learning and AI

Chang et al., (2023) argue that AI chatbots should be used in the classroom in ways informed by Zimmerman's self-regulated learning (SLR) framework. They argue that teaching students how to prompt and reverse prompt AI chatbots is important for developing students SRL. They also argue that data driven tools that provide learning analytics help learners to reflect on their learning and develop SLR strategies. Whilst there is a growing body of research into the role and uses of generative AI tools (such as ChatGPT) in education. There is limited research into the use of more sophisticated tools such as AI avatars.

2.5. Educators' perceptions of the use of AI in universities

Shamsuddinova, et al. (2024) found that educators were fairly optimistic about AI and open to its adoption in education. However, they also found that a lack of understanding and training in using AI tools is a significant barrier to its use. They also found socio-cultural reservations, systematic resistance to change, lack of structured policies and available resources were potential barriers to AI' adoption in education.

3. Methods

In order to address the aims of this study, semi-structured interviews were conducted with 10 Lecturers from a UK Business School.

There were a mix of lecturers and senior lecturers. Lecturers predominantly came from the academic areas of innovation management, entrepreneurship and marketing. Below are details of the various participants.

Table 1. Interview participants

Participant	Role	Academic Subject Area	Years of Teaching
1	Senior lecturer	Innovation and Science Policy	8
2	Senior lecturer	Innovation Management	9
3	Senior lecturer	Sustainability and Innovation	15
4	Lecturer	Sustainability and Innovation	4
5	Senior lecturer	Marketing	7
6	Senior lecturer	Entrepreneurship	20
7	Senior lecturer	Innovation Management	21
8	Lecturer	Entrepreneurship	10
9	Lecturer	Innovation Management	30
10	Senior lecturer	Marketing	16

Interviews were conducted both in-person and online. The interview questions focused on their familiarity with AI tools in education, their previous use and perceptions of AI and it's use in education. They were questioned specifically on their attitudes towards the use of advanced AI tools using avatars as teaching assistants and the use of AI to create more personalised teaching opportunities. To aid participants who may not be familiar with the functionality of such tools, a list of potential functions was given to them, and they were asked to discuss and rank these. These functions were identified by reviewing existing AI tools and platforms. The qualitative data was analysed using thematic analysis. Key themes were identified around the attitudes and perceptions of educators as well as challenges and barriers to the adoption of AI for education perceptions.

4. Analysis and discussion

The main areas of focus for this analysis are lecturers general perceptions of using AI to improve personalized learning, using an AI teaching assistant and the different functionality of AI tools.

4.1. AI as an aid for personalized learning

Out of the ten participants, a significant majority recognised the potential of AI-powered tools to enhance teaching and learning, particularly in providing personalised learning experiences and addressing specific challenges students face. However, most participants also expressed

concerns about the practical implementation of these tools, the need for proper training, and the potential risks associated with their misuse.

Participant 5 emphasised that AI can significantly support personalised learning. They remarked, "AI can definitely help... AI can definitely serve some important function", but they went on to say, "AI is designed to support, not to replace... we still need to design it, we still need to frame it in a way that AI does the job that we need it to do".

Participant 2 mentioned the potential benefits of AI tools for overcoming language barriers. They pointed out, "people struggling purely because of language barrier... AI can help facilitate understanding by simplifying language". Participant 2 mentioned concerns about the practical aspects of adopting new AI technologies, particularly the learning curve associated with new platforms. They stated, "you need a tutorial, always... because we all use Excel and Word, but we only use like 5% of the features". This underscores the need for comprehensive training and support to ensure that educators can fully utilize AI tools without being overwhelmed by them.

Overall, lecturers identified a fairly limited range of ways AI tools can create personalised learning opportunities, whilst there were some perceived benefits, there were also concerns and perceived barriers to its adoption and full utilisation.

4.2. Lecturers' perceptions of AI avatars as teaching assistants

Out of the ten lecturers interviewed, three showed a level of comfort or interest in using AI avatars as teaching assistants, while the other seven expressed varying degrees of concern or scepticism. The main issues raised included the authenticity of AI avatars, the potential loss of personal touch in teaching, and the need for adequate support and control over the technology.

Participant 6 expressed a positive outlook, stating, "I think that'll be quite good fun," although they did clarify that they wanted to have some control over the avatar's appearance. Participant 3 was also positive and found the idea "really interesting" and was open to experimenting with it, especially if institutional support and resources were provided. Participant 10 reflected a generally optimistic view, they commented, "I think we're at an exciting time and I think there's quite a lot of potential in looking into how AI broadly, and avatars as part of that, form part of a teaching offering".

However, the majority of lecturers were more hesitant than optimistic. Participant 8 acknowledged potential benefits but questioned the appropriateness of AI in contexts that rely heavily on interpersonal skills, stating, "From a learner's perspective, those developing that set of personal communication skills are also, I think, an important element of it". Some lecturers had concerns about avatars that may resemble them, or which may be perceived to be giving content and answers on behalf of them, Participant 2 stated "I'm not very comfortable of having, like, a fake version of me saying things that I don't have control over." This highlights a

significant concern among educators about the loss of personal control and authenticity when using avatars and potentially deepfake technology.

Participant 9 took a broader view, recognising the potential of AI avatars but also the challenges of fully understanding their implications at this early stage. They mentioned, "I think at the moment it feels like we're at a very experimental time. People are trying things; they may not work initially because the technology perhaps isn't yet fully developed."

4.3. Lecturers' ranking different functions of AI teaching assistants

To assist the participants with considering possible functions of an AI teaching assistant, a list of possible functions, created from reviewing existing technologies and platforms, was used and participants were asked to rank the features.

Table 2 shows that lecturers appear to favour functions where the AI tool can aid the lecturer in tasks that take considerable resources, such as grading assessments and where students are able to ask questions and check their understanding of specific content. Lecturers are less favourable to utilise AI tools as an aid to identify and understand student performance, creating video avatars of their own content or hosting discussions with students. Interestingly, answering students questions in different forms was ranked fairly highly, but hosting interactive activities like debates and discussions was ranked the lowest. There appears to be some aspects of a lecturers role, where they have a direct impact on the activity, assessing performance and challenging ideas, that they see AI as being less favourable for.

Table 2. Ranking of an AI assistant's potential functions

Ranking	AI Assistant Feature
1st	Grade assessments (based on lecturers criteria)
2nd	Answer questions on asynchronous lectures
3rd	Host Q&A sessions
4th	Check student understanding post-lectures
5th	24 hour instant answers to any questions
6th	Identifying and understanding individual student performance
7th	Create video avatars for lecturers' content
8th	Host discussions and debates and moderate these

However, even for the more favoured functions, there was still quite a degree of scepticism for their use. Only two out of the ten participants were somewhat optimistic about the potential for

AI-assisted grading to reduce workload, particularly in specific contexts like mathematical or technical subjects. Participant 7 stated "It'd be great to put it all into ChatGPT and have ChatGPT mark it...we gotta embrace [AI], right, rather than resist". However, the other eight expressed significant reservations about the current capabilities of AI, particularly regarding its ability to handle subjective assessments that require a deeper understanding of content and context. Participant 5 raised concerns about the accuracy of AI grading, noting that despite setting clear criteria, "it's still not accurate" and that AI might struggle with "the slight differences in the neurons," referring to the unique ways students express themselves.

5. Conclusion

Whilst it can be seen that there is potential for AI to be utilised as a teaching assistant and aid personalized learning, the lecturers in this study on the whole demonstrated considerable hesitation and scepticism in its use. The main concerns were around the quality and reliability of AI, AI being seen to represent them and their views/knowledge, the resources required to learn how to use it correctly and its use in situations which would normally involve personal interactions between lecturers and students.

If AI is to be used to create more personalised learning, then universities need to support staff to understand, explore and embed these tools, whilst also addressing the concerns they have.

Whilst this study adds to our understanding of educators attitudes and perceptions of emerging AI technologies and tools, there is a need for future research to investigate this with educators from a wider range of subject areas and universities. With tools already developed and in use in some institutions, future research should also collect data on specific tools and educations perceptions of them when utilized in their classrooms.

References

Aggarwal, D. (2023). Exploring the scope of artificial intelligence (AI) for lifelong education through personalised & adaptive learning. *Journal of Artificial Intelligence, Machine Learning and Neural Network*, 41, 21-26. https://doi.org/10.55529/jaimlnn.41.21.26.

Baskara, R. (2023). Personalised learning with AI: implications for Ignatian pedagogy. *International Journal of Educational Best Practices*, 7(1), 1.https://doi.org/10.31258/ijebp.v7n1.p1-16.

Chang D.H., Pin-Chuan Lin, M., Hajian, S., & Wang, Q, Q. (2023) Education design principles of using AI chatbot that supports self-regulated learning in education: goal setting, feedback and personalization. *Sustainability,* 15(17), https://doi.org/10.3390/su151712921.

Fink, M.C., Robinson, S.A., & Ertl, B. (2024). AI-based avatars are changing the way we learn and teach: benefits and challenges. *Frontiers in Education*, 9. https://doi.org/10.3389/feduc.2024.1416307.

FitzGerald, E., Jones, A., Kucirkova, N., & Scanlon, E. (2018). A literature synthesis of personalised technology-enhanced learning: what works and why. *Research in Learning Technology*, 26. https://doi.org/10.25304/rlt.v26.2095.

Grubaugh, S., & Levitt, G. (2023). Artificial intelligence and the paradigm shift: reshaping education to equip students for future careers. *International Journal of Social Sciences and Humanities Invention*, 10(06), 7931-7941. https://doi.org/10.18535/ijsshi/v10i06.02.

Kabudi, T., Pappas, I. O., & Olsen, D. H. (2021). AI-enabled adaptive learning systems: a systematic mapping of the literature. *Computers and Education: Artificial Intelligence*, 2, 100017. https://doi.org/10.1016/j.caeai.2021.100017.

Keppell, M. (2014). Personalised learning strategies for higher education. *International Perspectives on Higher Education Research*, 3(21). https://doi.org/10.1108/s1479-362820140000012001.

Kinash, S., Birt, J. R., & Judd, M. (2018). Is technology enabling or disabling diverse learners studying online?, *Handbook of Distance Education*, 295-310. https://doi.org/10.4324/9781315296135-23.

Liu, D., Kondo, E., Samnick, K., Liu, D., King, D., & Bridgeman, A. (2024). Recipes for institutional adoption of a teacher-driven learning analytics tool: case studies from three Australian universities. *ASCILITE Publications*, 422-432. https://doi.org/10.14742/apubs.2017.767

Prowse, A., Vargas, V. R., & Powell, S. (2020). Design considerations for personalised supported learning: implications for higher education. *Journal of Further and Higher Education*, 45(4), 497-510. https://doi.org/10.1080/0309877x.2020.1789915.

Rudolph, J., Mohamed Ismail, F. M., & Popenici, S. (2024). Higher education's generative artificial intelligence paradox: the meaning of chatbot mania. *Journal of University Teaching and Learning Practice*, 21(06). https://doi.org/10.53761/54fs5e77.

Selwyn, N. (2018). Technology as a focus of education policy. *The Wiley Handbook of Educational Policy*, 457-477. https://doi.org/10.1002/9781119218456.ch20.

Shamsuddinova, S., Heryani, P., & Naval, M.A. (2024) Evolution to revolution: critical exploration of educators' perceptions of the impact of Artificial Intelligence (AI) on the teaching and learning process in the GCC region. *International Journal of Educational Research*, 125. https://doi.org/10.1016/j.ijer.2024.102326.

Shemshack, A. and Spector, J. M. (2020). A systematic literature review of personalised learning terms. *Smart Learning Environments*, 7(1). https://doi.org/10.1186/s40561-020-00140-9

Xu, X. (2024). Navigating the AI revolution: implications for business education and pedagogy. *Journal of Curriculum and Teaching*, 13(1), 371. https://doi.org/10.5430/jct.v13n1p371.

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Advancing Female Careers in Academia and Industry: Lessons from the FAME Program

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Abstract

The Female Academics meet Executives (FAME) program at the University of Graz aims to support female students and academics by providing practice-oriented discussions with successful women from business, academia, and entrepreneurship. This case study examines the program's objectives, implementation, and outcomes. Findings suggest that FAME enables participants to expand their professional networks and develop essential career and leadership skills. Insights from this study offer valuable recommendations for higher education institutions seeking to develop programs that support women in academic and professional contexts.

Keywords: *female academics, female career, women entrepreneurship, female leadership.*

1. Introduction

In response to the increasing demand for gender diversity and equality in leadership roles, the European Union has introduced various initiatives to promote women's participation in business and academia (European Commission, 2024). Despite these efforts, women remain underrepresented in executive positions, facing challenges such as limited access to networks, mentorship, and career development opportunities (André et al., 2023). Addressing these issues requires targeted educational programs that equip female academics with the necessary skills and support to advance in their careers.

As a result, universities across Europe have implemented programs aimed at fostering female leadership and entrepreneurship. These initiatives aim to bridge the gender gap by providing mentorship, networking opportunities, and practical training to empower women in various career paths (Kirkwood, 2009). However, the success of such programs depends on their ability to address specific challenges faced by female academics and professionals, such as work-life balance, career progression barriers, and industry-specific expectations (Brush et al., 2018).

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This paper examines the Female Academics meet Executives (FAME) program at the University of Graz, which aims to empower female students and academics through interactive workshops, mentorship opportunities, and real-world insights from experienced executives. This case study explores the program's objectives, implementation, and content, providing valuable insights into the effectiveness of such initiatives.

This paper is intended for educators and policymakers in the field of gender equality, entrepreneurship and leadership education to offer insights into best practices and inspire the development of similar initiatives in the future. The following sections provide a brief overview of gender-focused career development programs before delving into the case study, followed by a discussion of results and concluding remarks on the potential improvements and future directions for similar programs.

2. Theoretical Framework

The underrepresentation of women in leadership roles has led to the creation of targeted programs aimed at fostering female leadership and entrepreneurship. These initiatives often include mentoring, networking, and specialized workshops to address the unique challenges women face in professional settings. The Female Academics Meet Executives (FAME) program at the University of Graz exemplifies such an initiative, offering structured support to aspiring female leaders.

2.1. Mentoring and Its Impact on Female Leadership Development

Mentoring is crucial for the professional advancement of women, providing guidance, knowledge transfer, and psychosocial support. Through mentoring relationships, women develop essential skills, gain insights into organizational dynamics, and receive encouragement to pursue leadership positions. Research indicates that mentoring programs significantly contribute to career progression by enhancing self-confidence and leadership capabilities among female participants (Burke & McKeen, 1990). However, women often face challenges in finding suitable mentors, which can impede their professional growth (Burke & McKeen, 1990).

2.2. Networking Opportunities and Career Advancement

Professional networks offer platforms for women to connect, share experiences, and access resources pivotal for career development. Networking facilitates exposure to diverse perspectives, potential collaborations, and opportunities that might otherwise remain inaccessible. Studies have shown that female business network initiatives can serve as inclusive policies for women entrepreneurship, as they do not distinguish between women with or without children, formal and informal companies, and the motivation to start a new venture (necessity or opportunity) (García & Welter, 2013).

2.3. Workshops and Skill Development

Workshops tailored for women in leadership focus on developing competencies such as strategic thinking, decision-making, and effective communication. These interactive sessions provide practical knowledge and foster an environment of continuous learning. Participation in such workshops has been linked to increased job satisfaction and a greater sense of empowerment among female professionals (Ragins & Cotton, 1999).

2.4. The Role of Female Leadership Programs

Comprehensive programs that integrate mentoring, networking, and workshops are instrumental in addressing the multifaceted challenges women face in leadership trajectories. By providing structured support and development opportunities, these programs contribute to a more inclusive and equitable professional landscape. The FAME program embodies this approach, offering participants exposure to successful female executives and fostering essential skills for career advancement.

2.5. Significance of FAME in Promoting Female Leadership

The FAME program's multifaceted approach addresses critical areas of development for female academics and professionals. By combining mentorship from accomplished women, opportunities for networking, and targeted workshops, FAME creates a holistic environment conducive to personal and professional growth. Such initiatives are vital in bridging the gender gap in leadership and promoting diversity within organizations.

Comparable initiatives exist both nationally and internationally, such as the doc:muv mentoring program at the University of Vienna, the Women Leadership Forum in Austria, and the internationally renowned Women’s Leadership Program at Yale School of Management. While these programs focus on mentoring, networking, or leadership training, none combine academic integration, hands-on peer learning, and cross-sector exposure in the same structured and credit-bearing format as FAME. This unique combination makes FAME a model that bridges academia and industry while fostering long-term professional development.

In summary, programs like FAME play a crucial role in empowering women by providing the necessary tools, networks, and support systems to succeed in leadership roles. The integration of mentoring, networking, and skill development workshops within these programs addresses the unique challenges faced by women and fosters an environment where they can thrive professionally.

3. Case Study

In this section, we analyze the FAME (Female Academics Meet Executives) program at the University of Graz and elaborate on its objectives, implementation, and content. The program, initiated by the Department of Corporate Leadership and Entrepreneurship, has been running successfully for over ten years. More than 500 participants have benefited from this initiative, which exclusively admits female students and academics. Admission to the program is competitive, requiring an application process where a select number of participants are accepted each semester to ensure quality and diversity. The program is open to students from all disciplines, fostering a rich mix of perspectives and experiences. It offers elective modules designed to support female students and academics in their career development by providing networking opportunities, mentoring, and practical insights from professionals in academia, business, and entrepreneurship.

3.1. Objectives of the Program

The primary objectives of the FAME program are to empower female students and academics by providing insights into career development opportunities in academia, business, and entrepreneurship. The program builds a strong professional network among participants and role models from different industries while offering practical knowledge and strategies for career advancement through hands-on experience and expert-led discussions. It encourages participants to explore their strengths and develop strategies for their personal and professional growth. In addition, it promotes an environment of peer learning and support, where participants can share experiences and challenges with like-minded individuals, and enhances the visibility and confidence of female participants in their respective fields. By focusing on interdisciplinary participation, the program ensures that participants can learn from diverse fields, broadening their understanding and opportunities.

3.2. Implementation of the Program

FAME is offered as an elective course program at the University of Graz, allowing participants to earn ECTS credits upon successful completion. Initially launched as a single course, all participants—regardless of their career goals—were grouped together. Over time, it became clear that participants had distinct career aspirations and faced different challenges, prompting a restructuring of the program into three specialized courses:

- FAME Career: Tailored for participants aiming for careers in industry, focusing on overcoming challenges in male-dominated sectors, breaking the glass ceiling, and balancing career and family life.

- FAME Startup: Designed for those interested in entrepreneurship and self-employment, covering topics such as determining the right time to start a business, managing risks, and balancing entrepreneurship with personal life.
- FAME Science: Focused on academic career paths, addressing topics like pursuing a PhD, career progression in academia, becoming a professor, and navigating challenges in technical and scientific fields as a woman.

This restructuring enabled the program to maintain its small-group format while responding to growing demand and varied interests. Each course continues to attract students from a wide range of academic backgrounds. Participants often value the program not only for its academic credits but also for its relevance to their personal and professional development. Many join out of intrinsic motivation rather than curricular requirements.

FAME is open to students from all disciplines and universities in Austria. Applicants must be enrolled at the University of Graz or co-registered as guest students. Successful participants receive a FAME certificate, which serves as a meaningful credential for future career opportunities. Admission is competitive. A selection process ensures a diverse and motivated cohort, with attention to disciplinary balance and participants' readiness to engage with the program. Criteria include motivation, prior experience, career aspirations, and academic progress, ensuring a fit between program content and participant needs.

4. Content of the program

The FAME program offers a structured learning experience that blends theoretical input with practical application. Each semester starts with a Kick-Off Event outlining the program's objectives, structure, and the three specialized modules—FAME Career, FAME Startup, and FAME Science—helping participants align the content with their career goals. The event also fosters networking among participants and facilitators. Figure 1 illustrates the key phases and components of the semester.

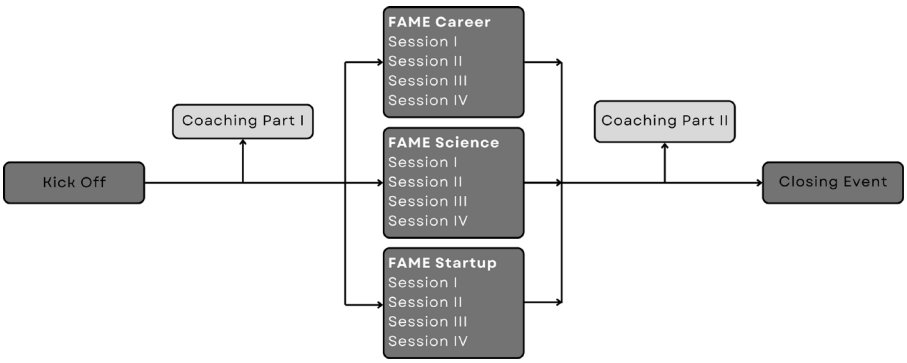


Figure 1. Structure of the FAME program per semester. Source: Authors' illustration.

Following the Kick-Off, participants take part in an **initial career coaching session** aimed at identifying their strengths, aspirations, and areas for development. This session offers self-reflection tools and personalized guidance to support informed career decisions. A unique feature of FAME, this coaching provides tailored advice typically available only in corporate environments at a high cost.

Throughout the semester, each module includes four interactive three-hour sessions, led by experienced professionals from academia, industry, and entrepreneurship. These sessions allow participants to engage with experts who share insights into career challenges and opportunities. Discussions cover gender-specific topics such as career advancement in male-dominated fields, work-life balance, and entrepreneurship. Participants gain practical knowledge and strategic approaches applicable to their careers.

A distinctive feature of FAME is its emphasis on peer-to-peer learning and leadership development. Participants take an active role by moderating at least one session per semester, collaborating with guest speakers, facilitating discussions, and ensuring key topics are covered. This experience enhances essential skills such as communication, leadership, and event coordination. After each session, participants submit a summary report to document key takeaways for future reference.

To further strengthen networking, all participants receive a comprehensive contact list with details of fellow participants and guest speakers. This initiative fosters long-term professional relationships, enabling alumni to reconnect with their peers even years after completing the program.

Towards the end of the semester, a final career coaching session helps participants consolidate their learnings and strategize their next steps. This session builds on previous insights, providing personalized guidance to prepare for future career decisions and address challenges.

As part of the program's commitment to fostering professional relationships, each semester concludes with a Closing Event, which includes a panel discussion featuring speakers from all three modules. The panel discussion revisits major themes explored throughout the semester, providing further insights and encouraging reflection on the participants' career paths. This event also serves as a prime networking opportunity, where participants can establish meaningful connections with role models and fellow participants.

Overall, the structure and content of the FAME program are designed to provide a holistic experience that empowers female students and academics with the knowledge, skills, and networks necessary to succeed in their chosen fields. The program’s evolution from a single course to a specialized three-module format demonstrates its adaptability and responsiveness to the diverse career aspirations of its participants. In addition, an internal evaluation conducted

during the 2024/25 winter semester provided first insights into the program's impact, which are discussed in the following section.

5. Discussion

The FAME program has proven to be a successful model for promoting career development among female students and academics through its interdisciplinary, practice-oriented, and highly interactive approach. By combining theoretical input with real-world experiences, the program enables participants to gain valuable insights into academic, corporate, and entrepreneurial career paths. Particularly effective elements include structured networking, mentoring, and peer-to-peer learning. These components not only foster skill development and self-confidence but also empower participants to take initiative and build lasting professional relationships.

An internal evaluation conducted during the winter semester 2024/25 offers further evidence of the program's impact. Based on feedback from 29 participants, the guest speakers' advice and experiences were rated highly (average score: 4.7/5), and 83% of participants reported gaining new perspectives for their professional futures. Moreover, the program influenced career planning (3.9/5), improved participants' sense of preparedness (4.25/5), and strengthened their confidence in tackling career-related challenges (4.2/5). Importantly, nearly 80% of respondents reported expanding their networks, and nearly half initiated or intensified mentoring relationships.

Despite its success, FAME also faces certain challenges—most notably the limited capacity due to consistently high demand. Expanding the program while preserving its quality and mentoring intensity remains a key consideration for future development. Content-wise, the program must continue to adapt to evolving professional landscapes across sectors.

Looking ahead, several avenues for expansion have emerged. These include tailored modules for women in technical disciplines and STEM fields, where gender disparities remain significant, as well as adaptations for other educational institutions such as universities of applied sciences or even high schools. Finally, incorporating a broader, intersectional approach that considers additional dimensions of diversity—such as ethnicity, disability, or socioeconomic background—would make the program even more inclusive and impactful.

Overall, the FAME program demonstrates how targeted, well-designed educational initiatives can contribute meaningfully to the advancement of women in leadership and professional contexts. The combination of participant feedback, continuous evaluation, and flexible design makes it a replicable model with strong potential for broader application.

6. Conclusion

In conclusion, the FAME program serves as a valuable initiative that empowers female students and academics by equipping them with essential career skills, fostering a supportive professional network, and offering tailored guidance for their individual career paths. The program's interdisciplinary approach, small group structure, and strong focus on mentorship create a unique learning environment that addresses the specific challenges women face in their professional journeys. The success of the program highlights the significance of offering specialized career development initiatives for women in academia, industry, and entrepreneurship. Moving forward, expanding access to the program while maintaining its personalized approach, continuously adapting to emerging career trends, and further strengthening alumni engagement could enhance its long-term impact.

Ultimately, the FAME program provides a replicable model for other universities and institutions seeking to support female career development through a structured and comprehensive approach.

References

André, C., Jin, Y., Morganti, M., & Koske, I. (2023). *Promoting gender equality to strengthen economic growth and resilience: OECD Economics Department Working Papers* (No. 1776). OECD. https://www.oecd.org/en/publications/promoting-gender-equality-to-strengthen-economic-growth-and-resilience_54090c29-en.html https://doi.org/10.1787/54090c29-en

Brush, C., Greene, P., Balachandra, L., & Davis, A. (2018). The gender gap in venture capital-progress, problems, and perspectives. *Venture Capital*, *20*(2), 115–136. https://doi.org/10.1080/13691066.2017.1349266

Burke, R. J., & McKeen, C. A. (1990). Mentoring in organizations: Implications for women. *Journal of Business Ethics*, *9*(4-5), 317–332. https://doi.org/10.1007/BF00380330

European Commission. (2024). *Women in Digital Scoreboard 2024*. https://digital-strategy.ec.europa.eu/en/news/women-digital-scoreboard-2024

García, M.-C. D., & Welter, F. (2013). Gender identities and practices: Interpreting women entrepreneurs' narratives. *International Small Business Journal: Researching Entrepreneurship*, *31*(4), 384–404. https://doi.org/10.1177/0266242611422829

Kirkwood, J. (2009). Motivational factors in a push-pull theory of entrepreneurship. *Gender in Management: An International Journal*, *24*(5), 346–364. https://doi.org/10.1108/17542410910968805

Ragins, B. R., & Cotton, J. L. (1999). Mentor functions and outcomes: A comparison of men and women in formal and informal mentoring relationships. *Journal of Applied Psychology*, *84*(4), 529–550. https://doi.org/10.1037//0021-9010.84.4.529

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A New Multidimensional Approach to Assess Undergraduate Research Identity: Conceptualization, Measurement and Validation

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Abstract

Undergraduate research fosters critical thinking and independent inquiry, yet many students struggle with engagement due to low confidence, limited recognition, and lack of interest, hindering the development of a strong research identity. This study addresses these challenges by developing and validating the Research Identity Scale (RIS) grounded in Social Cognitive Theory. The RIS assesses three core dimensions: Performance-Competence, Interest, and Recognition. Using a rigorous multi-phase process including item generation, expert review, exploratory factor analysis, and confirmatory factor analysis. Results confirmed strong reliability, validity, and a robust three-factor structure. Findings highlight the interconnected roles of competence, intrinsic motivation, and recognition in shaping research identity. The RIS offers educators and policymakers a tool to assess and support students' research identity development, promoting interventions that enhance engagement and foster belonging. The study emphasizes the need for research-rich environments that cultivate confidence, motivation, and self-recognition in undergraduate researchers.

Keywords: *Research Identity, Scale Development, Social Cognitive Theory, Structural Equation Modeling.*

1. Introduction

Undergraduate research is widely regarded as a transformative educational practice that cultivates critical thinking, creativity, and independent inquiry (Yuan et.al.2020). Despite its recognized value, many students struggle to engage meaningfully in research due to low confidence, limited recognition, and lack of sustained interest (Adi Badiozaman, Ling, & Ng, 2024). These barriers hinder not only their immediate participation but also the development of a coherent research identity a vital psychological and professional construct that influences long-term academic engagement.

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Research identity refers to how individuals perceive themselves as researchers how confident they feel in their abilities, how invested they are in research activities, and how recognized they feel by the academic community (Lapum, 2008; Çakmak & Çelik, 2024). It is not static; rather, it evolves over time through dynamic interactions between the individual and their academic environment (Avraamidou, 2020). Rooted in broader understandings of identity as fluid and sociocultural, research identity encompasses beliefs, values, behaviors, and social experiences that collectively shape one's self-concept as a scholar (Castelló et al., 2021).

Drawing from Social Cognitive Theory (SCT), three core dimensions emerge as central to research identity: performance-competence, interest, and recognition. Performance-competence relates to self-efficacy and perceived ability to conduct research successfully (Bandura, 1997). Interest reflects intrinsic motivation and curiosity that sustain long-term engagement (Ryan & Deci, 2000). Recognition involves external validation from peers, mentors, and institutions essential for fostering a sense of belonging within the research community (Kamler & Thomson, 2014). Together, these dimensions interact to influence students' willingness to persist, take intellectual risks, and envision themselves as future researchers.

While existing tools often assess isolated aspects of research identity such as motivation or confidence there remains a lack of comprehensive, multidimensional instruments that capture the full scope of identity formation, especially at the undergraduate level. To address this gap, the present study introduces and validates the Research Identity Scale (RIS). Grounded in SCT and informed by extensive theoretical and empirical literature, the RIS aims to provide a robust framework for assessing the developmental pathways of research identity among undergraduate students. Through this study, we seek to answer the following research question:

RQ1: What are the key factors that contribute to the development of research identity among undergraduate students?

2. Research Methodology

The study used a structured scale development methodology, following a three-stage process that included item generation, exploratory and confirmatory factor analyses (EFA & CFA), and reliability and validity testing, based on established frameworks (DeVellis & Thorpe, 2021; Sultana and Farooq, 2024). The process was organized into three key stages to ensure theoretical robustness, empirical accuracy, and practical applicability of the Research Identity Scale. The stages are Stage 1: Item Generation and Selection- Development of the initial item pool based on literature review and expert evaluation. Stage 2: Scale Refinement- Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) to validate the scale structure. Stage 3: Scale Evaluation- Reliability and validity assessment using various psychometric criteria. Each stage was carefully designed to ensure theoretical robustness, empirical accuracy, and practical applicability of the developed scale. The details of each stage are as follows:

3.1. Stage 1: Item Generation and Selection

3.1.1. Item Generation

The Research Identity Scale (RIS) was developed through a thorough literature review on identity-related constructs in research engagement, deriving many items from the Research Skill Development (RSD) framework (Cutillas et al., 2023). An initial set of 51 items was created, followed by content validation using the Delphi method with a panel of eight experts in education, research methodology, and scale development. Items were rated for clarity, relevance, and theoretical alignment, retaining those with a Content Validity Index (CVI) of 0.80 or higher, resulting in 38 items. A pilot study with 30 research interns was conducted to ensure clarity and relevance for undergraduate students, yielding qualitative feedback for further refinements. The final validated item set consisted of 35 items, ready for factor analysis and scale validation.

3.2. Stage 2: Scale Refinement

3.2.1. Data Collection and Sampling Strategy

A total of 428 responses were collected from undergraduate students. After removing duplicates, incomplete responses, and inattentive entries, a final sample of 333 valid responses was used for analysis. A purposive sampling technique was employed, ensuring the inclusion of students actively engaged in research across diverse academic disciplines. Participation was voluntary, and informed consent was obtained. The study was approved by the Institutional Review Board (IRB) of University.

3.2.2. Exploratory Factor Analysis (EFA)

To determine the factor structure of the RIS, we performed Exploratory Factor Analysis (EFA) using IBM SPSS (v.29). The Kaiser-Meyer-Olkin (KMO) score was 0.834, and Bartlett's Test indicated significance ($p < 0.05$). We utilized Principal Component Analysis (PCA) with Varimax Rotation, removing items with factor loadings below 0.40 and cross-loading items. This resulted in a final three-factor structure: Performance-Competence (7 items), Interest (6 items), and Recognition (6 items), explaining 64.2% of the total variance and confirming the scale's validity.

3.2.3. Confirmatory Factor Analysis (CFA)

To validate the factor structure identified in EFA, Confirmatory Factor Analysis (CFA) was conducted using IBM AMOS (v.29). The results confirmed that the three-factor model provided a statistically valid representation of research identity. (Table 2.)

Table 1: Summary of items, factor loading, and factors that emerged in Exploratory factor analysis of the Research Identity Scale (RIS)

Factors	Items	Loading
Performance- Competence	PC 01_I can confidently deliver research presentations.	.821
	PC 02_I know how to develop and collect data through surveys.	.799
	PC 03_ I can write research papers to communicate my research findings.	.744
	PC 04_I can communicate my research findings with team members.	.735
	PC 05_I can manage and organize data.	.727
	PC 06_I can interpret data graphics etc. from scientific articles.	.647
	PC 07_I cannot collect data using different sampling techniques.	.602
Recognition	R 01_I don't have a scientific mindset.	.841
	R 02_I find it difficult to connect scientific research with societal values.	.816
	R 03_ I do not feel confident in my research skills.	.815
	R 04_I do not feel responsible for contributing to the scientific community.	.719
Interest	I 01_I rarely feel curious about exploring new research topics.	.806
	I 02_I perceive challenging research as an opportunity to grow and learn.	.758
	I 03_I H motivated to clarify research questions.	.568
Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser; Normalization. Rotation converged in 4 iterations.		

Table 2. Model Fit Indices of Research Identity Scale (RIS)

Fit Index	Recommended Value	CFA Model Value
χ^2/df (CMIN/df)	< 5.00	1.849
Comparative Fit Index (CFI)	> 0.90	0.975
Goodness of Fit Index (GFI)	> 0.90	0.968
Incremental Fit Index (IFI)	> 0.90	0.965
Tucker-Lewis Index (TLI)	> 0.90	0.945
Root Mean Square Error of Approximation (RMSEA)	< 0.08	0.051

3.3. Stage 3: Scale Evaluation

3.3.1. Reliability Testing

The internal consistency of the RIS was evaluated using Cronbach's alpha (α) and the Composite Reliability Index (CRI), both showing good reliability. Convergent validity was confirmed with an Average Variance Extracted (AVE) greater than 0.50, while discriminant validity was established by ensuring inter-factor correlations stayed below 0.85.

Table 3: Reliability statistics for dimensions of Research Identity Scale

Factor	Number of Items	Cronbach's Alpha (α)	Composite Reliability (CR)
Performance-	7	0.833	0.875
Competence	6	0.760	0.812
Interest	6	0.710	0.793

Note: A Cronbach's alpha > 0.70 confirmed the scale's internal reliability

Further, nomological validity of the Research Identity Scale (RIS) was assessed by examining its relationship with Research Motivation (ReMotv), an established construct in research engagement. Research motivation was measured using a three-item scale adapted from Yee and Lai (2021) and incorporated into the second section of the questionnaire. Participants rated each item on a five-point Likert scale, allowing for a standardized assessment of motivation levels. To evaluate the nomological network, research motivation was integrated into the Research Identity SEM model, testing its theoretical alignment with the RIS dimensions: Performance-Competence, Recognition, and Interest (Figure 1). The results revealed a positive correlation (r = 0.64) between Research Motivation and Research Identity, indicating that higher motivation is associated with a stronger research identity. The path coefficients further supported this relationship, demonstrating significant contributions of Research Motivation (0.64). This validation reinforces the theoretical and practical significance of the RIS, highlighting its ability to capture essential constructs related to undergraduate research engagement.

3. Discussion

The present study aimed to develop and validate the Research Identity Scale (RIS) to assess undergraduate students' research identity. The findings confirmed that research identity is a multidimensional construct, composed of three key dimensions: Performance-Competence, Interest, and Recognition. These dimensions align with the theoretical underpinnings of Self-Determination Theory (SDT), Social Cognitive Theory (SCT), and Self-Perception Theory (SPT), reinforcing the argument that research identity is shaped by intrinsic motivation, perceived competence, and social recognition.

The results of Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) confirmed that the three-factor structure provided a valid and reliable representation of research identity, with acceptable model fit indices across multiple psychometric assessments. Additionally, Structural Equation Modeling (SEM) validated the theoretical relationships among the three dimensions, indicating that competence, interest, and recognition collectively contribute to the formation of a strong research identity.

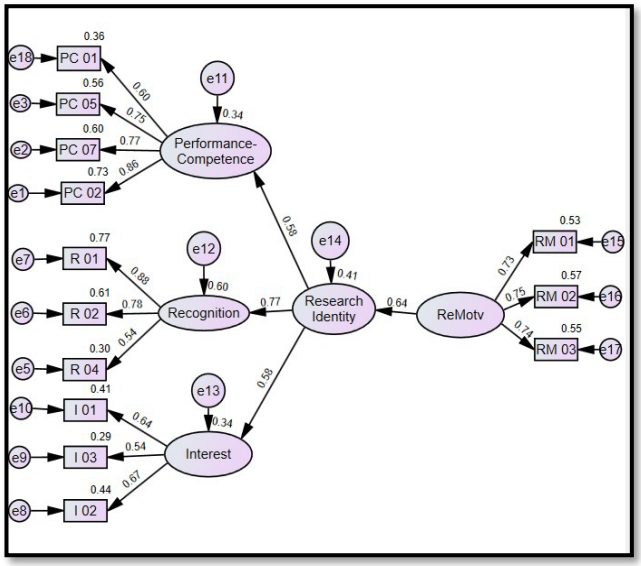


Figure 1: Structural Equation Model to assess the nomological validity of Research Identity with Research Motivation

Importantly, the validated RIS has significant practical utility in higher education settings. It can be employed by academic advisors, research coordinators, and educators to identify students with strong or developing research identities, enabling targeted mentoring and research opportunities. Institutions may integrate this scale into undergraduate research programs or workshops to assess baseline levels of research engagement and monitor growth over time. Furthermore, by recognizing and supporting students' competence and interest in research, universities can foster a culture that encourages scientific inquiry and early research involvement thereby promoting undergraduate scientific research in a more structured and evidence-based manner.

4. Future Research Directions

The findings of the present study provide a strong foundation for understanding undergraduate research identity however, several areas require further exploration. First, longitudinal studies are needed to examine how research identity evolves over time. Tracking students' research identity across different academic years and into graduate studies will offer deeper insights into the long-term impact of research engagement and how identity formation shifts throughout an academic career. Second, cross-cultural validation of the Research Identity Scale (RIS) is essential. Since this study was conducted within a single institutional setting, future research should test the scale across diverse cultural, educational, and institutional contexts to assess its generalizability and applicability in different learning environments. Third, a mixed-methods approach would provide a more comprehensive understanding of research identity formation.

Incorporating qualitative methods such as in-depth interviews, focus groups, and longitudinal case studies alongside quantitative assessments can offer richer insights into the personal and contextual factors shaping students' research identity. By addressing these areas, future research can deepen our understanding of the mechanisms that shape research identity and contribute to the development of targeted interventions that foster a stronger research culture in higher education.

5. Conclusion

The Research Identity Scale (RIS) developed in this study offers a validated framework to assess research identity among undergraduate students. The findings highlight key factors such as perceived competence, intrinsic interest, and recognition from peers and faculty in shaping research identity. This emphasizes the need for institutions to adopt strategies to enhance research engagement. The study provides a measurement tool for assessing research identity and insights for fostering a culture that values research in higher education. In practical terms, the RIS can be incorporated into student development initiatives to identify and nurture research potential. Its application can inform the design of targeted programs that promote undergraduate scientific research across diverse academic disciplines. By addressing these aspects, educational institutions can better support students as active contributors to research, enriching the academic community and improving the educational experience.

References

Adi Badiozaman, I. F., Ling, V. M., & Ng, A. (2024). University students' experiences and reflection on their transition to HyFlex learning during post-COVID times. *Journal of Educational Technology Systems*, 52(4), 448-470. https://doi.org/10.1177/00472395231226407

Avraamidou, L. (2020). Science identity as a landscape of becoming: Rethinking recognition and emotions through an intersectionality lens. *Cultural Studies of Science Education*, 15(2), 323-345. https://doi.org/10.1007/s11422-019-09954-7

Bandura, A. (1997). Self-efficacy: The exercise of control. W.H. Freeman and Company. https://psycnet.apa.org/record/1997-08589-000

Castelló, M., McAlpine, L., Sala-Bubaré, A., Inouye, K., & Skakni, I. (2021). What perspectives underlie 'researcher identity'? A review of two decades of empirical studies. *Higher Education*, 81, 567-590. https://doi.org/10.1007/s10734-020-00557-8

Çakmak, M., & Çelik, Ö. C. (2024). A case study on researcher identity development of novice and experienced teacher educators: A different or similar research journey?. *Social Sciences & Humanities Open*, 10, 101005. https://doi.org/10.1016/j.ssaho.2024.101005

DeVellis, R. F., & Thorpe, C. T. (2021). Scale development: Theory and applications. Sage publications. https://tms.iau.ir/file/download/page/1635238305-develis-2017.pdf

Kamler, B., & Thomson, P. (2014). Helping doctoral students write: Pedagogies for supervision.Routledge. https://doi.org/10.4324/9781315813639

Lapum, J. (2008, May). The performative manifestation of a research identity: Storying the journey through poetry. In Forum Qualitative Sozialforschung/Forum: Qualitative Social Research (Vol. 9, No. 2). https://doi.org/10.17169/fqs-9.2.397

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary educational psychology*, 61, 101860. https://doi.org/10.1016/j.cedpsych.2020.101860

Sultana, A., & Farooq, R. (2024). Towards the measurement of stereotype threat: scale development and validation. *Global Knowledge, Memory and Communication*. https://doi.org/10.1108/gkmc-10-2023-0378

Yee, X. P., & Lai, C. S. (2021). Relationship Between Academic Motivation and Procrastination Among Students at a Private University College in Kuala Lumpur. Unpublished. https://doi.org/10.13140/RG.2.2.27913.98403

Yuan, R., Yang, M., & Stapleton, P. (2020). Enhancing undergraduates' critical thinking through research engagement: A practitioner research approach. *Thinking Skills and Creativity*, 38, 100737. https://doi.org/10.1016/j.tsc.2020.100737

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Empowering Students Through Design Thinking: A Strategic Approach to Developing 21st-Century Skills in Higher Education

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Abstract

In alignment with the European Education Area's objectives, higher education must prepare students to navigate the complexities of a rapidly evolving, interconnected world. To develop these 21st-Century Skills, Design Thinking has emerged as a strategic approach to fostering sustainable and innovative solutions in higher education. An academic course in the summer semester of 2024 positioned Design Thinking at its core, equipping students with the tools to critically analyse dynamics while fostering their ability to design impactful, solution-oriented innovations in vocational education and training. The article answers the question of how the use of the Design Thinking approach supports students developing crucial competences of the 21st century.

Keywords: *Higher education; innovation; design thinking; human-centred design; digital learning environments.*

1. Introduction

According to the *European Education Area* higher education institutions must "educate students to be successful in a complex and interconnected world that faces rapid technological, cultural, economic and demographic change" (European Education Area, 2025). This context is strongly connected to the framework of the 21st-Century Skills which include foundational literacies, competences and character qualities (World Economic Forum, 2024). Following the discussion of the World Economic Forum, the four different competences, critical thinking/problem-solving, creativity, communication and collaboration, express how students should approach complex challenges (World Economic Forum, 2024).

The design, development and support of innovation processes, as an answer to complex challenges, is a diverse field of vocational education and training activities, which is a focus area of the Business Education study programme discussed in this paper. The course *Innovation in Vocational Education and Training* in Business Education at the University of Rostock aims

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to equip students with comprehensive competences in the development and design of innovations across various levels of the education system.

The realisation of the course in the past has shown that being spontaneously innovative is often a significant challenge for students, as academic curricula rarely require them to independently initiate, critically evaluate, and innovate within their projects. While the academic course aims to foster the development of these competences, such skills are typically underdeveloped at the outset. This initial lack of proficiency often heightens uncertainty and can, in some cases, result in reduced motivation (Chandraja et al., 2024).

One possible method in higher education to strategically tackle complex challenges and create sustainable and innovative solutions is to use the Design Thinking (DT) methodology. "Design Thinking encourages students to examine alternative perspectives, challenge presumptions, and develop original solutions to problems that they encounter in the real world by focusing on empathy, teamwork, and iterative ideation" (Alhafis et al. 2024). This constitutes the point of departure for the design-based research study outlined in this paper, which will be elaborated upon in the following sections.

2. Implementing a new didactical approach within Design-Based Research

The further development of the course adheres to the methodological principles of Educational Design-Based Research (DBR) and is systematically evaluated and continuously refined through an iterative design and research framework (Anderson & Shattuck, 2012; Euler, 2024). The study follows the generic model according to McKenney and Reeves and maps the core processes of analysis and exploration, design and construction (development) as well as evaluation and reflection. Parallel to these phases is the implementation and dissemination of the so-called interventions (Reimann, 2017). The research and development process was collaboratively designed by business education lecturers and a DT expert, aiming to foster sustainable change through the involvement of broadly qualified educators. In addition to its practical focus, the project sought to generate theoretical insights regarding the implementation and further development of teaching units. The didactic design was based on the assumption that learning the DT process, which is seen as an 'intervention' according to the DBR approach, enhances innovation capabilities related to 21st-Century Skills and promotes their long-term integration. The empirical findings were then to be related to the theoretical correlations already presented and thus contribute to an expansion of the theory.

This paper presents a micro-cycle of the DBR, which includes the evaluation of the intervention carried out based on a document analysis (McKenney & Reeves, 2012). As part of the evaluation framework of the DBR study, the students' written reflections are used as a data collection method to further specify the core challenge for which a solution is being sought (Euler, 2024; McKenney & Reeves, 2012). Based on the reflections of the students, the

intervention team is able to draw conclusions regarding the effectiveness of the DT process. The course has been iteratively refined through several evaluation rounds conducted by the development team and will be implemented again, incorporating these revisions, in the next summer semester.

A total of 20 students participated in the course, organised into teams consisting of a minimum of two and a maximum of four members. The dataset for this micro-cycle is derived from written reflections submitted by the students as part of their final reports. These reports, completed at the conclusion of the course, provide a robust foundation for the qualitative analysis of individual and team learning processes, as well as subjective experiences. The reflections were conducted collaboratively within each team and were structured to address two distinct aspects: the innovation process based on the DT approach and the dynamics of teamwork.

The qualitative analysis of the data was carried out using Mayring's approach to qualitative content analysis (Mayring 2022). In the content approach, deductive categories were developed for coding in relation to the four critical future skills critical thinking/problem-solving, creativity, communication and collaboration (World Economic Forum 2024). Intercoder reliability was ensured by communicative validation, as the two lecturers both examined the material and discussed different interpretations.

3. The intervention: Design Thinking Coaching

Based on the DBR approach the starting point is a practically relevant educational problem for which a new solution has yet to be developed: in this case, a teaching-learning concept to foster students' innovation skills for the future. As an empirical approach, it is not about testing theory, but rather about applying and developing theory (Reimann, 2017). The main aim of the intervention in the course was to develop conceptually complex teaching units for the effective and structured promotion of innovation skills, and at the same time to reflect on the possibilities and limitations of their implementation in the DT process in an explorative and research-based way (Delius, 2022).

DT was chosen for this study due to its strong emphasis on user-centered innovation, iterative prototyping, and interdisciplinary collaboration. Unlike other active learning methods, DT actively promotes divergent thinking and early experimentation to foster novel solutions. Furthermore, DT's strong integration in both educational and professional innovation contexts ensures a high degree of applicability and relevance to real-world innovation processes.

The new key element, the intervention in the context of DBR, was the coaching on DT designed to foster "outside the box" thinking and provide a robust theoretical foundation for systematically approaching innovation within professional learning contexts. Firstly, the course introduced students to DT methodology as a human-centred approach to problem-solving in

line with the Massachusetts Institute of Technology (Massachusetts Institute of Technology, 2025). Through a combination of theory, case studies, and hands-on projects, introduced by a DT expert in the field of instructional design, the students developed a high-level understanding of the DT process and how to apply it to real-world challenges. The secondary aim of the programme was to highlight the importance of collaboration (including collaboration with tech) and introduce students to emerging technologies that are impacting education.

4. Results & Discussion

The developed project ideas, which have been evaluated within one micro-cycle within the BDR study, illustrate digital teaching-learning arrangements that the student groups have developed. The final reports show that the previously trained DT methodology was applied and reflected upon differently. The students' reflections on both the application of DT and the team reflection were analysed in the context of the four 21st-Century Skills critical thinking/problem-solving, creativity, communication and collaboration.

4.1. Critical thinking/problem-solving

This competence is reflected in the students' reflection reports on multiple levels. Firstly, it is evident in the critical analysis of the innovation's content and its practical implications. The students systematically examine communication barriers, the limited acceptance of the proposed innovation, and the challenges faced by small and medium-sized enterprises due to resource constraints. Additionally, they address the broader issue of the theory-practice gap, which poses fundamental challenges to the successful implementation of innovative concepts. Furthermore, their reflections extend to the use of digital tools in teaching and learning environments, critically evaluating their functional scope and potential licensing constraints.

- “SMEs in particular could also find it difficult to incorporate their specific needs and content due to resource bottlenecks, which could lead to their trainees being disadvantaged.” (P 01)

Secondly, the students engage in a critical examination of the DT process itself. While they acknowledge the value of an iterative approach, they emphasise, based on their own experiences, the necessity of continuous adaptation to enhance the developed solutions. Key aspects identified include the importance of feedback mechanisms, the role of prototyping, and the integration of external perspectives to refine ideas. The student groups used these aspects to varying degrees. Moreover, they highlight flexibility as a fundamental prerequisite for ensuring the effectiveness of the overall process.

4.2. Creativity

The clear structure of the DT process and creativity methods to think outside the box proved to be particularly helpful, as it guided the creative thought processes and provided targeted impetus for new ideas.

Developing their ideas for potential innovations, the students used digital platforms such as *Gather.town* and *Minecraft*, which provide interactive and collaborative environments. In addition, AI-supported tools and communication applications were used to organise teamwork efficiently. It is worth noting that some of these digital tools were deliberately used in a playful or misappropriated way to generate unconventional ideas.

- "We came up against limits during this phase, but we quickly recognised our focus and our scope for action in this respect." (P 02)

Various established methods of idea generation were used to support creative development. These included brainstorming, conducting surveys, creating sketches and creative walks. These methods helped to gather innovative impulses, deepen the problem analysis and visualise initial conceptual drafts.

A key factor for creative collaboration within the teams was promoting open communication, transparency and empathy.

4.3. Collaboration

The team reflection analyses highlighted various opportunities for both personal and collective growth through collaboration. This process not only fostered innovation but also supported the professional and personal development of the participants. A central challenge for the students was coordinating teamwork and managing time, which they addressed through strategies such as scheduled meetings, spontaneous online discussions, and the use of communication tools. Flexibility, mutual understanding, and adaptability to changing schedules emerged as key competencies supporting effective collaboration. Role allocation significantly influenced team dynamics, with some groups assigning roles explicitly and others allowing them to evolve naturally. In both cases, role differentiation was seen as enhancing efficiency by utilising individual strengths, while maintaining a flexible and democratic structure that supported shared decision-making and active participation.

- "As the project progressed, we decided to focus on specific roles in order to accelerate progress and increase the effectiveness of our work." (P 03)

Feedback was essential for refining ideas and navigating uncertainties, with teams using structured feedback loops to validate and adjust their approaches. This iterative culture not only improved the quality of solutions but also promoted continuous learning and self-development.

4.4. Communication

Communication and collaboration are closely interconnected, as effective teamwork relies on openness and transparency. A structured approach, including regular in-person and online meetings and asynchronous communication via messengers, ensured synchronised progress and efficient coordination. Transparent communication was essential to maintaining fairness in decision-making and preventing negative impacts on individual team members. Additionally, flexibility and democratic task distribution were identified as key success factors, fostering adaptability and efficiency. Finally, the integration of feedback and continuous reflection played a crucial role in improving work quality and optimising processes, enabling iterative refinement and collective progress.

- "In conclusion, we have learnt that the integration of feedback and continuous reflection on the work process is essential to ensure the quality of the work and identify opportunities for improvement." (P 03)

5. Conclusions

The evaluation of the micro-cycle of the data analysis of the written student reports proved that the application of the DT process in an academic course contributed to foster 21st-Century Skills such as critical thinking/problem-solving, creativity, collaboration, and communication. The present analysis highlights the multidimensional nature of teamwork in innovation projects and demonstrates how students overcame challenges through independent problem-solving, structured role allocation, and the integration of feedback. Despite being assigned the same task, the results exhibit significant variation, indicating that the process of innovation design is highly individualised. Key success factors for teams composed of independent actors working towards a common goal in a non-standardised, uncertainty-driven process include flexibility, adaptability, communication, and cooperation - an observation supported by the analysed data. Accordingly, DT appears to be a suitable methodological framework for equipping students with essential future skills.

As students often find it challenging to engage spontaneously in innovative and conceptual work, despite these being fundamental competencies of the 21st-Century Skillset and essential for the demands of new work environments, the integration of the DT approach can serve as an effective pedagogical entry point. It promotes problem orientation, provides a structured pathway toward innovation development, and simultaneously, enhances and organises collaborative teamwork. For this reason, the success of implementing DT in educational contexts should not be evaluated solely through traditional criteria such as user satisfaction or the adoption and implementation of specific solutions. Rather, its value lies in fostering

students' competence development, with particular emphasis on cross-disciplinary collaboration and the generation of innovative outcomes.

Ultimately, the findings presented here must be interpreted within the limitations of qualitative research. It becomes evident that the reflection process led some students to produce standardised responses to provide an anticipated "desired" answer. While this phenomenon cannot be thoroughly examined within the framework of content analysis, it suggests, upon deeper interpretation, not necessarily the development of innovation competencies, but rather a strategic orientation toward achieving a favourable course grade. Furthermore, retrospective reflection by students may have led to cognitive distortions, and the time pressure under which the final reports were written could have further influenced the accuracy of their self-assessments. This also indicates that the implementation of the DT method within this intervention did have limitations in prioritising the quality of the innovative solution over formal assessment. Consequently, this may inhibit the development of innovation-related competencies. This is also why the outcomes of the student projects, the innovative concepts in vocational education and training, are evaluated by the intervention team, consisting of lecturers and DT experts, according to predefined criteria. This evaluation is conducted independently of the students' written reflections and is systematically compared with the results from the previous and subsequent cohorts. This process constitutes an additional micro-cycle within the broader research framework.

This paper presents the DBR-based development of a debate on Empowering Students Through Design Thinking: A Strategic Approach to Developing 21st-Century Skills in Higher Education within the field of business education. In addition to the course's design principles, structure, and procedure, the results of a content analysis were outlined and evaluated. Critical thinking/problem-solving, creativity, collaboration, and communication were identified as essential components in the design of innovative educational spaces within the context of business education. The course prototype was piloted for the first time in the summer semester of 2024 and will be offered again in the summer semester of 2025 with targeted adjustments. In the next step, the students' reflections will be analysed again and placed in the context of the teaching-learning experiences of the intervention team. Against the backdrop of this development process, the following questions arise:

- Do students perceive the course as an opportunity to develop 21st-Century Skills?
- Does the course change students' imagination of how to conceptualise, implement, and evaluate innovations in a dynamic work and life environment?

In this context, further research will explore how 21st-Century Skills can be systematically developed through the use of Design Thinking in academic teaching.

References

Anderson, T., & Shattuck, J. (2012). Design-Based Research. *Educational Researcher*, 41(1), 16–25. https://doi.org/10.3102/0013189X11428813

Chandraja, C. V., Ajayan, T., & Ruskin, Shabi, George, Mathew (2024). Innovative pedagogies: Adapting teaching strategies for modern learning environments. *21st Century Teaching and Learning in Classrooms*, 63–74.

Delius, K. (2022). Wie Wissenschaft und Praxis Fachunterricht gemeinsam weiterentwickeln können: Eine Design-Based Research-Studie zur Förderung der Sprechkompetenz im Englischunterricht. *EDeR. Educational Design Research*, 6(3). https://doi.org/10.15460/eder.6.3.1704

Euler, D. (2024). Design-Research – a paradigm under development. In D. Euler & P. F. Sloane (Eds.), *Design-Based Research* (pp. 15–44). Franz Steiner Verlag.

European Education Area. (2025). Innovation in education. https://education.ec.europa.eu/education-levels/higher-education/innovation-in-education

Massachusetts Institute of Technology. (2025). Unit 2 Assignment: Design Thinking with Students. https://openlearninglibrary.mit.edu/courses/course-v1:MITx+11.155x+1T2019/course/

McKenney, S. E., & Reeves, T. C. (2012). Conducting educational design research. Routledge.

Reimann, G. (2017). Design-Based Research. In D. Schemme & H. Novak (Eds.), Berichte zur beruflichen Bildung. Gestaltungsorientierte Forschung - Basis für soziale Innovationen: Erprobte Ansätze im Zusammenwirken von Wissenschaft und Praxis (49-61). *Bundesinstitut für Berufsbildung BIBB*.

World Economic Forum. (2024). The skills needed in the 21st century. https://widgets.weforum.org/nve-2015/chapter1.html

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The Development of a Toolbox of Models for Multidisciplinary Student Social Enterprise Education

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Abstract

Whilst entrepreneurship is increasingly common as part of a university education, social enterprise and sustainable enterprise are often included as bolt-ons with less detail on the subtleties of the differences such as measuring social value. However, multidisciplinary cohorts studying entrepreneurship represent an excellent opportunity to foster social and sustainable entrepreneurship ideas in a meaningful way. To allow students to focus on the social issues, and for students from different backgrounds to collaborate, we have created a toolbox of models, split into four sections which address opportunity recognition, designing a solution, evaluating sustainability, and addressing impact. The quality of the work produced by the students shows that these have been effective, and students are able to pick from a range of tools depending on their needs. This toolbox is now available to all.

Keywords: *Social Enterprise, Sustainability, Entrepreneurship Education, Toolbox, Business Model Canvas*

1. Introduction

Entrepreneurship education (EE) is now an important part of a university education, allowing students to not only start their own ventures, but to be effective innovators when taking a job in a commercial organization. The United Kingdom's Quality Assurance Agency (QAA, 2018) suggests that EE falls into three classifications – teaching "about" entrepreneurship, teaching "for" entrepreneurship, and teaching "through" entrepreneurship. Social entrepreneurship has a variety of definitions (Peredo & McLean, 2006) but is considered to be applying entrepreneurship to solving social problems. Abu-Saifan (2012) stated that Social Entrepreneurship is the 'field in which entrepreneurs tailor their activities to be directly tied with the ultimate goal of creating social value'. Most accept that the university has a responsibility to create graduates with an understanding of social issues, sustainability, and

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social value (Zamora-Polo & Sánchez-Martín, (2019)). Embedding sustainability into the curriculum can be challenging despite its importance (Anastasiadis et al., 2021), with one of the key tensions linked to sustainable entrepreneurship balancing purpose and monetization. Therefore, it is important for enterprise education to equip students with the competencies they need for improving the income, health, and well-being of communities in an equitable way without a significant negative spillover elsewhere because of the need to generate revenue.

Social entrepreneurship is of interest to students from across the university (Jones & Phillips, 2021). However, it is often included as a bolt on in regular entrepreneurship courses, and often lacks the subtle differences that social enterprises have over regular businesses. For example, understanding metrics for success for social enterprise in terms of outputs and outcomes, the potential difficulties in scaling up when ecosystems even between cities in the same country can be so different, and dealing with complex stakeholders. Further, Steiner et al (2018) have found through a survey of social entrepreneurship courses that suitable frameworks and tools for social entrepreneurship are rarely used. They also suggest that cross disciplinary education would help students gain a deeper understanding, including sciences, engineering, and humanities students. The use of models in learning "for" entrepreneurship is especially helpful when teaching multidisciplinary classes (Papadopoulou & Phillips, 2019; Sanchez-Romaguera & Phillips, 2018) for clarity of purpose, vision, and mission. Social entrepreneurship also has been shown to work well in extracurricular activities where students feel they can take more of a risk where marks are not at stake (Mukesh et al., 2024; Phillips, 2017, Phillips, 2010) and learning by doing is used wherever possible (Chang et al., 2014). Roslan et al (2022) from their literature review have found that lack of experience from teaching staff and issues around curricula design are a particular problem, and that university industry collaborations are recommended to aid student and staff understanding of social entrepreneurship (Fang et al., 2023). Design thinking has been suggested as a suitable approach and Kickul et al (2018) have suggested a model incorporating four main themes of innovation, impact, sustainability, and scale. In addition, an approach increasingly adopted by entrepreneurs to tackle sustainability challenges is the creation of commons, i.e. shared resources that are accessible, inclusive, and democratically managed by and for communities. There is therefore a need for a toolbox of models that encourage the inclusion of social value as well as profitability and that student entrepreneurs can use different models as appropriate to crystalise their own thoughts and to communicate their ideas with other stakeholders, including other students in multidisciplinary groups. Students would be able to pick and choose from a range of models in the toolkit that are most applicable to their project. This was used for two courses that were multidisciplinary and feedback was used to improve the toolbox, which is now available for all. The toolbox is available here https://www.entrepreneurship.manchester.ac.uk/resources/commons-entrepreneurship-toolbox/

2. Methodology

Undergraduate students participating in two courses used the models from the toolbox as a pilot study as part of their course, Enterprise in Healthcare and Essential Enterprise. Courses were multidisciplinary and feedback was obtained by qualitative means, as well as looking at the quality of the students submitted work.

3. Results and Discussion

The toolbox created is split into four sections (Figure 1) and the toolbox provides a high-level overview of the tools and facilitation guides to help students explore problems and design solutions that meet user's needs in an inter-disciplinary setting. The sections correspond to the IDEA model (Figure 1). The toolkit is designed to be flexible in helping to understand the root level of issues rather than superficially fixing symptoms, and able to be used between different disciplines. This toolbox provides tools and methods that were employed in the classroom by the creators to meet students' requests for more social purpose within the curriculum. The tools can be combined in different ways to design a curriculum, workshop or hackathon based on the needs of the students and staff. We also refer to additional tools that we did not have the opportunity to use with students but have been used in other professional contexts for co-creation and gathering collective intelligence. We encourage educators to adapt and experiment with the tools in this toolbox in the context of higher education.

1 Identifying Opportunities. Student assessments, even within the enterprise curriculum, often focus on individual assessments because of tensions in group work, student complaints and backlash for the lecturer in terms of evaluation scores. But open and participatory approaches are very important for social innovation in order to address the United Nations Sustainable Development Goals.

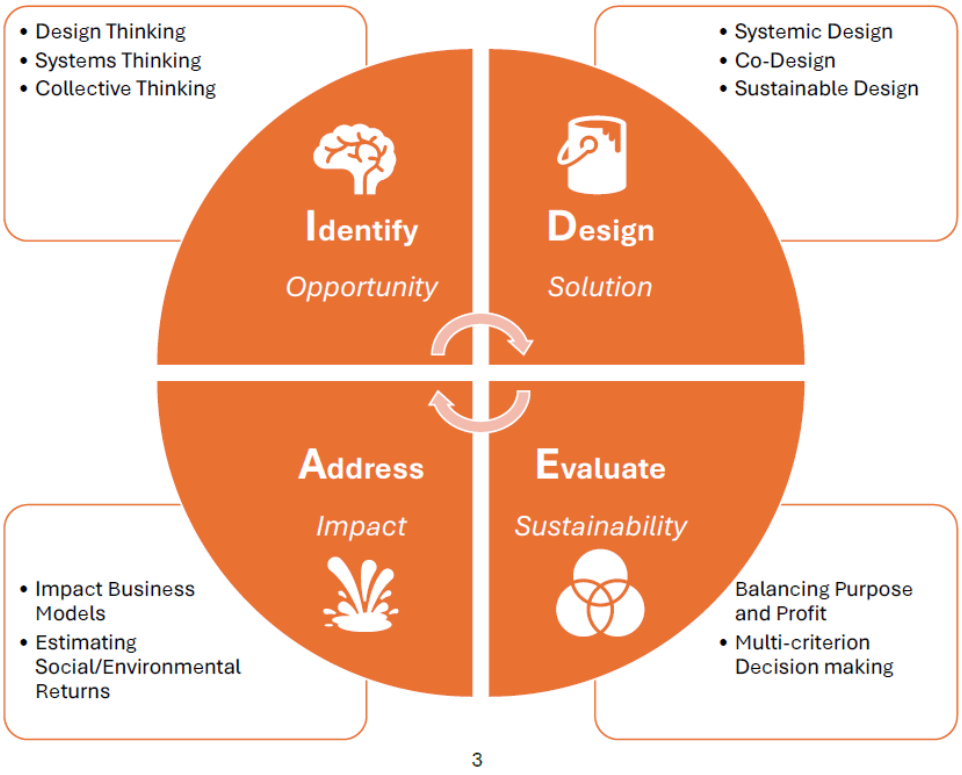


Figure 1: The Four Sections of the Toolbox

This gap can be bridged by designing in group work at the formative assessment stage. The process follows the design councils double diamond framework for innovation https://www.designcouncil.org.uk/our-resources/framework-for-innovation/. The opportunity diamond represents exploration of the context surrounding the problem, and the solution diamond represents evaluation of viable solutions. Divergent thinking involves broad ideation, while convergent thinking involves narrowed and focused consideration. As part of the formative assessment, students can focus on a process of first using both divergent and convergent thinking in groups to explore various problems and converge on an opportunity worth pursuing. Each student in a group can then frame their own independent strategy for exploiting the opportunity in their summative assessment, satisfying the need for groupwork but also allowing students to work on their individual assessments without the traditional problems encountered in groupwork. This process would not only help define a small set of problems that are worth solving and defined by students themselves, but it also encourages group building towards co or extra-curricular activities whist retaining individual control of assessment performance and utilizing the power of multidisciplinary groups. As a side effect of this method,

we found that several groups used their formative groupwork to voluntarily enter the extracurricular "Sustainathon" activity.

2 Designing a Solution. For students to begin to design a solution, we encourage systemic design. Systems design often refers to hard technical systems that are completely 'designable' where designers have complete control over systems parts and components, understand how they link to each other and can define the system boundaries. In systemic design however, the boundaries cannot be objectively defined and the systems have properties that cannot be fully predicted. This is often the case for social enterprises and the ecosystems in which they operate, with a complex range of stakeholders and sometimes unintended negative consequences of trying to do good. For example, a 'healthcare system' where it is often not clear what and who is included or excluded, and how it will look like and behave in the next 1, 2 or 10 years from now. Systemic design is about the collective – neighbourhoods, societies, ecological systems – rather than isolated individuals. Recognising that no-one has a true picture of the system, systemic designers invite multiple stakeholders to participate in defining and driving a course of action, again suiting multidisciplinary working. They may even challenge the deep structure of current systems and work on shifting systems design into a desired direction. Figure 2 is a student idea which suggests collaborating with a radical automation technology and local authority to raise awareness among citizens about not just recycling, but also encouraging users to reduce waste. Citizens here provide collective intelligence and data - and even though the student proposal is of a speculative nature, it invites further possibilities to reduce wasteful consumption and change people's mental models.

3 Evaluating Sustainability. For evaluating sustainability, students can be encouraged to think about sustainability and social impact using the triple bottom line analysis of economic, social, and financial and each impact could be measured with a sustainability index (SI) such as that by Penn and Fields (included in the toolbox). These allow students to prioritize solution design options based on the relative importance of each of the 3 aspects of the triple bottom line.

4 Addressing Impact. The toolbox includes Impact Business Models (IBMs) to help students focus on social impact. IBMs are the ways that a programme/business is designed to create a specific positive benefit/outcome for one of its stakeholders. It is focused on benefiting a specific stakeholder group with a specific positive benefit/outcome, rather than a "general" overall positive impact that is not specific to a particular beneficiary or not linked to a specific benefit that the stakeholder receives, which is a key issue for success metrics for social enterprises. One can create the business model on Miro or download the ecosystem icons and create a business model offline, for example on PowerPoint.

Feedback from the students who used the toolbox. Students especially liked sharing ideas in groups at the formative stage, the interactivity that the toolbox afforded and the opportunity for multidisciplinary work.

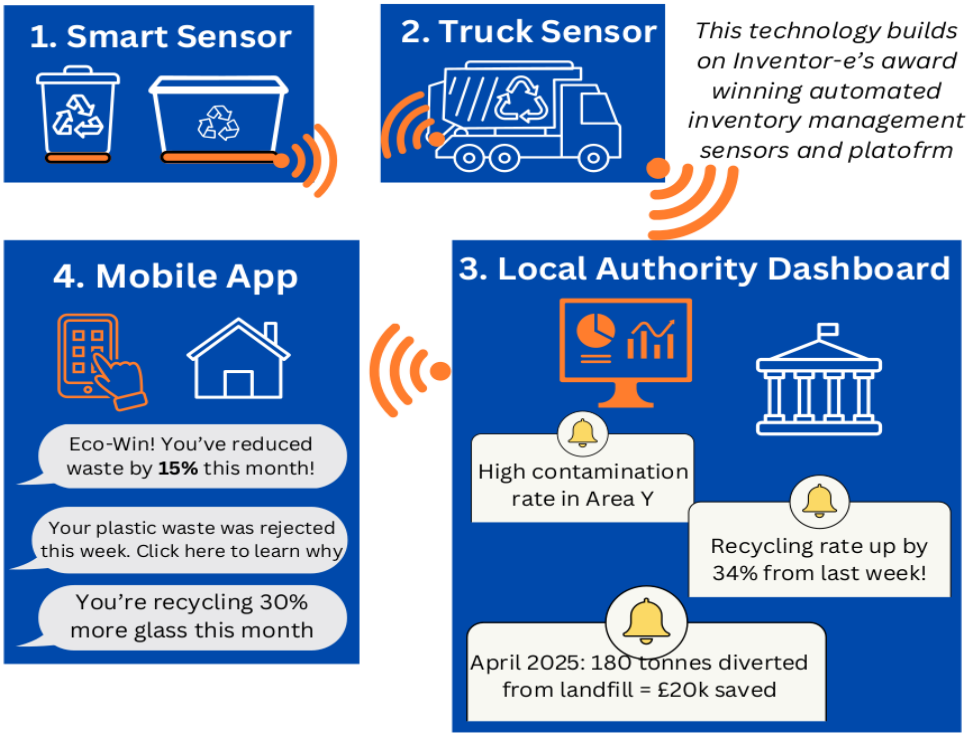


Figure 2: A Solution Design Which Incorporates and Incentivizes People to Recycle

"*I liked how many of the sessions were very interactive, giving me the chance to share my ideas with other students and hear theirs too.*"

"*I was really surprised actually with my curriculum not having anything unless you chose to do, say, biology with business or biology with something like that. I was really surprised that my core curriculum had nothing like that on offer. And I found the module really useful.*"

"My group randomly decided to do the "Sustainathon" just for the experience of it. And now I'm super interested in it and I really want to see how far we can take it….I study English literature, Rachel studies biology, Tyler studies law. So I think that we have managed to kind of pool our own assets and knowledge into it…so I think being open, especially when it's coming when it's working towards solutions which is like a worldwide problem like sustainability I think is very important."

"I feel like it was really very conducive…. we got a chance to interact with… the Biomedical's team with the graphene team. So we've gotten the chance to interact with such different fields, and people, expertise of different fields. So we get a chance to think about all these ideas. Apart

from that, once we were introduced to these competitions, which are going on, like. Venture Further or, you know, Bright Idea Networks or competitions."

"I don't know about other people's subjects, but within psychology, we rarely meet anyone who's outside of a psychology course…our course is very literature, very focused. It's almost like. we have our modules kind of set out for us and there's only so much room we can move and manoeuvre, so I don't really get the chance to meet people who are outside."

4. Conclusion

Based on the needs outlined in the introduction for a range of tools that could both be used for multidisciplinary collaborative work and allow a better focus on creating solutions with social impact, this toolbox was designed to help educators design and deliver a collaborative social innovation education, supporting students to understand, analyse and solve complex global challenges. The tools can be combined in different ways to design a curriculum depending on the context, whether an on-curricular course, workshop, or hackathon, which addresses issues raised about social entrepreneurship education by Roslan et al, (2022) and are ideal for cross disciplinary teaching. We added additional tools that we did not have the opportunity to use with students but have been used in other professional contexts for co-creation and gathering collective intelligence. We encourage educators to adapt and experiment with the tools in this toolbox in different contexts in higher education.

https://www.entrepreneurship.manchester.ac.uk/resources/commons-entrepreneurship-toolbox

References

Abu-Saifan, S. (2012). Social Entrepreneurship: Definition and Boundaries. *Technology Innovation Management Review*, *2*(2), 22-27.

Anastasiadis, S., Perkiss, S., Dean, B. A., Bayerlein, L., Gonzalez-Perez, M. A., Wersun, A., & Gibbons, B. (2021). Teaching sustainability: complexity and compromises. *Journal of Applied Research in Higher Education*, *13*(1), 272-286.

Chang, J., Benamraoui, A., & Rieple, A. (2014). Learning-by-doing as an approach to teaching social entrepreneurship. *Innovations in Education and Teaching International*, *51*(5), 459-471.

Fang, S., Zhang, L., & Phillips, R.A. (2023). University-Industry Collaboration (UIC) for social enterprise: A design thinking approach. *British Academy of Management Conference*, 2023.

Jones, M., & Phillips, R.A. (2021). A Qualitative Study of the Inclusion of Social Enterprise in the Entrepreneurial Education Curriculum. In *7th International Conference on Higher Education Advances (HEAd'21),* 1097-1104.

Kickul, J., Gundry, L., Mitra, P., & Berçot, L. (2018). Designing With Purpose: Advocating Innovation, Impact, Sustainability, and Scale in Social Entrepreneurship Education. *Entrepreneurship Education and Pedagogy*, *1*(2), 205-221.

Mukesh, H. V., Shetty, J., Kenny, B., & McGuirk, H. (2024). Value for Value: Social Entrepreneurship Education Through Value Creation Extracurricular Activity. *Journal of Social Entrepreneurship*, 1–26.

Papadopoulou, K., & Phillips, R.A. (2019). A comparison of on-curricular and off-curricular activities in enterprise education for postgraduate students. *5th International Conference on Higher Education Advances (HEAd'19)*, 55-64.

Peredo, A. M., & McLean, M. (2006). Social entrepreneurship: A critical review of the concept. *Journal of World Business*, *41*(1), 56-65.

Phillips, R. A. (2017). Measuring Entrepreneurial outcomes from a residential enterprise school for postgraduate researchers. *Journal of Asia Entrepreneurship and Sustainability*, *13*(2), 62-89.

Phillips, R.A. (2010). Encouraging a more enterprising researcher – the implementation of an integrated training programme of enterprise for Ph.D. and postdoctoral researchers. *Research in Post Compulsory Education 15*(3), 289-299.

Roslan, M. H. H., Hamid, S., Ijab, M. T., Yusop, F. D., & Norman, A. A. (2022). Social entrepreneurship in higher education: challenges and opportunities. *Asia Pacific Journal of Education*, *42*(3), 588-604.

Sanchez-Romaguera, V., & Phillips, R.A. (2018). A comparison of a first and third year UG enterprise unit: lessons from experiential learning and interdisciplinarity. *4th International Conference on Higher Education Advances (HEAD'18)*, 899-907.

Steiner, S. D., Brock, D. D., Pittz, T. G., & Liguori, E. (2018). Multi-disciplinary involvement in social entrepreneurship education: A uniquely threaded ecosystem. *Journal of Ethics & Entrepreneurship*, *8*(1*),* 73-91.

QAA (2018). Enterprise and Entrepreneurship Education: Guidance for UK Higher Education Providers https://www.qaa.ac.uk/the-quality-code/enterprise-and-entrepreneurship-education

Zamora-Polo, F., & Sánchez-Martín, J. (2019). Teaching for a better world. Sustainability and sustainable development goals in the construction of a change-maker university. *Sustainability*, *11*(15), 4224.

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ChatGPT's role in Higher Education: Functional capabilities, and their impact on student satisfaction

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Abstract

This study investigates how ChatGPT is perceived and utilized by university students who use it for academic writing, summarizing and brainstorming. It examines what drives satisfaction beyond usage frequency and ease of use, focusing on three core functional capabilities: quality of information, learning facilitation, and human language interaction. Structural modeling techniques applied to survey data reveal that student satisfaction is shaped by how these capabilities are experienced, along with perceptions of clarity and usability. The results highlight that educational impact depends not only on access to technology but also on how well AI tools align with students' academic needs and expectations. The study concludes with practical recommendations for educators and institutions seeking to integrate generative AI effectively in higher education.

Keywords: *ChatGPT; generative AI; higher education; functional capabilities; student satisfaction; AI in education.*

1. Introduction

Generative AI tools, particularly ChatGPT, have emerged as transformative assets in education. By offering personalized support, reliable information, and natural language interactions, ChatGPT enhances learning efficiency and fosters engagement. As Parasuraman and Colby (2014) highlight, readiness to embrace advanced technologies is critical to unlocking their potential. However, this study reveals that simply increasing usage frequency does not directly lead to satisfaction. Instead, functional capabilities and comparative ease and clarity act as key mediators in transforming usage into a fulfilling experience. ChatGPT's functional capabilities are defined across three dimensions: quality of information, which emphasizes accuracy, relevance, and reliability; learning facilitation, focusing on providing tailored support and problem-solving strategies; and human language interaction, which enhances accessibility

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through natural, conversational exchanges. These dimensions, combined with ease of use, highlight the need for tools that not only perform well but are also intuitive and engaging.

2. Theoretical background and hypotheses

The Technology Acceptance Model (TAM) serves as the theoretical foundation for understanding the role of functional capabilities and usability in mediating satisfaction. Davis (1989) emphasized that perceived usefulness and ease of use are fundamental to technology adoption. Similarly, Parasuraman et al. (1988) stress the importance of service quality in shaping user satisfaction. Prior studies have also shown that effective communication and user-friendly design enhance satisfaction with AI-driven systems (Slaam et al, 2023, Ngo, 2023). This study develops the following hypotheses, summarized in Figure 1:

- H1: ChatGPT usage frequency positively influences perceptions of functional capabilities.
- H2: ChatGPT usage frequency positively influences perceptions of comparative ease and clarity.
- H3: Functional capabilities positively influence overall student satisfaction with ChatGPT.
- H4: Comparative ease and clarity positively influence overall student satisfaction with ChatGPT.
- H5: Functional capabilities mediate the relationship between usage frequency and student satisfaction.
- H6: Comparative ease and clarity mediate the relationship between usage frequency and student satisfaction.

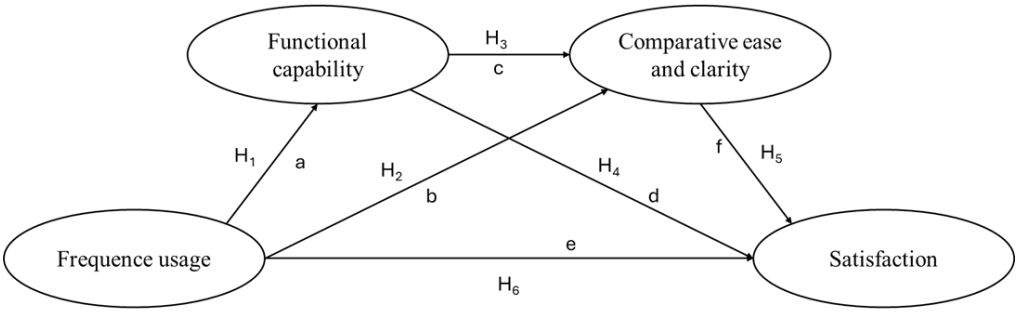


Figure 1. Research model.

3. Methodology

This study surveyed 610 university students, collecting data on ChatGPT usage, functional capabilities, comparative ease and clarity, and satisfaction. Constructs were measured using validated scales on a 5-point Likert scale, adapted from prior studies to ensure reliability and contextual relevance. The data were analyzed using structural equation modeling (SEM) to examine both direct and indirect effects. Table 1 shows loadings of the Exploratory Factor Analyses.

Table 1. Matrixes of the components extracted using PCA and Varimax rotation.

Usage frequency

	(1) Usage frequency	(2) -
UFR7	**0.809**	0.194
UFR5	**0.774**	0.131
UFR1	**0.758**	0.266
UFR3	0.635	0.305
UFR4	0.513	0.484
UFR8	0.110	**0.744**
UFR10	0.163	0.644
UFR9	0.274	0.621
UFR11	0.218	0.621
UFR2	0.443	0.527
UFR6	0.424	0.432

Comparative ease and clarity

	(1) Comparative ease of use and clarity
RPL1	**0.870**
RPL3	**0.785**
RPL2	**0.767**

Satisfaction

	(1) Satisfaction
SAT2	**0.905**
SAT3	**0.837**
SAT1	**0.798**

Functional capabilities

	(1) Information quality	(2) Learning facilitation	(3) Human lang. interaction
CAP4	**0.774**	0.124	0.164
CAP6	**0.736**	0.125	0.194
CAP7	**0.724**	0.203	0.202
CAP5	0.663	0.227	-0.029
CAP9	0.210	**0.868**	0.147
CAP10	0.214	**0.863**	0.185
CAP8	0.194	**0.835**	0.130
CAP2	0.196	0.104	**0.831**
CAP1	0.354	0.094	**0.711**
CAP3	-0.029	0.199	0.684

The reliability and discriminant validity were assessed through the recommended statistics: alpha of Cronback, composite reliability, average of extracted variance (AVE); and the correlations among constructs compared with the square root of AVE (Hair et al., 2010, Nunnally and Bernstein, 1994).

4. Results

The structural equation modeling (SEM) analysis revealed strong support for the proposed dual-mediation model, with key fit indices indicating excellent model fit. The Comparative Fit Index (CFI) was 0.948, exceeding the recommended threshold of 0.90, while the Root Mean Square Error of Approximation (RMSEA) was 0.052, with a 90% confidence interval between 0.050 and 0.053, meeting the commonly accepted standard of 0.06 or lower. These results suggest that the hypothesized model is well-specified and adequately represents the data. See the standardized coefficients alongside with its t-values on the arrows of Figure 2.

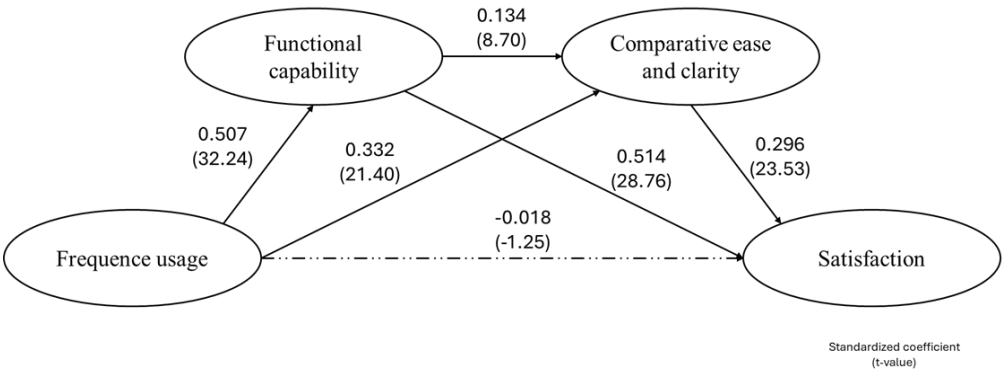


Figure 2. Research model with standardized coefficients.

The findings confirm that usage frequency does not directly lead to satisfaction, as the direct effect was insignificant. Instead, satisfaction is fully mediated by two key factors: functional capabilities and comparative ease and clarity. Functional capabilities contribute to satisfaction by delivering accurate information, facilitating autonomous learning, and engaging users in human-like interactions. This finding underscores the value of ChatGPT's ability to provide personalized and effective educational support, aligning with prior studies that emphasize the importance of service quality in user satisfaction (Parasuraman et al., 1988; Sallam et al., 2023).

Comparative ease and clarity further enhance satisfaction by ensuring that ChatGPT is perceived as intuitive and efficient compared to alternative resources. These results highlight that user

satisfaction arises from both the quality of the tool's functionalities and the simplicity of its interactions, emphasizing the importance of seamless usability in educational contexts.

5. Conclusions and Contributions

This study highlights the critical role of functional capabilities and usability in maximizing satisfaction with ChatGPT. The findings suggest that satisfaction arises not from frequent usage alone but from the interplay between what the tool can do and how intuitively it delivers its features. By introducing the construct of functional capabilities, categorized into quality of information, learning facilitation, and human language interaction, this research provides a detailed framework for understanding how ChatGPT supports learning.

For practitioners, the study emphasizes the need to enhance ChatGPT's usability, ensure reliable and relevant outputs, and foster natural interactions that meet user expectations effectively. Developers should focus on refining both functionality and ease of use to ensure the tool delivers meaningful educational value. Policymakers and educators can leverage these findings to integrate generative AI responsibly, ensuring it complements traditional learning methods while maintaining academic integrity.

References

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS quarterly, 319-340.

Hair JF; Black WC; Babin BJ; Anderson RE. (2010). Multivariate Data Analysis. (P. P. Hall, Ed.) (7th edition). New York: Prentice Hall.

Ladhari, R. (2012). The lodging quality index: an independent assessment of validity and dimensions. *International Journal of Contemporary Hospitality Management*, *24*(4), 628-652.

Ngo, T. T. A. (2023). The perception by university students of the use of ChatGPT in education. International Journal of Emerging Technologies in Learning (Online), 18(17), 4.

Nunnally, J. C., & Bernstein, I. H. (1994). Psychometric Theory (McGraw-Hill Series in Psychology). New York: MacGraw-Hill.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1988). Servqual: A multiple-item scale for measuring consumer perc. Journal of retailing, 64(1), 12.

Parasuraman, A., & Colby, C. L. (2015). An updated and streamlined technology readiness index: TRI 2.0. Journal of service research, 18(1), 59-74.

Sallam, M., Salim, N. A., Barakat, M., Al-Mahzoum, K., Ala'a, B., Malaeb, D., ... & Hallit, S. (2023). Assessing health students' attitudes and usage of ChatGPT in Jordan: validation study. JMIR medical education, 9(1), e48254.

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Well-being among Medical Students in Digital Learning Environments

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Abstract

This study examines how subjective well-being varies across psychological well-being levels among medical students in online learning (via Microsoft Teams). A cross-sectional survey involving 250 undergraduate medical students from a Ukrainian state university was conducted using validated instruments (the 84-item version of Ryff's Scales of Psychological Well-Being and the Oxford Happiness Inventory). Results revealed significant group differences in subjective well-being based on psychological well-being ($p < 0.001$), with mean scores increasing from 39.4 in the low well-being group to 62.0 in the high group. The findings suggest that psychological well-being is associated with subjective well-being and highlight the need for support for students with lower well-being. Furthermore, online platforms facilitated research, demonstrating their potential for future studies, although data accuracy and ethical adherence concerns persist. This research supports the development of targeted interventions within digital learning settings and encourages further exploration of the long-term psychological impacts of online education.

Keywords: *Psychological well-being; medical students; online learning; subjective well-being; digital education.*

1. Introduction

The mental health of medical students has become a growing concern in medical education, with elevated rates of anxiety, depression, and burnout documented across different academic stages (Haykal et al., 2022). Moreover, societal disruptions, such as the COVID-19 pandemic and the ongoing military conflicts, have worsened these conditions, disrupting traditional learning environments and limiting access to support systems (Aristovnik et al., 2023; Savelyuk, 2022). As a result, the psychological burden on students has intensified, particularly within digitally mediated academic environments (Wang, 2023). While extensive research has

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addressed the negative impact of stress on medical students, much less is known about how psychological and subjective well-being relate to each other, particularly in remote learning contexts (Wang et al., 2023). These constructs are often treated independently in empirical work, despite growing interest in their possible interconnections in digital education settings (McGee et al., 2024). Furthermore, psychological well-being and subjective well-being are often treated as separate constructs, with limited integration in empirical studies, highlighting the need to better understand their relationship in digital educational contexts. Thus, the purpose of this study is to examine differences in subjective well-being among medical students with varying levels of psychological well-being in an online learning environment.

2. Related Work

To better understand student well-being in digital learning contexts, this section briefly reviews recent literature, focusing on key theoretical ideas, common assessment methods, and psychological factors relevant to medical students. It first explains the main differences between hedonic and eudaimonic well-being, then describes typical methodological approaches used in digital educational research. Afterwards, factors influencing medical student well-being are discussed. Finally, current gaps in research are highlighted to suggest areas for further investigation.

2.1. Concepts and Methods of Assessing Well-being in Digital Education

Hedonic and eudaimonic well-being represent two interrelated yet conceptually distinct approaches to assessing an individual's psychological state; the former primarily reflects subjective life satisfaction and positive emotions, whereas the latter encompasses deeper dimensions such as purpose in life, autonomy, and personal growth (Ryff et al., 2021). Despite the lack of full consensus in terminology, subjective well-being is most often equated with happiness, while psychological well-being is associated with more complex dimensions of optimal functioning and personal growth (Ryan & Deci, 2001).

Despite decades of separate empirical research on hedonic and eudaimonic well-being, little work has addressed how these dimensions function together in digitally mediated academic contexts (McGee et al., 2024; Wang et al., 2023). Concurrently, research addressing sociodemographic factors (age, gender, racial and economic disparities) has shown that hedonic and eudaimonic components follow different developmental trajectories and are linked to distinct pathways of influence on health outcomes (Wilkes et al., 2019; Ryff et al., 2021). In the context of increasing digitalization in medical education, adopting a more integrated perspective on well-being may contribute to a deeper understanding of students' psychological functioning under changing educational conditions (Hill et al., 2018; Wilkes et al., 2019).

As a comprehensive framework for evaluating well-being in digital settings remains underdeveloped, the available measurement tools display considerable variability, and some may be insufficiently grounded in theory or lack conceptual alignment (Zhang et al., 2024; Linton et al., 2016). Furthermore, instruments created to measure well-being in digital educational settings have not been clearly defined or widely accepted. The transition to online education has led to significant advancements, including adapting traditional assessment tools such as Ryff's Psychological Well-Being Scale for digital use. However, validating these adapted tools remains challenging and requires careful review and thorough testing to ensure they are reliable and suitable for online use (Palma-Gómez et al., 2020; Mustika et al., 2021). Additionally, assessing medical students' well-being introduces further complexity, requiring specialized instruments such as the Medical Student Stress Profile or the Medical Student Well-Being Index (Haykal et al., 2022). Refining existing tools through context-sensitive modifications through context-specific adaptations may help improve the precision of student well-being assessments and better support evolving psychological needs in digital educational contexts (Linton et al., 2016).

2.2. Factors Affecting Medical Student Well-being

Previous studies have identified significant adverse effects of academic and personal stressors on medical students' mental health, including burnout, depression, and emotional fatigue (Hill et al., 2018; Wilkes et al., 2019). Meanwhile, recent research underscores the significant influence of individual psychological factors, specifically perfectionism, resilience, and self-efficacy, on students' stress levels and overall mental health (Hill et al., 2018; Wilkes et al., 2019). Simultaneously, recent shifts toward digital learning have introduced additional stressors that differ in nature and intensity. In particular, long hours of screen time and less face-to-face contact can increase feelings of isolation and hurt students' mental health (Mustika et al., 2021; Wang, 2023). Therefore, these findings draw attention to the broader context in which medical students experience psychological distress and highlight the importance of further examining how digital learning environments affect their mental health and well-being.

2.3. Benefits and Challenges of Digital Learning

Recent shifts toward digital education in medical curricula have generated new pedagogical opportunities and notable psychological risks, which require careful consideration. One significant advantage is the capability of digital platforms to support autonomous emotional regulation through technology-based interventions. For instance, a meta-analysis reported that mindfulness apps were associated with reduced stress and anxiety while improving overall well-being and attentional control among university students (Chen et al., 2023). Although this analysis focused primarily on general university populations, similar positive outcomes have

been explicitly observed among medical students, suggesting potential for targeted applications in medical education (Fazia et al., 2023).

Moreover, beyond mindfulness-focused interventions, digital education in medical training has been associated with a variety of pedagogical benefits, including improved clinical skill acquisition through video-based instruction (Morgado et al., 2024), enhanced anatomical learning via virtual reality platforms (Minouei et al., 2024), increased accessibility of academic content (Li et al., 2024), strengthened diagnostic reasoning with the aid of artificial intelligence tools (Wang et al., 2024), and better preparation for telemedicine and remote patient communication (Shende and Wagh, 2024). Overall, these findings suggest that digital education may offer indirect mental health benefits by promoting emotional regulation and adaptive skill development.

Despite these pedagogical advantages, recent studies highlight significant psychological and physiological challenges associated with digital learning, especially within high-pressure fields such as medicine. Prolonged screen exposure, for example, has been associated with visual discomfort, as well as reduced concentration and cognitive fatigue (Devi & Singh, 2023; Jakhar et al., 2023). Additionally, the multitasking demands and informational overload common in digital environments negatively affect working memory and learning efficiency (Kirschner and De Bruyckere, 2017).

In addition, certain psychological vulnerabilities have been documented in digital learning environments. For instance, Groenestein et al. emphasize the ambiguity and insufficient empirical clarity surrounding the Fear of Missing Out, a digitally intensified phenomenon rooted in social comparison and informational hyperexposure, which has been empirically associated with increased psychological distress among student populations (Groenestein et al., 2024). This underscores the importance of carefully examining digital learning contexts from a psychological perspective.

Overall, while digital learning has introduced new formats for delivering medical education, it has also raised questions related to students' psychological and cognitive experiences. Although psychological well-being and happiness have been examined separately, their relationship in the context of online learning is not yet well understood. The following section outlines the empirical approach adopted to explore this relationship.

3. Methods

3.1. Participants and Procedure

Participants were medical students enrolled at Zaporizhzhia State Medical University during the 2020–2021 academic year. Due to the COVID-19 pandemic, this cross-sectional study was

conducted fully online. Students aged 18 or older with internet access participated voluntarily after providing informed consent. Ethical approval was obtained from Zaporizhzhia National University and Zaporizhzhia State Medical University. Participants were recruited through announcements on the university's website, inviting them to complete a one-time anonymous survey. Invitations containing background information and a direct link to the questionnaire were sent via email using Microsoft Forms, integrated into Office 365 Education. During this period, students primarily engaged in synchronous online academic activities (lectures, seminars, consultations) via Microsoft Teams, supplemented by asynchronous elements such as recorded lectures and self-paced work materials.

3.2. Assessment Instruments

Data collection included demographic information (age, gender, year of study) and responses to two validated questionnaires. First, psychological well-being was assessed using the Ryff's Scales of Psychological Wellbeing, adapted into an 84-item Ukrainian version (Karskanova, 2011). This instrument evaluates six dimensions: self-acceptance, positive relations with others, autonomy, environmental mastery, purpose in life, and personal growth. Responses were measured on a 6-point scale, ranging from «strongly agree» to «strongly disagree». Second, subjective well-being was evaluated using the Oxford Happiness Inventory (Argyle et al., 1989), which was validated and appropriate for the population studied. The 29-item questionnaire utilized a 4-point response format.

3.3. Data Analysis

Survey data were exported to Microsoft Excel and securely stored. Only complete responses to both questionnaires were included in the final analysis to ensure accuracy and minimize bias. A total of 254 respondents (42.3%) completed both scales, 521 participants (86.8%) answered the 29-item questionnaire, and 257 (42.8%) completed the 84-item test.

Statistical analyses were performed using Stata 15 (StataCorp, College Station, TX, USA). Continuous variables were reported as means and 95% confidence intervals (CIs), while categorical variables were presented as frequencies and percentages (n, %). Group differences were evaluated using one-way ANOVA with Bonferroni post-hoc tests for pairwise comparisons. Cases with incomplete data were excluded to minimize bias. Statistical significance was set at $p<0.05$.

4. Results

4.1. Characteristics of the Study Population

The final analytic sample comprised 250 medical students, of whom 24.8% were male, with participants ranging in age from 18 to 35 years. Students were recruited from the second (8.3%), third (42.5%), fourth (25.6%), and fifth (23.6%) years of undergraduate study. All responses were collected during the 2020–2021 academic year via a digital survey platform (Microsoft Forms) during remote instruction necessitated by the COVID-19 pandemic.

4.2. Descriptive Statistics and Group Categorization

To assess psychological well-being, the 84-item version of Ryff's Scales of Psychological Well-Being was utilized, while subjective well-being was evaluated using the 29-item Oxford Happiness Inventory. As no validated normative thresholds exist for these instruments in the target population, quartile-based categorization was applied. Specifically, for the psychological well-being scale, the total scores corresponding to low and high levels were calculated as 332 and 391. Similarly, these thresholds were determined as 40 and 60 for the subjective well-being scale.

The cross-distribution of psychological and subjective well-being levels is summarized in Table 1, reflecting patterns of co-occurrence across the respective low, medium, and high categories.

Table 1. Cross-distribution of psychological and subjective well-being levels among medical students.

	Psychological well-being		
	Low-score (n=63)	**Med-score (n=126)**	**High-score (n=61)**
Subjective well-being			
Low-score (n=60)	31	25	4
Medium-score (n=128)	26	80	22
High-score (n=62)	6	21	35

The findings reveal that a substantial proportion of students with low psychological well-being (49.2%) also report low subjective well-being, while 39.7% exhibit medium levels. This pattern suggests a predominant association between lower psychological well-being and reduced subjective satisfaction. As presented, most individuals with medium psychological well-being (63.5%) align with medium subjective well-being. However, some variability exists, as 20.6% report low subjective well-being, and 17.5% achieve high levels. This variability highlights the

potential influence of external or contextual factors on the psychological and subjective well-being relationship.

In contrast, high psychological well-being demonstrates a robust positive correlation with high subjective well-being, with 57.4% reporting high levels, 34.4% indicating medium levels, and only 9.8% reporting low levels. Overall, these results underscore the importance of well-being in influencing subjective experiences and propose that focused interventions targeting psychological health could lead to substantial improvements, particularly for individuals in the low and medium categories.

4.3. Statistical Comparison of Subjective Well-being Across Psychological Profiles

A one-way ANOVA was conducted to assess whether psychological well-being category significantly predicted subjective well-being scores. The data indicate a significant effect of psychological well-being on subjective well-being scores ($F(2,247)=44.84$, $p<0.001$). Additionally, post-hoc analysis using the Bonferroni test revealed statistically significant differences across psychological well-being groups (low, medium, and high). More specifically, the difference between the low and medium groups was 10.2 points ($p<0.001$), with mean subjective well-being scores increasing from 39.4 (95% CI: 35.18–43.50) in the low group to 49.5 (95% CI: 47.46–51.59) in the medium group. Importantly, a greater difference of 22.6 points ($p < 0.001$) was observed between the low and high groups, with the latter achieving a mean score of 62.0 (95% CI: 58.69–65.22). Finally, the medium and high groups differed by 12.4 points ($p < 0.001$), indicating a progressive increase in subjective well-being with higher levels of psychological well-being. The analysis found a positive relationship between psychological and subjective well-being. Students with better psychological well-being tended to feel happier.

4.4. Summary of Key Findings

In summary, the final analytic sample consisted of 250 medical students aged 18 and 35, with participants fairly distributed across academic years. Quartile-level psychological and subjective well-being comparisons showed a recognizable co-occurrence pattern among the student groups. Specifically, most students with low psychological well-being also reported low subjective well-being, whereas students with high psychological well-being more frequently demonstrated high subjective well-being levels. Furthermore, a one-way ANOVA revealed statistically significant differences in subjective well-being scores across the three psychological well-being categories ($F(2,247)=44.84$, $p<0.001$). Post-hoc Bonferroni tests confirmed that subjective well-being scores increased significantly and progressively from the low to the high psychological well-being groups. Notably, however, a subgroup of students with high psychological well-being reported only medium levels of subjective well-being, and a smaller number even reported low subjective well-being. These discrepancies indicate that the

relationship between psychological and subjective well-being is not uniform and may be influenced by individual traits or learning conditions that were beyond the scope of the current work. Overall, the results demonstrate a generally positive link between psychological and subjective well-being, though individual variations within groups indicate the need for more detailed analysis.

5. Discussion

The observed association between psychological and subjective well-being provides a foundation for interpreting the diverse patterns found within the student population.

5.1. Personal Factors

In line with previous research (Wilkes et al., 2019; Hill et al., 2018), our results indicate that subjective well-being can vary considerably among students with moderate or high levels of psychological well-being. One possible explanation for this variation lies in personality traits like maladaptive perfectionism or low self-acceptance. Even students with pronounced perfectionistic traits, such as excessive self-demands and fear of failure, may perform well in specific areas of psychological functioning, particularly autonomy and environmental mastery. However, their levels of subjective well-being may remain low due to constant internal pressure and dissatisfaction. Similar patterns have been observed in recent Ukrainian studies, which identified a strong link between perfectionism and emotional difficulties among medical students, particularly in online and blended learning (Savina, & Malakhovetska, 2021). These patterns suggest that even strong psychological functioning may not ensure emotional satisfaction if undermined by maladaptive personality traits.

5.2. Educational and Environmental Factors in Digitally Mediated Medical Training

Another important consideration is the possibility that discrepancies between psychological and subjective well-being reflect difficulties in forming a coherent professional identity. Limited clinical exposure and fewer interpersonal interactions can impede students' sense of belonging within the medical profession. As a result, students' personal growth and life purpose may be compromised, affecting core dimensions of well-being such as life purpose and personal growth. Evidence from Ukrainian universities affected by war further highlights this trend: students frequently reported emotional burnout and increased uncertainty regarding their academic and professional trajectories (Shulhai, Fedchyshyn, & Shulhai, 2023).

Another group of relevant factors relates to structural and pedagogical pressures within digital learning environments. These perspective align with theoretical models emphasising self-acceptance and personal growth (Ryff, 1989; Ryff & Keyes, 1995). Notably, a subgroup of students with high psychological well-being but medium subjective well-being suggests the

influence of contextual or individual factors (Hill et al., 2018). Overall, these observations point to the need for further research into the conditions that moderate the link between psychological and subjective well-being.

In particular, digital learning environments introduce additional academic and technological stressors. Personality traits aside, structural and educational factors also play a significant role. High-stakes assessments and the extended use of digital learning platforms may lead to cognitive fatigue and decreased social connection. Even psychologically resilient students may feel less satisfied when lacking emotionally supportive communication and peer engagement in online environments.

Beyond psychological and educational factors, methodological aspects of digital data collection also deserve attention. In practical terms, present analysis highlights the advantages of concise psychometric instruments in online research, which facilitate higher response rates and participant engagement (Reips, 2021). Nonetheless, ensuring honesty, maintaining anonymity, and addressing potential biases in digital settings remain critical for methodological refinement.

5.3. Directions for Intervention and Further Research

When considered as a whole, these findings emphasize the importance of implementing feasible and widely applicable interventions such as peer mentoring, structured reflection, and hybrid learning models. These strategies can help reduce psychological strain while supporting students' identity development and emotional well-being in digital and crisis-affected academic contexts (Palma-Gómez et al., 2020; Wang, 2023).

5.4. Summary of Discussion

The present findings suggest that the relationship between psychological and subjective well-being in digital medical education may not be straightforward. While a generally positive link was observed, some students demonstrated unexpected combinations of well-being levels, for example reporting high psychological well-being but only moderate or low subjective happiness. This variation may be related to influences that were beyond the scope of this work. Future research could explore both personal and sociocultural contributors to these discrepancies, including personality traits, academic adaptation, the structure of remote learning, and the broader cultural context in which students experience emotional well-being. Altogether, this discussion illustrates the importance of approaching student well-being as a multidimensional construct shaped by both individual characteristics and the specific conditions of digitally mediated education.

6. Limitations

Despite its contributions, this study has several limitations. First, the cross-sectional design limits the ability to draw causal conclusions. Second, caution is warranted when generalizing the findings, as the sample was limited to Ukrainian medical students, whose experiences may not fully represent broader student populations. Although validated instruments were used, the research did not include tools specifically designed for medical students, such as the Medical Student Well-Being Index, which may have provided additional insight.

Furthermore, a limitation concerns the cultural and contextual relevance of the instruments applied. The conceptual foundations of the Ryff Scales and the Oxford Happiness Inventory reflect psychological constructs rooted in individualistic cultural frameworks. These may not fully align with the values of more collectivist societies, such as Ukraine, where interpersonal connectedness, social roles, and group belonging play a more central role in self-perception and well-being.

In addition, the current work utilized earlier adapted versions of both instruments (Ryff Scales, 84 items), as more current, culturally validated versions were not available at the time. In contrast, recent international studies often use updated and shorter formats, such as the 18- or 42-item Ryff Scales and the Oxford Happiness Questionnaire Short Form. This indicates the importance of selecting tools that are not only linguistically and culturally appropriate but also aligned with current methodological practices.

The timing of data collection also presents limitations. Conducted during the COVID-19 pandemic, the study raises important considerations regarding the long-term psychological effects of digital learning. However, the lack of follow-up assessments restricts our understanding of how these effects evolve over time. In Ukraine, where digital education continues in regions affected by ongoing conflict, the long-term mental health implications of remote learning remain a critical direction for further research. Nonetheless, the present analysis demonstrates that psychometric instruments can be effectively used in digital environments to assess student well-being.

Within this context, the findings may serve as a reference point for future research and help inform institutional strategies aimed at supporting mental health in online learning environments.

7. Conclusions

The current research examined how subjective well-being differs depending on psychological well-being levels among medical students in an online learning context. The results suggest a generally positive association between the two constructs. At the same time, individual-level variation indicates that this relationship is not entirely uniform and may be shaped by additional

personal and contextual factors not directly addressed in the present design. This observation points to the need for further investigation into the mechanisms underlying these well-being differences.

In light of these findings, it may be helpful to develop student support strategies that take into account psychological diversity and the specific demands of digital medical education. Furthermore, future studies could explore how longer-term exposure to remote learning, in combination with individual dispositions and sociocultural conditions, affects emotional adjustment in medical training. Overall, these results may support the implementation of evidence-based approaches to student well-being and contribute to the adaptation of educational practices within increasingly digital learning environments.

References

Argyle, M., Martin, M., & Crossland, J. (1989). *Happiness as a function of personality and social encounters.* (17). https://www.semanticscholar.org/paper/Happiness-as-a-function-of-personality-and-social-Argyle-Martin/aea33ca743bfa855f400a595d36ee7087b207f5a

Aristovnik, A., Karampelas, K., Umek, L., & Ravšelj, D. (2023). Impact of the COVID-19 pandemic on online learning in higher education: A bibliometric analysis. *Frontiers in Education*, *8*. https://doi.org/10.3389/feduc.2023.1225834

Chen, B., Yang, T., Xiao, L., Xu, C., & Zhu, C. (2023). Effects of mobile mindfulness meditation on the mental health of university students: Systematic review and meta-analysis. *Journal of Medical Internet Research, 25*, e39128. https://doi.org/10.2196/39128

Devi, K. A., & Singh, S. K. (2023). The hazards of excessive screen time: Impacts on physical health, mental health, and overall well-being. Journal of education and health promotion, 12, 413. https://doi.org/10.4103/jehp.jehp_447_23

Fazia, T., Bubbico, F., Nova, A., Buizza, C., Cela, H., Iozzi, D., Calgan, B., Maggi, F., Floris, V., Sutti, I., Bruno, S., Ghilardi, A., & Bernardinelli, L. (2023). Improving stress management, anxiety, and mental well-being in medical students through an online mindfulness-based intervention: A randomized study. *Scientific Reports, 13*(1), 8214. https://doi.org/10.1038/s41598-023-35483-z

Groenestein, E., Willemsen, L., van Koningsbruggen, G. M., Ket, H., & Kerkhof, P. (2024). The relationship between fear of missing out, digital technology use, and psychological well-being: A scoping review of conceptual and empirical issues. *PLOS ONE, 19*(10), e0308643. https://doi.org/10.1371/journal.pone.0308643

Haykal, K.-A., Pereira, L., Power, A., & Fournier, K. (2022). Medical student wellness assessment beyond anxiety and depression: A scoping review. *PloS One*, *17*(10), e0276894. 2. https://doi.org/10.1371/journal.pone.0276894

Hill, M. R., Goicochea, S., & Merlo, L. J. (2018). In their own words: Stressors facing medical students in the millennial generation. *Medical Education Online*, *23*(1), 1530558. https://doi.org/10.1080/10872981.2018.1530558

Jakhar, F., Rodrigues, G. R., Mendonca, T. M., Nayak, R. R., Kamath, G., Kamath, S. J., & Kamath, A. (2023). Dry eye symptoms and digital eyestrain – Emerging epidemics among

university students due to online curriculum amid the COVID-19 pandemic: A cross-sectional study. *Indian Journal of Ophthalmology, 71*(4), 1472–1477. https://doi.org/10.4103/IJO.IJO_2760_22

Karskanova, S. V. (2011). Opytuvannyk "Shkaly psykhologichnoho blahopoluchchya" K. Riff: protses ta rezultaty adaptatsiyi [Questionnaire "Psychological Well-Being Scales" by C. Ryff: Adaptation process and results]. Praktychna psykholohiya ta sotsial′na robota [Practical Psychology and Social Work], (1), 1–10. [in Ukrainian]

Kirschner, P. A., & De Bruyckere, P. (2017). The myths of the digital native and the multitasker. *Teaching and Teacher Education, 67*, 135–142. https://doi.org/10.1016/j.tate.2017.06.001

Li, S., Wei, W., Li, X., Ma, L., Li, Q., Sun, X., & Chen, X. (2024). Impacts of blended learning with BOPPPS model on Chinese medical undergraduate students: A comprehensive systematic review and meta-analysis of 44 studies. *BMC Medical Education, 24*(1), 914. https://doi.org/10.1186/s12909-024-05917-x

Linton, M.-J., Dieppe, P., & Medina-Lara, A. (2016). Review of 99 self-report measures for assessing well-being in adults: Exploring dimensions of well-being and developments over time. *BMJ Open*, *6*(7), e010641. https://doi.org/10.1136/bmjopen-2015-010641

McGee, R. G., Wark, S., Mwangi, F., Drovandi, A., Alele, F., Malau-Aduli, B. S., & The ACHIEVE Collaboration. (2024). Digital learning of clinical skills and its impact on medical students' academic performance: A systematic review. *BMC Medical Education*, *24*(1), 1477. https://doi.org/10.1186/s12909-024-06471-2

Minouei, M. A., Omid, A., Mirzaie, A., Khosravi, S., & Ghaffari, M. (2024). Effectiveness of virtual reality on medical students' academic achievement in anatomy: Systematic review. *BMC Medical Education, 24*, 1407. https://doi.org/10.1186/s12909-024-06402-1

Morgado, M., Botelho, J., Machado, V., Mendes, J. J., Adesope, O., & Proença, L. (2024). Video-based approaches in health education: A systematic review and meta-analysis. *Scientific Reports, 14*(1), 23651. https://doi.org/10.1038/s41598-024-73671-7

Mustika, R., Yo, E. C., Faruqi, M., & Zhuhra, R. T. (2021). Evaluating the Relationship Between Online Learning Environment and Medical Students' Wellbeing During COVID-19 Pandemic. *The Malaysian Journal of Medical Sciences : MJMS*, *28*(5), 108–117. https://doi.org/10.21315/mjms2021.28.5.11

Palma-Gómez, A., Herrero, R., Baños, R., García-Palacios, A., Castañeiras, C., Fernandez, G. L., Llull, D. M., Torres, L. C., Barranco, L. A., Cárdenas-Gómez, L., & Botella, C. (2020). Efficacy of a self-applied online program to promote resilience and coping skills in university students in four Spanish-speaking countries: Study protocol for a randomized controlled trial. *BMC Psychiatry*, *20*(1), 148. https://doi.org/10.1186/s12888-020-02536-w

Reips, U.-D. (2021). Web-based research in psychology: A review. *Zeitschrift für Psychologie*, *229*(4), 198–213. https://doi.org/10.1027/2151-2604/a000475

Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: a review of research on hedonic and eudaimonic well-being. *Annual review of psychology, 52*, 141–166. https://doi.org/10.1146/annurev.psych.52.1.141

Ryff, C. D. (1989). Beyond Ponce de Leon and life satisfaction: New directions in quest of successful ageing. *International Journal of Behavioral Development*, *12*(1), 35–55. https://doi.org/10.1177/016502548901200102

Ryff, C. D., Boylan, J. M., & Kirsch, J. A. (2021). Eudaimonic and hedonic well-being: An integrative perspective with linkages to sociodemographic factors and health. In M. T. Lee, L. D. Kubzansky, & T. J. VanderWeele (Eds.), Measuring well-being (1st ed., pp. 92–135). Oxford University Press. https://doi.org/10.1093/oso/9780197512531.003.0005

Ryff, C. D., & Keyes, C. L. (1995). The structure of psychological well-being revisited. *Journal of Personality and Social Psychology*, *69*(4), 719–727. 3. https://doi.org/10.1037//0022-3514.69.4.719

Savelyuk, N. (2022). *Psykhologichne blahopoluchchya studentskoyi molodi: Porivnyalnyi analiz u kovidnomu i voyennomu kontekstakh* [Psychological well-being of student youth: A comparative analysis in the COVID and war contexts]. *Psykholohichni perspektyvy* [*Psychological Prospects Journal*], 39, 322–340. https://doi.org/10.29038/2227-1376-2022-39-sav [in Ukrainian]

Savina, M. V., & Malakhovetska, M. O. (2021). *Vplyv rivniv perfektsionizmu na formuvannia emotsiinoi dezadaptatsii* [The influence of the dimensions of perfectionism on the formation of emotional maladjustment]. *Psychiatry, Neurology and Medical Psychology*, (17). https://doi.org/10.26565/2312-5675-2021-17-08 [in Ukrainian]

Shende, V., & Wagh, V. (2024). Role of telemedicine and telehealth in public healthcare sector: A narrative review. *Cureus, 16*(9), e69102. https://doi.org/10.7759/cureus.69102

Shulhai, A. H., Fedchyshyn, N. O., & Shulhai, O. M. (2023). *Syndrom vyhorannia studentiv-medykiv pid chas viiny ta chynnyky, yaki yoho vyznachaiut* [The burnout syndrome of medical students during the war and the factors that determine it]. *Medychna osvita* [*Medical Education*], (3), 104–111. https://doi.org/10.11603/m.2414-5998.2023.3.14276 [in Ukrainian]

Wang, Q., Zhang, Y., Zhang, Y., & Chen, T. (2023). The Impact of Mindful Learning on Subjective and Psychological Well-Being in Postgraduate Students. *Behavioral Sciences*, *13*(12), Article 12. https://doi.org/10.3390/bs13121009

Wang, Y. (2023). The research on the impact of distance learning on students' mental health. *Education and Information Technologies*, *28*(10), 12527–12539. https://doi.org/10.1007/s10639-023-11693-w

Wang, Y. J., Yang, K., Wen, Y., Wang, P., Hu, Y., Lai, Y., Wang, Y., Zhao, K., Tang, S., Zhang, A., Zhan, H., Lu, M., Chen, X., Yang, S., Dong, Z., Wang, Y., Liu, H., Zhao, L., Huang, L., Li, Y., … Zhao, S. (2024). Screening and diagnosis of cardiovascular disease using artificial intelligence-enabled cardiac magnetic resonance imaging. *Nature Medicine, 30*(5), 1471–1480. https://doi.org/10.1038/s41591-024-02971-2

Wilkes, C., Lewis, T., Brager, N., Bulloch, A., MacMaster, F., Paget, M., Holm, J., Farrell, S. M., & Ventriglio, A. (2019). Wellbeing and mental health amongst medical students in Canada. *International Review of Psychiatry (Abingdon, England)*, *31*(7–8), 584–587. https://doi.org/10.1080/09540261.2019.1675927

Zhang, W., Balloo, K., Hosein, A., & Medland, E. (2024). A scoping review of well-being measures: Conceptualisation and scales for overall well-being. BMC Psychology, 12(1), 585. https://doi.org/10.1186/s40359-024-02074-0

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Extracurricular Activities and academic performance among University Students

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Abstract

This study aims to investigate the impact of extracurricular activities (ECA) on student success. Based on the Stimulus-Organism-Response (SOR) model, this study investigates how ECA act as stimuli that triggers inner psychological changes, which, in turn, help students to develop cognitive, social, and emotional skills. A mixed-methods approach was used combining qualitative with quantitative anal to collect data. Data was collected from a diversified pool of students across various academic institutions. Structural equation modelling (SEM) was employed to analyse the data and test the proposed model. Our findings emphasize the significance of including extra-curricular activities in students' educational curricula to foster the overall development of the learner. Universities are invited to promote and expand various extracurricular programs and entice students to take part of the various programs for a better educational outcome. The application of the SOR model is to be considered as our major contribution.

Keywords: *Extracurricular activities; Academic performance; SOR model*

1. Introduction

The impact of extracurricular activities (ECA) in the context of academic achievement is increasingly garnering research interest. Studies have shown that ECA are more and more recognized not only through their recreational value but also for their substantial contributions to students' academic personal and academic development. These activities, while ranging from sports, arts, volunteering, present significant and unique challenges that can have a concrete impact on academic performance. Referring to the Stimulus-Organism-Response (SOR) model (Mehrabian &Russell, 1974), extracurricular activities act as an off-campus stimulus of the internal psychological processes, leading thereby to the enhancement of the personal and academic outcomes of the participants. This framework not only explains the catalytic roles of interactions within various activities but also establishes how such interactions initiate the

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pertinent development required in students (Mehrabian & Russell, 1974). More studies have shown that ECA enhance not only cognitive but also emotional critical thinking. Jensen (2013) says that these activities build emotional intelligence and problem-solving in students by facilitating strong social relationships and challenging them to manage time and solve real-world problems. In the modern world, these skills are increasingly in demand as academic environments become more and more competitive. Besides this aspect, extracurricular activities that are practiced regularly have been shown to give students a great boost of confidence and a satisfactory level of mental health which allows them to be readily equipped with the resilience and capabilities to transition into a future professional landscape (Smith, 2015). ECA is a wider road to enhance individual attributes that further develop strong ties, which finally improve self-knowledge and make clearer career decisions. Such a wholesome development is poignant because, in addition to preparing a student in academia, it makes one socially and emotionally ready to handle the complexities of adult life. ECA offer a stage for experiential situations that a regular classroom does not typically provide. By virtue of these activities, learners acquire first-hand learnings in the technique of teamwork, leadership, and public speech that are inevitable in a higher-education environment as well as in the work environment. From personal growth, the merits go on to create a network of bonding and participation amongst the participants, ultimately driving school spirit and solidarity**.** How participation in extracurricular activities influences students' academic performance and social integration? The rest of this paper is organized as follow: Section 2 present a literature review. Methods are introduced in section 3, sections 4 shows results and analysis, conclusion is presented in section 5.

2. Literature review

The SOR theory, first developed by Mehrabian and Russell in 1974, provides a conceptual framework for explaining how external stimuli influence individual responses through internal cognitive and emotional mechanisms. The sequence is spelled out as S-O-R: the environmental stimuli activate internal organismic states of the individuals, which consequently evoke certain responses. Stimuli are external factors, which can be physical, social, or situational in nature, through which individuals experience them. They may be tangible, such as components of environmental contexts, including social interactions, or intangible, including cultural norms and expectations (Jacoby, 2002). Engaging in ECA suggests participation in sports, clubs, or competitions that allow for development of different skills, promotes engagement, and support physiological activity for ECA. The SOR theory, therefore, is particularly helpful in the understanding of ECAs' effects since activities within ECA act to the students as stimuli for developing an emotional and cognitive state and finally determining behaviors and outcomes. Zhang et al. (2022) describe extracurricular activities as voluntary, organized programs that promote personal and social development. Prior research, like Malin's (2022), has shown that ECA provide a way to build interpersonal skills like communication, cooperation, and

leadership via frequent collaborative contacts. Mariano et al. (2021) found a positive link between ECA involvement and interpersonal success; on the other hand, a lack of engagement restricts such people. According to Malin (2022), intellectual participation in ECA enhances cognitive capacities such as critical thinking and problem solving. Activities such as arts, discussions, and research require participants to examine and synthesize information, which Zhang et al. (2022) discovered to increase cognitive flexibility and adaptability. Kanar and Bouckenooghe (2021) claim that involvement in a variety of ECA promotes analytical thinking, but Bundick (2011) records that the degree of interaction matters. Hence: ***H1*- Engagement in ECA positively affects perceived soft skills enhancement; *H2*- Engagement in ECA positively affects cognitive abilities.** Student motivation, defined as the intrinsic drive to pursue goals in the article, is significantly influenced by purpose-driven ECA (Malin, 2022). These activities, which relate to personal interests, provide a sense of belonging and responsibility which leads to a continuous involvement. Zhang et al. (2022) discovered that reflective ECA like volunteering or leadership programs, increased intrinsic motivation, whereas irrelevant activities had no impact (Bundick, 2011a). therefore: **H3- Engagement in ECA positively affects student motivation. Self-regulated learning** is a significant predictor of academic performance (Zhang et al., 2022). Goal setting, time management, and strategic thinking are common requirements in ECA, all of which improve self-discipline and academic achievement. For example, Malin (2022) discovered that students who participated in ECA such as athletics or governance had higher self-regulation abilities, which enhanced their academic performances. While differences occur based on the activity, this study looks into how these talents transform into improved academic achievements. Hence: ***H4*- Self-regulated learning positively influences academic achievement. Self-regulation** is an essential constituent of learning as it enables students to plan and scale their learning strategies. This dimension is developed through structured extracurricular activities (ECA). Griffiths and Jackson (2021) argue that ECA enhance self-regulation since students are tasked with setting targets, planning, evaluating and modifying their actions. leaders in training or students in debate clubs develop the ability to think strategically and be self-disciplined. Based on the above, we hypothesize that:***H5*- Engagement in ECA has a positive effect on self-regulated learning.**

Physical activity, which can be understood as those bodily movements including playing sports and exercising, tends to have a positive correlation with academic performance. Chen and his colleagues (2020) reported that involvement in physical extracurricular activity lets the students feel less burden, focus better and even perform better cognitively, which overall, makes them excel in Academics. Therefore: **H6- Physical activity positively influences academic achievement**. **Student motivation to perform well is the** internal drive to achieve good grades can be by students participation in ECA. ECA greatly increase students' motivation by further engaging them in tasks that are relevant to their aspirations, Griffiths and Jackson (2021). Participants' motivation seems to rise in proportion with their satisfaction and success because

they can relate their efforts with the outcomes achieved through the ECA. A personal achievement is the feeling or satisfaction which one derives after reaching a certain meaningful goal. Such a feeling contributes a lot to a student's academic success. According to Ginosyan et al. (2020), students that win in ECA usually develop self-efficacy which they translate to curricular performance and therefore high grades and self-confidence. Experience of these programs enhances achievement in other areas. So: **H7- Student motivation positively mediates the relationship between engagement in ECA and personal accomplishment. Perceived overqualification** describes a situation or a feeling in which someone believes that he possesses more skills or is more knowledgeable than the requirements of a specific role. Participation in extra-curricular activities (ECA) is said to enable students acquire higher level **competences** such as leadership, critical thinking, and interpersonal skills as noted by Buckley and Lee (2021), which are always not limited to the requirements of the studies. Munir and Zaheer (2021) also stress the role of such ECA in developing students' potentials in online learning environments through competitions and joint activities that boost their confidence and self-perception of over qualification. Hence: **H8- Personal accomplishment contributes positively to academic achievement, H9-Engagement in ECA has a positive effect on perceived overqualification. Activity** is fundamental to health and certainly well-being and as it is the participation in the ECA that renders this in most cases. In Ribeiro et al. (2024), it has been suggested that ECA participation which may include sporting and recreational clubs encourages participation on a regular basis in physical activity with a focus on improving physical fitness and mental health. This is supported by Buckley and Lee (2021), where the authors describe the expectations of ECA as defining the context in which students are active and participative in exercising and not reverse. Thus, we put forth that: **H10- Engagement in ECA has a positive effect on students' physical activity. Student satisfaction** is a feeling of contentment in students once they go through extracurricular activities. Buckley and Lee (2021) argue that being involved in extracurricular activities (ECA) creates a room for interaction amongst students, acquisition of skills, and achievement which leads to satisfaction. According to Ribeiro et al. (2024), students can get a good perception of their education because ECA help them to cope with difficult studies and at the same time have good social and developmental experiences. Students who **are satisfied with their courses** are likely to perform better in their academics since they get more motivated to work on their studies (Ribeiro et al., 2024). **Student satisfaction** operates as to mediate students' expectations and experiences making them more attentive and to performing better academically (Buckley and Lee, 2021). Munir and Zaheer (2021) show that satisfaction, derived from enjoyable ECA, facilitates psychological engagement and academic effort towards persistence in unusual settings. Ribeiro et al. (2024), states that students who are motivated tend to perform better academically since they are more willing to work and get involved with their work. Motivation may serves as a mediating variable, reconciling student anticipation with experience and subsequently improving their attention and academic performance (Buckley and Lee, 2021). Motivated students in distance learning

environments are more likely to actively participate in ECA, resulting in increased self-efficacy and personal growth (Munir and Zaheer, 2021). Finaly, Among the skills deemed important in any academic and professional undertaking, soft skills such as communication, teamwork and problem-solving are critical Ribeiro et al. (2024) argue that ECA foster such learn-by-doing competences that encourage the students to team up and tackle problems. Students who have a good grip of soft skills will show better handling of group work dynamics in academic activities and as a result perform better academically (Buckley and Lee 2021) Therefore: **H11- Engagement in ECA positively affects student satisfaction toward their own curriculum; H12- Student satisfaction positively influences academic achievement; H13- Student motivation positively influences personal accomplishment; H14- Perceived Soft Skills positively influence Academic Achievement**.

3. Method

Nonprobability sampling method combining convenience and snowball sampling methods was used (Chetioui & Abbar, 2017). The sample included 200 respondents from different age groups and backgrounds. Participants rated these items on a five-point Likert scale. Demographic information including gender, age, and Education level was collected. The qualitative data regarding the extra-curricular activities were gathered through a focus group composed of seven students who were either over-involved in activities or those who were less involved. This diversity made it possible to obtain a wide range of experiences and perspectives. The study sessions took a duration of more than 40 minutes where participants were able to have elaborative discussions about the 18 open-ended given questions. Ideally, these questions were meant to understand the reasons behind the incidences of involvement in certain extra-curricular activities and their impact on performance, peer relations, and career ambitions (*Results of the qualitative methods can be shared upon request)*. 45% of respondents were females and 55% males. 18 to 25 years age range *made 81*% of the sample followed by people falling within 26 to 30 years age range 12% and most of the respondents were undergraduates (42%). Regarding involvement in extracurricular activities (ECA), most participation to sports activities making it 42% while community service activities were 17%, clubs 13%, arts 12% and 16% accounted other activities. The sample comprises students from semi-public universities (43%) and private universities (39%) among others. In terms of amounts of time spent on ECA in a week, 31% spent 1-3 hours and 30% spent 3-5 hours. (*respondents' profile available upon request*).

4. Results

A structural equation modeling has been applied to evaluate the underlying relationships in the proposed conceptual model (Hair et al., 2019). The reliability of the construct was assessed and Cronbach Alpha (CA) and composite reliability (CR) of all constructs exceed 0.7, suggesting

the sufficiently construct reliability (Henseler et al., 2009; Lebdaoui et al., 2022; Chetioui et al., 2023). The loadings of all items are higher than 0.7, thus supporting the indicator reliability (Henseler et al. 2009). Average variance extracted (AVE) for all constructs were found to be greater than 0.5, which guarantees the convergent validity. Furthermore, the discriminant validity was confirmed (*Discriminant validity results; CR, CA, AVE and HTMT results can be shared upon request*). Our model's R-square of 48.7%, which in the interpretation of predictive power is generally considered as high (Cohen, 1992). The direct impacts of our model are reported in Table 1 Remarkably, involvement in activities outside of the regular academic curriculum (ECA) is the key driver for diverse outcomes one may look for. Active Participation in ECA's has been found to have significant effects on students in terms of engagement, self-perceived soft skills development, and self-regulated learning ($\beta = 0.521$, $p < 0.001$; $\beta = 0.423$, $p < 0.001$; $\beta = 0.402$, $p < 0.001$; respectively). Engagement also has a positive relationship with feeling high levels of personal accomplishment as $\beta = 0.438$, $p < 0.001$, and may also assist or impact on cognitive performance as $\beta = 0.348$, $p < 0.001$ which suggests some improvement in both psychological and cognitive development. Exercise helps perform on schoolwork with the lowest beta of 0.118 and a non-significant p-value of 0.289 that shows one on one relation is minimal. It is worth noticing that, feeling overqualified ($\beta = 0.228$, $p = 0.023$) and using self-control ($\beta = 0.387$, $p < 0.001$) explain one's level of performance better suggesting that these mediating factors have a role in performance. However, high levels of personal accomplishment construct and perceived levels of soft skills didn't explain academic performance significantly ($p > 0.05$) which shows that not all constructs contribute to the same degree. Furthermore, self-regulated learning significantly moderates the relationship between the engagement in extracurricular activities and academic achievement with $\beta = 0.387$; $p < 0.001$, showing that it plays a critical role in translating ECA participation into improved academic performance. On the contrary, the motivational level of the students does not serve as a moderator for the link between ECA participation and academic performance ($\beta = 0.08$; $p > 0.05$), indicating that motivation indeed is an important element, but it alone cannot strengthen this connection.

5. Discussion and Conclusions

The research findings provide a comprehensive exploration of the impact ECA on student outcomes. While prior studies generally highlight the positive effects of ECA on academic performance and personal growth (Zhang et al., 2022; Malin, 2022; Griffiths & Jackson, 2021), this study presents nuanced insights into the varied roles of different constructs. Specifically, while engagement in ECA significantly enhances student satisfaction, self-regulated learning, and perceived soft skills, these effects are context-dependent. Interestingly, this research also sheds light on the role of self-regulated learning and student motivation as moderating variables. Self-regulated learning was found to significantly strengthen the relationship between ECA participation and academic achievement, highlighting its critical role in helping students manage

Table 1 Direct relations

		Beta	SD	T- stat.	P- value
H1	Cognitive Abilities -> Academic Achievement	0.152	0.113	1.344	0.179
H2	Engagement in ECA -> Cognitive Abilities	0.348***	0.107	3.244	0.001
H3	Engagement in ECA -> Personnal Accomplishment	0.438***	0.106	4.139	0.000
H4	Engagement in ECA -> Perceived Overqualification	0.332**	0.133	2.499	0.012
H5	Engagement in ECA -> Student Motivation	0.367***	0.108	3.393	0.001
H6	Engagement in ECA -> Self-regulated learning	0.402***	0.121	3.323	0.001
H7	Engagement in ECA -> Perceived Soft Skills	0.435***	0.098	4.446	0.000
H8	Engagement in ECA -> Student Satisfaction	0.521***	0.09	5.824	0.000
H9	Physical Activity -> Academic Achievement	0.118	0.098	1.199	0.230
H10	Personnal Accomplishment -> Academic Achievement	-0.013	0.14	0.091	0.928
H11	Perceived Overqualification -> Academic Achievement	0.228*	0.119	1.911	0.056
H12	Student Motivation -> Academic Achievement	0.081	0.148	0.541	0.588
H13	Self-regulated learning -> Academic Achievement	0.387***	0.104	3.732	0.000
H14	Perceived Soft Skills -> Academic Achievement	-0.115	0.145	0.795	0.427
H15	Student Satisfaction -> Physical Activity	0.562***	0.093	6.016	0.000

their academic responsibilities effectively. On the other hand, student motivation, while important, did not emerge as a significant moderator, underscoring the complex interplay between motivational states and academic outcomes. The findings also align with previous studies on the positive influence of physical activity and cognitive engagement through ECA on student development (Chen et al., 2020; Kanar & Bouckenooghe, 2021). This study offers valuable insights for educational institutions aiming to optimize the benefits of ECA. Specifically, fostering self-regulated learning and creating structured ECA programs tailored to enhance cognitive abilities, and satisfaction can significantly enhance academic outcomes. Furthermore, the diverse influences of ECA emphasize the need for personalized approaches that account for the varied needs and profiles of students. This study has a few limitations: ECA could be explored un different countries, and a longitudinal approach to measuring ECA over may capture disparities in findings. Future research may break down activities by type (e.g. physical vs cultural for example) as the impacts may be different.

References

Buckley, P., & Lee, P. (2018). The impact of extra-curricular activity on the student experience. *Active Learning in Higher Education*, *22*(1), 37–48. https://doi.org/10.1177/1469787418808988

Bundick, M. J. (2011). Extracurricular activities, positive youth development, and the role of meaningfulness of engagement. *The Journal of Positive Psychology*, *6*(1), 57–74. https://doi.org/10.1080/17439760.2010.536775

Chetioui, Youssef & Abbar, Hassan. (2017). Customer Relationship Management (CRM) in service firms: A model proposal to measure the impact of the implementation of CRM dimensions on Hotel Performance. *International Journal of Scientific & Engineering Research*. 8(5), May-2017.

Chetioui, Y., Errachid, Y., Lebdaoui, H. (2023), Organizational justice, employee empowerment, and innovative behavior in the post-COVID era: Evidence from SMEs in a majority-muslim country. In: Ramadani, V., Alserhan, B., Dana, L.P., Zeqiri, J., Terzi, H., Bayirli, M., editors. Research on Islamic Business Concepts. GIMAC 2022. Springer Proceedings in Business and Economics. Springer, Singapore

Cohen, J. (1992). Statistical Power Analysis. Current Directions in Psychological Science, 1(3), 98–101. https://doi.org/10.1111/1467-8721.ep10768783

Fredricks, J. A., & Eccles, J. S. (2006). Is extracurricular participation associated with beneficial outcomes? *Developmental Psychology*, 42(4), 698-713.

Ginosyan, S., Grabski, H., & Tiratsuyan, S. (2020). In vitro and in silico Determination of the Interaction of Artemisinin with Human Serum Albumin. *Molecular Biology*, *54*(4), 586–598. https://doi.org/10.1134/s0026893320040056

Griffiths, T., Dickinson, J., & Day, C. J. (2021). Exploring the relationship between extracurricular activities and student self-efficacy within university. *Journal of Further and Higher Education*, *45*(9), 1294–1309. https://doi.org/10.1080/0309877x.2021.1951687

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). Multivariate data analysis: A global perspective. Upper Saddle River, NJ: Pearson Education.

Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. In *Advances in international marketing* (pp. 277–319). https://doi.org/10.1108/s1474-7979(2009)0000020014

Jacoby, J. (2002). Stimulus-Organism-Response reconsidered: An evolutionary step in modeling (Consumer) behavior. *Journal of Consumer Psychology*, *12*(1), 51–57. https://doi.org/10.1207/s15327663jcp1201_05

Jensen, E. (2013). Teaching with poverty in mind: What being poor does to kids' brains and what schools can do about it. Alexandria, VA: ASCD.

Kanar, A., & Bouckenooghe, D. (2021). Extracurricular participation as a predictor of cognitive and social outcomes. *Educational Psychology Journal*, 33(2), 189-207.

Lebdaoui, H., El Asri, M., & Chetioui, Y. (2022). Environmental Kuznets curve for CO2 emissions - an ARDL-based approach for an emerging market. *Interdisciplinary Environmental Review*. Vol. 21, No. 3-4. https://doi.org/10.1504/IER.2021.121658

Mariano, M., da Silva, A.R., Lima, J.L.S. *et al.* Effectiveness of the Elos 2.0 prevention programme for the reduction of problem behaviours and promotion of social skills in schoolchildren: study protocol for a cluster-randomized controlled trial. *Trials* **22**, 468 (2021). https://doi.org/10.1186/s13063-021-05408-0

Marsh, H., & Kleitman, S. (2002). Extracurricular school activities: The good, the bad, and the nonlinear. *Harvard Educational Review*, *72*(4), 464–515. https://doi.org/10.17763/haer.72.4.051388703v7v7736

Mehrabian, A., & Russell, J. A. (1974). An approach to environmental psychology. Cambridge, MA: The MIT Press. A Verbal Measure of Information Rate for Studies in Environmental Psychology – ProQuest

Moore,D. T. (2013). Engaged Learning in the Academy: Challenges and Possibilities. New York, NY: Palgrave Macmillan

Munir, R., & Zaheer, H. (2021). Enhancing motivation and self-regulated learning through extracurricular activities: A case study. *Educational Psychology Review*, 29(3), 345-360.

Qin, Z., Li, Y., Ye, X., Zhou, J., Cao, M., & Chen, D. (2020). ECA: an efficient and conditional privacy preserving collision warning system in fog-based vehicular ad hoc networks. *CCF Transactions on Networking*, *3*(3–4), 205–217.https://doi.org/10.1007/s42045-020-00041-y

Ribeiro, C., Martins, T., & Fonseca, R. (2024). The influence of extracurricular activities on employability and academic performance. *International Journal of Educational Studies*, 15(1), 34-56.

Smith, J. (2015). Impact of extracurricular activities on students. *Educational Journal of the University of Patagonia*, 3(1), 23-30.

Zhang, Y., & Xu, W. (2022). Cognitive benefits of extracurricular involvement: A cross-sectional analysis. *Educational Review Quarterly*, 10(3), 112-130.

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"My idea of Sustainability": outlines from an experiment with students at the University of Trento (Italy)

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Abstract

Sustainability is still an elusive and fluid concept which requires to be better defined and explained in its key dimensions. In this regard, the role of higher education is of crucial importance today. A critical prerequisite when trying to integrate sustainability-related topics into university courses is to understand students' opinions and needs in this regard. The paper illustrates an experiment conducted with students of the bachelor's degree in environmental engineering at the University of Trento. Based on her own teaching experiences and on the activity within a university working group on sustainability, the author makes some considerations on the challenging task of designing an interdepartmental course on sustainability at the University of Trento

Keywords: *Sustainability; Higher Education; University of Trento.*

1. Introduction

The discourse on sustainability and its corollary, sustainable development, has gained new impulse over the last few years, as the 2030 deadline approaches and the need to try to implement the 17 Sustainable Development Goals (SDGs) endorsed by the global community (United Nations 2015) becomes increasingly urgent. Nevertheless, sustainability is still an elusive and fluid concept, and, despite its pervasiveness and popularity, requires better definition and explanation in its key dimensions, taking into careful account possible interlinkages, synergies and trade-offs (Mensah, 2019, Ninno Muniz et al. 2023, Schneider et al., 2019, Vogt & Weber, 2019). Tackling this challenging goal entails a clear multi-disciplinary and scientifically based approach being adopted, as is now widely recognized by academics and practitioners (Plail, 2024, Schneider et al., 2019). In fact, the plethora of definitions and the often inappropriate, sometimes contradictory, use of the term can lead to confusion, risking the concept of sustainability being reduced to an appealing label for a product, a naïve slogan for environmental activist associations – despite the best of intentions – or an empty mantra for international agencies. All this contributes to creating a widespread feeling of discouragement,

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frustration heightened by the current geopolitical situation and a kind of disenchantment about the concept of sustainability itself.

In this regard, the role of both research and higher education is of crucial importance today. Higher education, in particular, has a demanding but stimulating task and a tremendous responsibility. In a world more and more connected across place, scale and sector, the issue must be addressed with a holistic approach and requires the development of a language that cuts across the various disciplines.

2. What is going on at the University of Trento

Trento, located in the heart of the central-eastern Italian Alps, has a typical medium-sized university, in relation to the Italian average. The 11 Departments and 4 University Centers (University of Trento, 2025a), with the recent inclusion of the School of Medicine and Surgery, cover an ample range of disciplines involved in issues strictly connected with sustainability.

"UniTrento sostenibile" is the strategy of the University of Trento put in place to promote action in a wide range of areas, involving many organizations, departments and centers and a variety of stakeholders. The code of ethics of the university, approved by the Academic Senate in March 2014, makes clear reference to the principle of environmental sustainability as a general rule of conduct for all university members. Since 2015, there has been a Rector's delegate for environmental sustainability and, more recently, each department has appointed its own delegate. Initial efforts by the University of Trento to achieve sustainability resulted in the Environmental sustainability plan 2016/2018, a sort of roadmap for the management of sustainability-related processes within the university, and a first step toward the achievement of sustainability goals (University of Trento, 2025b). The Environmental sustainability plan 2025-2027 has just been completed and is about to be made operational. Between June and November 2024, two important conferences took place, hosted by the Department of Physics and the Department of Law, which took into consideration other important dimensions of sustainability. In particular, the International Scientific Workshop on Challenges of Sustainable Education, 11–12 June 2024, (proceedings in print) addressed the tricky question of how to include sustainability in curricular courses. A workgroup, of which I am part, has recently been put in place to address the problem from an interdisciplinary perspective and put forward proposals. In numerous courses, the topic has been debated for some time now, albeit from a standpoint linked to the specific disciplinary field, which sometimes limits a broader and more general understanding of the problem and makes the exchange of knowledge and experiences difficult. The basic idea is to design an interdepartmental course which is intended for students from different disciplines, with the aim of dealing with the different dimensions of sustainability, stimulating reflexive interactions and creating a common language. The content and logistical organization of such a course, and aspects related to its evaluation, are a real challenge and must

be carefully weighed and discussed. The request coming from student associations in this regard, however, is a strong incentive to move forward in this direction.

3. The experiment

When I started thinking about how it was possible to integrate sustainability issues into a specific course, my first concern was to understand students' opinions and expectations in this regard. Young generations have different channels and tools than our traditional ones to form their own opinions.

The first question I asked myself was: is there a need for sustainability at least on the part of my students? As a teacher of the Ecology course, aimed at students in the third year of the First Cycle Degree in Environmental Engineering, I have seen students' expectations and motivation, their sensitivity and their beliefs towards environmental issues, change a lot over time. In an ice-breaking workshop that I do every year right in the first lesson, some key words emerge that allow me to understand which are the issues that students consider priority. In recent years the word sustainability and other words closely related to it emerge with increasing frequency (figure1). For students who enroll in environmental engineering, sustainability is seen as a topic that must be addressed.

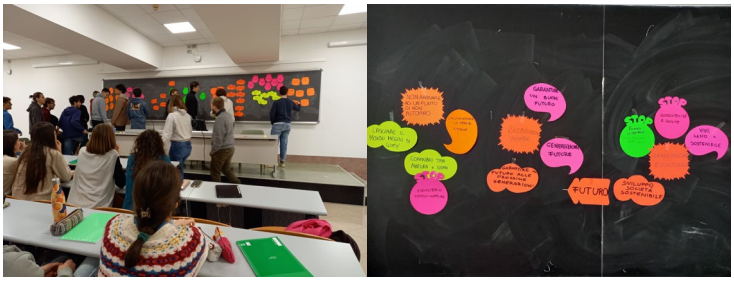


Figure 1. A moment of the workshop and some key words that emerged

A second question is: what is students' idea of sustainability? I asked them: during the academic year 2023-2024, towards the end of the course, before dealing with the meaning, history and principles of sustainable development in a specific lesson, I asked my students to write, in a short text and with a short time available, what their personal idea of sustainability was. Everyone took the task very seriously and many of the ideas that arose from this exercise were good food for thought for me.

The first thing that emerged is that sustainability has different meanings:

"Sustainability can take on many meanings; environmental sustainability, for example, refers to the prudent, responsible use of the resources on which we depend, in order to safeguard the world around us"

"I consider sustainability to be synonymous with respecting certain criteria at the environmental level, and whose goal is to reduce the environmental impact of harmful human activity. I believe, too, that sustainability is an umbrella term that covers different concepts"

The long-term perspective appears clear:

"Support, sustenance, and substance are all concepts I would use to explain what sustainable means to me personally. Sustainable is that which: 'supports' life; is needed for, and is beneficial to, current and future 'sustenance'¬; and utilizes only those 'substances' that are necessary, without going to excess. Whatever is sustainable is long-lasting yet easily and safely disposed of"

A word that often occurs is «respect»:

"Sustainability means respecting the world's ecosystems, in an effort to maintain the balance of nature"

"In my opinion, sustainability means a correct balance between man and nature, in which man is committed to respecting the environment around him"

"Sustainability is an ideal worth pursuing. It is a form of respect … respect that, for years and years, has been sorely lacking due to indifference"

I was happy to see that after taking the ecology course, the awareness had developed that man is dependent on ecosystems:

"Personally, sustainability means, as far as is possible, being one with Nature. Even before we begin talking about 'having a lesser impact' or 'making eco-sustainable choices,' we need to rid ourselves of the idea of man as the dominant species, one that is able to control and exploit everything that surrounds him. Sustainability means, first of all, making oneself 'as small as possible,' in the sense of humbling oneself and understanding that we are but inhabitants of this planet we call 'home,' We do not own Earth; we merely share it alongside a whole series of species vastly different to ourselves. For me, sustainability is a way of thinking, a mindset … humble, open, and kind and caring"

"… in conclusion, we need sustainability if we are to carry on living. While there are many who, sadly, feel no connection whatsoever to Nature, the truth is we are in fact intimately connected to – and practically dependent on – Nature. We need to respect her, and love her, not least because she is the source of our very existence"

Somebody stressed that pursuing sustainability involves «scaling back»:

"… to conclude, therefore, my idea of sustainability is to recoup as much material and energy as possible from waste matter, protect the environment from the effects of the presence of human beings, and, by scaling back our lifestyles, lessen our environmental impact"

… and that sustainability implies cooperation:

"We need to stop being egotistical, to stop thinking that, just because we will no longer be here in a hundred years' time, the problem is not ours to deal with. Instead, we need to take charge of the situation and via our behaviour try to do those things, however small, that will enable us to be more sustainable"

"Sustainability rhymes with cooperation, in my opinion, and I believe it can only be achieved if each of us is willing to make our own personal contribution. We can start by acknowledging that such contribution, however small, can and does have an enormous impact on the entire population"

"We need to put aside our egos. We need to realize that we do not exist as individuals on this Earth but are part of a community. I firmly believe the only way we can better the current situation is by starting with ourselves"

Finally, there were also indications regarding role and responsibility of higher education:

"I find the topic of sustainability covered in the Bachelor's degree in environmental engineering only marginally dealt with. The Bachelor's degree addresses the basics in mathematics and science needed to tackle the Master's degree. In my opinion, aspects such as pollution, sustainability, and environmental protection should be covered in greater detail during the Bachelor's … This would create a greater awareness of the subject on the part of students … Moreover, any course that deals qualitatively in subjects of this kind can stimulate greater interest not only in the degree course, but also in the department"

"Sustainability is destined to become increasingly central in the years ahead, and the subject around which I would like, in some way, to build my future career"

4. Lessons learned and perspectives

It is understandable that students enrolled in a course in environmental engineering have touched mainly on issues related to the environmental dimension of sustainability. Furthermore, considering the small sample of students whose opinion was asked (a class of 50 students enrolled in the third year), it certainly cannot be thought that the opinions expressed are representative of the entire student population of the University of Trento. Anyway, deliberating over an interdepartmental course, identifying its content and defining its structure in detail cannot fail to consider the opinions and needs of students from all degree courses and to take into account the different sensitivities towards the different dimensions of sustainability. How to integrate students' needs and expectations into the course design process? One possible way is to invite student representatives to discuss in the workgroup, but in this case, it may be difficult to have a vision broad enough to reflect the entire student population. I then came up

with the idea, shared by some colleagues, to exploit the exercise done by my students in the academic year 2023–2024, to stimulate suggestions and indications from students of all degree courses and at all levels. During these last months we are working on the creation of a roll-up containing some of the ideas expressed by the students of the Ecology course, in the form of Post-it notes that will be placed at the entrance of the various departments.

The poster, titled "My idea of sustainability", will include a sentence explaining the origin of those short texts, as well as a QR code allowing anyone who wishes to do so to express her or his own ideas and put forward issues relating to sustainability that would be interesting to address in a dedicated course. A first section, very compact, is dedicated to the collection of some essential personal data. In the second section, first of all, students are asked to express their personal idea of sustainability (this is the only open question). They are then asked to indicate, according to a five-point Likert scale, how important they think it is to include sustainability in the curricula of the University of Trento. Finally, they are asked to give their opinion (according to a five-point Likert scale) on the importance of dealing with each of a few themes proposed for each dimension of sustainability, leaving the possibility of identifying any others. The answers to the open question will be analyzed with NVIVO, a program in use at the Department of Sociology and Social Research of the University of Trento. The aim of the poster will be, first, to stimulate curiosity and raise awareness among students regarding the problem and then to collect opinions, information and suggestions that can provide useful insights and facilitate a better understanding of students' expectations and needs: a sort of compass to better orient oneself in the complexity of the students' world and to better approach, even if indirectly, young people. The total number of students at the University of Trento is around 16,000: considering the tradition of participation and activism that characterizes this university, we expect a good percentage of responses. Although it is difficult to hazard predictions, we are confident that we will be able to obtain a good data base.

Alongside the creation of the poster we have undertaken a survey at national and European level, to try to understand how the topic of sustainability is addressed in other universities. The survey is facilitated by the fact that the University of Trento is part of the Italian network RUS (Network of Universities for Sustainable Development) and the European network ECIU (European Consortium of Innovative Universities).

It will take a few months for this first step to be considered concluded. However, in October we expect to be able to discuss the first results of this preparatory work with students and colleagues, during a " lesson zero", open to the entire community of the University of Trento.

References

Mensah, J. (2019). Sustainable development: Meaning, history, principles, pillars, and implications for human action: Literature review. *Cogent Social Sciences*, 5: 1653531. https://doi.org/10.1080/23311886.2019.1653531

Ninno Muniz, R.; Millar, M.; Tavares da Costa Junior, C.; Gouvea Buratto, W.; Nied, A.; Villarrubia Gonzales, G. (2023). *Sustainability*, 15: 14049. https://doi.org/10.3390/

Plail, M., (2024). Sustainability for all. *Cell Reports Sustainability*, 1: 100016. https://doi.org/10.1016/j.crsus.2024.100016

Schneider, F.; Klay, A.; Zimmermann, A.B.; Buser, T.; Ingalls, M.; Messerli, P. (2019). How can Science support the 2030 Agenda for Sustainable Development? Four tasks to tackle the normative dimension of sustainability. *Sustainability Sciences*, 14: 1593-1604. https://doi.org/10.1007/s11625-019-00675-y

United Nations (2015). *Transforming our world: the 2030 Agenda for Sustainable Development* A/RES/70/1 https://documents.un.org/doc/undoc/gen/n15/291/89/pdf/n1529189.pdf accessed on 23 Jan 2025

University of Trento (2025a) https://www.unitn.it/en/ateneo/1694/history-of-the-university accessed on 21 Jan 2025

University of Trento (2025b) https://www.unitn.it/en/ateneo/75604/sustainability-unitrento-sostenibile accessed on 21 Jan 2025

Vogt, M. & Weber, C. (2019). Current challenges to the concept of sustainability. *Global Sustainability*, 2, e4, 1-6. doi:10.1017/sus.2019.1

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Adapting technical higher education to labor market dynamics in the context of Romania's reindustrialization

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Abstract

Our research aims to analyze the correlation between the situation of technical higher education in Romania and the labor market requirements, in the context in which reindustrialization policies are being promoted at the European and national levels. Technical universities in Romania are not keeping up with the needs of the labor market. There is a need for an educational program adjusted to the requirements of the labor market and an educational system that capitalizes on practical skills so that future engineers can innovate and provide solutions to the challenges of today's industry. The results show that, although Romania has a high share of engineering graduates, above the European average, the continuously decreasing trajectory of the working-age population in the economy and a high emigration rate affect the labor market balance. The implications of these facts for Romania's future economic growth are briefly discussed.

Keywords: *Engineering; students and graduates; reindustrialization; Romania.*

1. Introduction

The European Commission has often made clear that new skills are needed in the labor market for a sustainable and resilient economy. All measures taken to decarbonize the economy and reduce energy consumption, efficient use of natural resources through effective strategies, protect ecosystems and biodiversity, etc., require jobs that combine cross-cutting skills with specific skill sets. Most green skills and green jobs are in the fields of engineering, science, and technology, as well as management and monitoring. (European Parliament, 2020). In this respect, Europe's higher education institutions are playing an increasingly important role by accelerating the dissemination of research results and stimulating collaboration and partnerships with businesses. Universities and industry can develop symbiotic relationships (Figure 1), provided that their expectations are complementary: tertiary graduates are absorbed by industry, and research in universities is used by industry and transformed into products and services.

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Numerous examples show that the industry would like graduates whose skill sets align with the requirements of today's economy. To achieve this goal, firms fund concentrated research in universities and support the establishment of new laboratories, which identify new research topics (Brito et al., 2017). In this context, Romania, like many other former communist countries, needs to adapt the structure and offer of technical university education to correspond to the new trends and ensure a qualified and competent workforce to support the many projects currently underway through European funding programs.

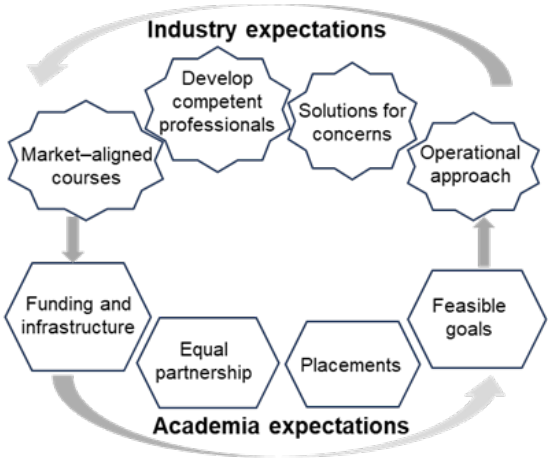


Figure 1. Relationship between industry and academia. Source: adapted from Gann et al. (2018)

The theoretical ground of this investigation intersects two research fields. The first one includes studies related to the situation of higher education, especially technical education. Romania is currently facing a decline in the number of students choosing to become engineers (Dobrescu & Radu, 2015; Curaj, Salmi and Hâj, 2022). The situation is the complete opposite of the communist period, when many young people chose to study engineering (Rădulescu, 2006). During the communist years, the massive industrialization of the country made engineering the most sought-after profession. Admission to the country's technical universities was very strict and the authorities supervised and encouraged only the best students to enter. Whether in the machine-building or petrochemical industries, the engineering profession came with social prestige and high incomes. After the 1989 Revolution, economic and social changes affected the demand for engineers in society. Most of the country's industrial platforms were closed or significantly downsized, so jobs in this field, including those for graduates of higher technical education, declined significantly (Ministry of Education, 2023). The second direction is offered by the new interest in reindustrialization and sustainable economy. The current trend of reindustrialization, manifested throughout Europe and supported by numerous investments (Borgersen & King, 2016), is reflected in a need for engineers in all fields of activity (Capello & Cerisola, 2023; Popescu et al, 2024). In Romania, there is an estimated shortage of around

500000 engineers (Panorama, 2023). To be able to develop products with high added value, there is a need for people with adequate technical qualifications in all the fields in which such products are made - electronics, electrical, telecommunications, fine mechanics, and the auto industry. Starting from these premises, the main objective of this article is to highlight, present and discuss the correlation between the development of higher technical education and the industrial development of Romania, in the current context of European policies and provisions. The analysis of indicators such as the share of students and graduates in engineering compared to other fields and the determination of deviations from the EU average, the identification of the determining factors of the reduction of young people's interest in engineering, the formulation of practical recommendations for all stakeholders completes the objectives of our study. The paper's structure is presented as follows: after section 1 (introduction and review of the literature), section 2 presents the methods and data sources used to achieve the previously mentioned objectives. Section 3 presents and synthesizes the study's results and shows to what extent the results obtained validate the working hypothesis. In the last section, we formulate the conclusions of the study and provide practical guidelines for decision-making in this sector of activity.

2. Data and Methodology

The statistical data used in this paper were taken from the National Institute of Statistics of Romania, as well as from Eurostat, both platforms representing a gateway for downloading data sets relevant to the topic addressed. To complete the information, reports and studies published by the Ministry of Industry, the National Bank of Romania, and the Ministry of Education, as well as articles published in the specialized economic press were consulted. As methods used, we mention: quantitative analysis of statistical data and their primary processing by using programs such as Excel to produce descriptive statistics; comparative analysis of Romania's values with the EU average or with the values recorded by other European countries; production of graphs for a better visualization of the disparities between the indicators used.

3. Results and Discussion

3.1. Evolution of the number of engineering students and graduates in Romania and the European Union.

An analysis of Eurostat (2022) shows that almost a quarter (24.7%) of graduates have turned to business, administration, or law degrees (Figure 2), followed by engineering, manufacturing and construction (14.7%) and health and well-being (14.1%). The same trend is followed by graduates from Romania: most graduates have followed business (26.8%), while engineering,

production – construction it is also highly appreciated (16.8% in Romania, 2.1% above the EU average).

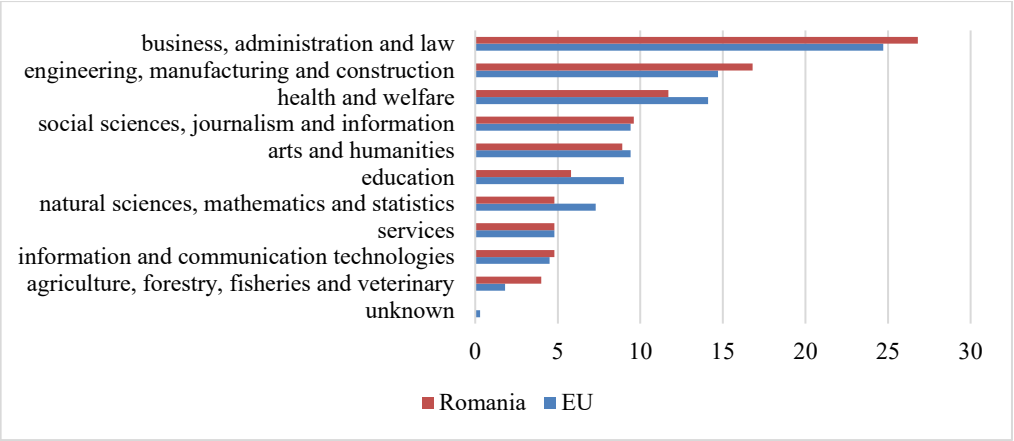


Figure 2. Distribution of tertiary education graduates by broad field of education in Romania and the European Union, 2022. Data source: Eurostat.

The engineering field has seen a decline in interest among young people as computer and communications technology has become increasingly attractive. When opting for their field of study, many technically inclined young people gave up studying civil engineering (considered more difficult). They have turned massively to IT, a sector that also benefits from many tax breaks, a situation not only in Romania but also in other European countries such as Finland, Estonia, Ireland, etc. (Figure 3).

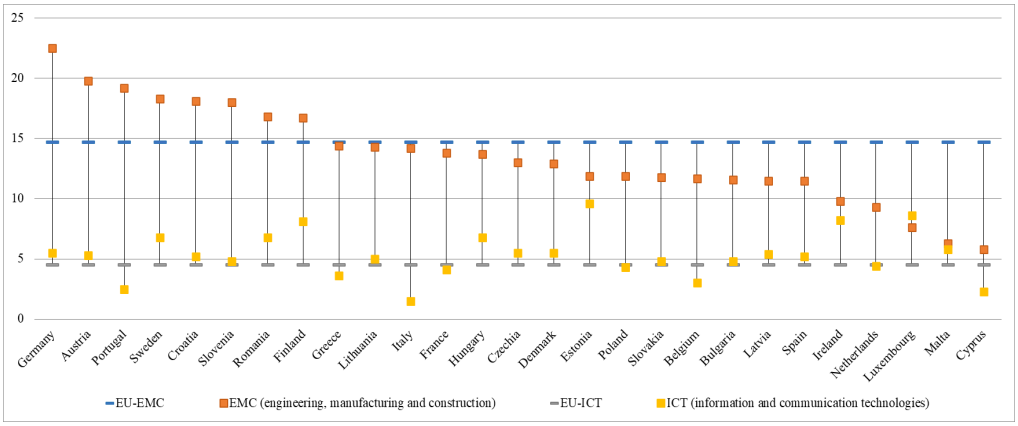


Figure 3. Distribution of tertiary education graduates in engineering/manufacturing/construction and information/communication technologies, 2022 (%). Data source: Eurostat.

After a maximum of almost 22% in 2015, the share of engineering students has continued to decline in recent years in Romania, with values below 20% (National Institute of Statistics). Among the causes that have led to the reduction in the number of engineering students, we mention the migration of young people to universities outside Romania (especially to Western Europe), the decrease in the school population, and the increase in the dropout rate during university studies. For example, in 2024, at the Polytechnic University of Bucharest, the largest technical university in the country, 9,000 students were admitted in their first year. Between 30 and 35% of them don't finish college, according to estimates (cronicile.cursdeguvernare.ro, 2024). So that leaves 6,000 students who complete their studies. Of these, around 15% go abroad and work there, leaving less than 5,000 graduates in the country, far less than the demand in the labor market.

An estimate by the rectors of Romania's technical universities (confirmed by the analysis of recruitment firms) (cronicile.cursdeguvernare.ro, 2024, p.68) shows that in the next decade, Romania will need about. 500,000 engineers. This would mean more than a doubling of the number of places in technical universities, taking into account that school drop-outs reduce the annual number of graduates to less than 20,000. The need for engineers became visible with the establishment of research centers for foreign companies. The problem of a highly qualified labor force has become visible in recent years after many of the companies that used to do only production in Romania have set up research departments. As long as multinational companies in the industry focused strictly on production in Romania, the shortage of engineers was not very visible. In recent years, many companies have partially moved their research divisions from other countries or have opened research centers in Romania, so there is still a need for specialists. Basically, since then, the problem of highly skilled labor has become very visible.

3.2. Advantages of the engineering profession in Romania today.

Engineering is one of the most promising fields of employment. From civil engineering to mechanical and electrical engineering, the demand for specialists has grown considerably. Romanian engineers have access to opportunities in both the local and international markets. Technical specializations not only provide secure jobs but also support the economy through complex infrastructure initiatives, technological innovations and green solutions. The engineering sector continues to be one of the most promising and stable sectors in the Romanian labor market, with an average of 10% of all jobs available every month and an annual expansion in the number of vacancies in this sector. This stability makes it tempting for candidates looking for a clearly defined career with varied opportunities and competitive salaries. According to data provided by the National Institute of Statistics, net salaries in this sector can exceed €2000/month, depending on specialization and experience. Flexible and responsive engineering programs are needed to cope with rapid technological progress. Their modernization is urgent in Romania due to innovation lags and skills shortages. Involving industry professionals in co-

designing and delivering relevant programs requires higher education institutions to form long-term links to facilitate the inclusion of students in companies and issue constant feedback to academia to increase the quality of programs. A study on the employability of higher education graduates in Romania conducted in 2021 (Deaconu et al., 2022) shows that the highest employment rate during their studies is recorded among those who majored in the fields of Engineering Sciences (63.9%), Social Sciences (63.7%) or Mathematics and Natural Sciences (61.2%). If we compare the generation of graduates in 2016 with the generation of graduates in 2020, we observe that in the field of engineering, the employment rate during their studies increased from 61.5% (2016) to 64.8% (2020). According to the same study, graduates with higher earnings are also those with higher job security. The most job-secure graduates are those in Information and Communication Technology (ICT) (94.6%) and Engineering, Manufacturing and Construction (77.5%).

3.3. Reindustrializing Romania

Romania's economy has grown steadily since 2007 (the year of joining the European Union), mainly based on the positive contribution of consumption, closely followed by investment. Romania's economic structure has changed substantially over the last 20 years, with agriculture now accounting for less than 5% of GDP, while the share of industry has remained high at over 20%. The services sector is the most strongly converging with the European economy, contributing about 60% of the national GDP. In terms of the employed population, Romania's industrial sector has a similar share to the Central and Eastern European countries, but is substantially higher compared to the EU average. However, one in five employed persons still works in the agricultural sector (Figure 4). This human capital, which is still an undeniable asset to the Romanian economy, is confronted with a lack of qualified employees, especially in the industrial sector.

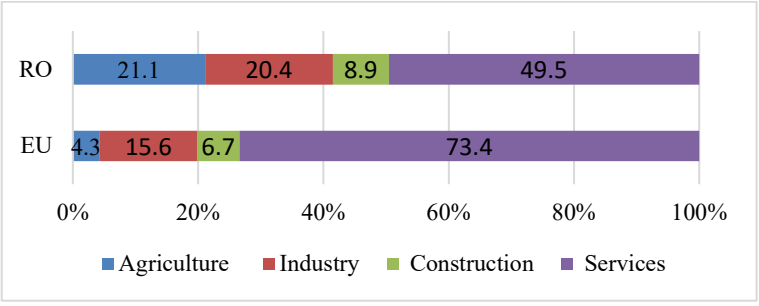


Figure 4. Share of persons employed by economic sectors (% of total), 2022. Data source: Eurostat.

Despite its macroeconomic performance, the labor market suffers from several structural shortcomings, with skills mismatches being among the most important. Romania needs to align labor force skills and labor market demand, especially in science, engineering, and technology.

This leads to underemployment, over-skilling, and skills shortages in sectors characterized by medium and high technology. Romania's manufacturing sector totaled 79,152 active enterprises in 2022 (Eurostat), up 1.5% from 2021, of which almost 78,000 were in manufacturing. In total, 1,100,669 people were employed in industry, down 3.5% from the previous year, accounting for 23.5% of those employed in the whole economy. The number of enterprises has steadily increased in recent years in most sectors, but the low- and medium-technology industrial sectors (food, textiles, clothing and footwear, wood products and furniture) account for more than 60% of the total number of enterprises and about 44% of the total number of employees (Romania's Industrial Strategy 2025 - 2030). European and national industrial development strategies cite research and development as one of the key factors for boosting economic competitiveness, alongside innovation and technological development. Ambitious targets for a green and digital industrial transition will put unprecedented pressure on all industrial sectors, not just those that have been substantially affected in the last three years, such as energy-intensive industries or industries dependent on electrical, electronic, automation, or strategic raw materials. The European Union has already devised plans to reduce these strategic dependencies, coupled with substantial resources directed toward research, innovation and technological development. In this context, the Ministry of Finance has developed the National Program for the Support of Large Industries, a program that will provide €1 billion in funding between 2025 and 2030 to support strategic investments to promote innovation in automation and the use of green technologies. This is one of the most important initiatives in the last 35 years for the revitalization and modernization of the Romanian manufacturing industry. In addition, to become competitive, the Romanian industry needs to develop the country's raw material processing branches, which requires a partnership between economic actors and authorities in the fields of economy, finance, energy, and agriculture. As the EU has readjusted its entire strategy and is trying to re-profile itself, Romania also needs to pay special attention to re-industrialization. Thanks to the European and international context, Romania has great potential at the moment, especially in the energy, aeronautics, and steel industries.

4. Conclusions

On the whole, Romania has a good situation in terms of the number of graduates in technical studies to the number of inhabitants, but not enough to meet the demands of an industry in search of highly skilled labor. This position could be improved in the future by the increase in the number of places in engineering faculties, but also by the change in the mentality towards engineering, an increasingly sought-after and better-paid occupation right from the start of a career. The current context is very favorable to these measures because, for the first time in the last 35 years, a major plan for reindustrialization has been announced in Romania, aimed at supporting industrial production activities with components that address both large industries, for technological renewal, but also components that are related to small industry or

manufacturing. At the same time, the extent to which human resources are qualified for the projected industrial development must be established. Some of the measures that need to be taken are: expansion of dual vocational and technical education, development of skills in science, technology, engineering and mathematics, teacher training, access to educational resources, laboratories and equipment, partnerships between technology companies and universities, creation of well-paid jobs and encouragement of work by prolonging working life.

References

Borgersen, T.-A., & King, R. M. (2016). Industrial structure and jobless growth in transition economies. *Post-communist Economies*, 28(4), 520–536. https://doi.org/ 10.1080/14631377.2016.1237037

Brito, C.D., Ciampi, M.M., Vasconcelos, R.M., Amaral, L., Santos, H.M., & Barros, V.F. (2017). Rethinking engineering education. *2017 IEEEE Frontiers in Education Conference (FIE), 1-5*.

Cronicile Curs de guvernare (2024), 77, p.70. https://cronicile.cursdeguvernare.ro/produse/no-77-toamna-2024/

Capello, R., & Cerisola, S. (2023). Regional reindustrialization patterns and productivity growth in Europe. *Regional Studies*, 57(1), 1–12. https://doi.org/10.1080/ 00343404.2022.2050894

Curaj, A.; Salmi, J.; Mihai Hâj, C.M. (2022). *Higher Education in Romania: Overcoming Challenges and Embracing Opportunities*. Springer. https://doi.org/10.1007/978-3-030-94496-4

Deaconu, Ș.M.; Hâj, C.M.; Bunescu, L.; Ciotlăuș, S.; Duma, I.; Dunca, L.I.; Lucheș, D.; Păun, M.; Simion, A.; Zamfirache, I.; Zamfirescu, R.I. (2022) - *Studiu privind angajabilitatea absolvenților de învățământ superior din România (2021)*, UEFISCDI Publishing House, 147 p., Online, ISBN: 978-606-95508-6-1.

Dobrescu, P. & Radu, L. (2015). Technical and Vocational Education in the Context of Reindustrialization. The Case of Romania. In *1st International Conference on Higher Education Advances, (HEAd'15)*. València, 24-26 June 2015. DOI: http://dx.doi.org/10.4995/HEAd15.2015.422

European Parliament (2020). *The future of tertiary education in Europe*. ISBN: 978-92-846-7167-0, DOI:10.2861/805265

Eurostat. https://ec.europa.eu/eurostat/statistics-explained/index

Gann, D.; Montresor, F.; Eisenberg, J. (2018). *3 ways to nurture collaboration between universities and industry*. World Economic Forum.

Ministry of Education, Report on the State of Higher Education in Romania, 2022 – 2023. https://www.edu.ro/sites/default/files/_fi%C8%99iere/Minister/2023/

Ministry of Economy. Romania's Industrial Strategy 2023-2027. https://economie.gov.ro/wp-content/uploads/2023/12/Proiect-de-Strategie-Industriala-a-Romaniei-2023-2027.pdf

National Institute of Statistics (INS), http://statistici.insse.ro:8077/tempo-online/

Panorama 2023. https://panorama.ro/infrastructura-egis-constructii-ingineri-romania

Popescu, C.; Covrig, M.; Mihaela Persu, M. (2024). Encounters of technology and space in the context of reindustrialization (Romania). *Applied Geography* 170 (2024) 103361.

Rădulescu, C.D. (2006) Învăţământul Românesc 1948–1989 – Între Derivă Şi Recuperare Instituţional - funcţională. *Calitatea Vieţii*, XVII, 3–4, 307–318.

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Graduate Career Tracking – a Case Study of a Faculty of Management in Poland

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Abstract

The aim of the article was to present a case study of graduate employability assessment of a faculty of management in Poland. The literature review showed that the main problem universities encounter while trying to track down the professional careers of their graduates concerns difficulties in contacting their alumni. It may be partially overcome by employing social media. The findings from the case study are in line with those of previous studies. The Faculty's decision-makers managed to increase the number of responses to their survey by using LinkedIn and Facebook. They collected valuable information on both the employability of their graduates, who, in most cases, progressed in their IT-related careers upon graduation, and the suggested changes in the curricula, e.g. organizing project management certification courses. The findings of the study may be useful to university decision-makers in their attempts to build efficient systems of graduate employability assessment systems.

Keywords: *employability; graduate tracking; graduate surveys; higher education.*

1. Introduction

Higher education in Poland has undergone a number of significant changes since the political transformation in 1989, when the centrally planned economy was replaced by a market economy. And just like in the entire Polish economy, in which before 1989 only 3% of people (outside agriculture) were employed in the private sector whereas the majority worked in large or very large state-owned enterprises, public universities dominated the sphere of higher education (religious schools were among the few exceptions). Studies, though tuition-free, were quite elitist - in the 1980s, enrollment rates oscillated around 10-12%. After 1989, there was a rapid development of non-public universities (the first one was established in 1991), and public universities began to offer some classes (mainly part-time and evening studies) in a paid mode

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(Cieciora, 2014). The number of students increased from 400 thousand in 1991 to 1,223.6 thousand in 2023 (Statistics Poland, 2023), and the enrollment rates exceeded 70%. As a result of globalization processes and Poland's accession to the Bologna Process in 1999, Polish higher education sector has also become internationalized. As a result of these changes, a heated discussion regarding the importance of academic education for the work environment also started to develop in the academic and business world. While some of the academic community took the position that the main task of universities is to focus on scientific work, especially basic research, there were also voices that one of the most important duties of universities today is to provide the economy with highly qualified human capital. In other words, when planning and improving study curricula and teaching methods, academic decision-makers should take into account the requirements of the labor market. Previously, this was not given much attention. Firstly, because in the times of the centrally planned economy there was almost no registered unemployment, and secondly, because with low enrollment rates, university graduates had a privileged position on the labor market. The massification of higher education and the development of a competitive market economy changed this approach. Researchers and higher education authorities began to analyze the requirements of labor markets and the employability of graduates, and, relatively recently, the Ministry of Higher Education and individual universities started tracking the career paths of graduates (Cieciora et al., 2021). The Ministry of Higher Education developed and has been using since 2015 The Polish Graduate Tracking System called ELA (an acronym in Polish standing for the Economic Fates of Graduates). ELA obtains and processes data from the POL-on system of the Ministry and administrative records of ZUS (an acronym in Polish standing for Social Insurance Institution). On average, almost 92% of graduates of individual fields of study are registered in ZUS. ELA creates reports for cohorts consisting of at least 10 graduates. The data can be easily linked and merged thanks to the use of the national identification number PESEL (an acronym in Polish standing for the Universal Electronic System for Registration of the Population) as an ID in both of the centralized databases (Jasiński et al., 2017; Rocki, 2024b, 2024a). Stakeholders – universities, employers and individual people can access the data concerning average salaries of graduates of all types and modes of studies, faculties, universities in a chosen year of graduation for free. The advantages of ELA are its objectivity, reliability, standardization, and country-wide scope. However, the data is aggregated and the system, also due to data protection legislation, cannot reveal information concerning individual graduates. Universities, therefore, undertake research on their own, regarding specific groups of their graduates, usually trying to obtain more detailed data. However, there are no standardization or centrally developed procedures for this type of research and universities do not have the necessary tools to obtain full, reliable, and in-depth information on the employability of their alumni. Nevertheless, some of them try to collect and analyze such information in order to improve the quality and attractiveness of their educational offer. The purpose of this article is to present a case study – an attempt to monitor the career progress of graduates of master's studies conducted by the management faculty of one of the

leading non-public universities in Warsaw, Poland. First, a concise literature review on the ways of tracking down graduate employability will be presented. Next, a survey-based attempt to contact the alumni and obtain feedback on the impact that the studies had on their professional careers will be described. Finally, the conclusions drawn from the graduate employability tracking down project will be presented and discussed.

2. An overview of literature review on tracking down graduate employability by individual higher education institutions

Numerous studies have attempted to analyze the issue of tracking down employability of graduates by their *Alma Maters*. Several lines of evidence show that universities resort mainly to graduate outcome surveys (Acero et al., 2023; Hojda et al., 2022; Pentang et al., 2022; Pico-Saltos et al., 2021), sometimes combining the information obtained from the surveys with data from country-central systems (Balogh & Sipos, 2020; Gatt et al., 2021; Tseng et al., 2024). The main challenge connected with using this tool are low response rates in surveys, still decreasing in the course of time (Connell et al., 2023). Hynninnen (2022) made an interesting observation that the response rates may depend on the progress of the professional career of the respondents – the less successful ones are less likely to complete the surveys (Hynninen et al., 2022). Sometimes mere tracking down graduates may pose a challenge in case they do not answer emails – one may then consider using social media such as Facebook or LinkedIn to try and find the missing alumni (Jackson & Bridgstock, 2018; Woolley et al., 2015).

3. Case study – measuring the employability of graduates of second-cycle studies at the Faculty of Information Management at Polish-Japanese Academy of Information Technology

3.1. Faculty of Information Management – general description

Polish-Japanese Academy (formerly School) of Information Technology (PJAIT) is a non-public university. It was founded in 1994 in Warsaw and has been developing dynamically since then. Its oldest and largest faculty is the Faculty of Computer Science. The Faculty of Information Management was established in 2003 and is currently the third largest faculty at PJAIT (next to the Faculty of Computer Science and the New Media Art). The number of students at the Faculty has been systematically increasing - from around 40 in 2004 to 742 in 2024. The Faculty offers studies combining education in the fields of computer science and management. First degree (Engineer's) studies last 7 semesters (full-time studies) or eight semesters (part-time studies). Since 2020, the Faculty has also been running second degree (Master's) studies (3-semester full-time studies and 4-semester part-time studies), whose graduates have a choice of two specializations: the more technical Architecture of Information

Systems and the more business-oriented Business Analysis and Application of Big Data Tools. The first graduates of the Master's studies graduated from the Academy in 2022.

3.2. Graduate Survey 2023

In 2023, the Faculty authorities made the first attempt to evaluate the learning outcomes of graduates of the Master's studies. They already had some experience with analyzing the employability of graduates of the Engineer's studies – the last such analysis was conducted in 2020. It was based on data from the ELA system and information obtained from a survey sent to all graduates of the Faculty. One of the conclusions drawn from conducting the first graduate employability study was that the survey cannot be too long (which was a mistake that was made when creating the first survey, the length of which was criticized by respondents). The new modernized and updated survey, created as a Google Form, contained fewer questions than the previous one – e.g. a long and detailed section devoted to the assessment of the value of all individual courses was replaced with two general questions concerning the evaluation of education of the use of IT tools in management (such as programming, Cloud Computing solutions, specialization subjects) and education regarding "soft", "non-engineering" aspects of management (such as negotiations, public speaking, Agile project management methodologies or creating start-ups). The first, metric part of the survey included questions about the specialization, mode of study, gender, employment status (employed or unemployed), industry and size of the company employing the graduate and the graduate's current position. Optionally, graduates could also provide the information on the amount of their earnings and the name of the company. The first part ended with a question about the perceived impact of the studies on the professional career of the respondent. The second part of the survey focused on evaluating the quality of the studies. In addition to the aforementioned question about assessing the "hard" and "soft" knowledge and skills acquired during the studies, respondents were asked to assess the substantive knowledge and commitment to work of the teachers, the organization of the studies (schedule, forms of checking the learning outcomes), the equipment of the rooms and laboratories and the quality of the software. Finally, respondents were asked whether they would choose the same studies again if they could turn back time, whether they would recommend introducing any changes to the study curricula, and whether they see a need to introduce any new studies (e.g. postgraduate studies). The most important results of the survey will be presented in the subsection below.

As far as other data taken into consideration in the learning outcomes analysis are concerned, the Faculty authorities checked the data from the ELA system. The information they derived from the ELA register was quite positive – the median wage of the graduates was 1,06, i.e. higher than the average in their region, none of them was unemployed and the average job search span was only 0,78 month (*ELA*, n.d.). They did not, however, try to include the GPA (grade

point average) variable in the analysis as all the graduates achieved a very high GPA (above 4,5 in the 2,0 to 5,0 scale).

3.2.1. The course of the Graduate Survey 2023 project

The survey was sent to all 68 graduates of the Master's studies, to their school email addresses (graduates can also use them after graduation). In the first week, 8 people completed the survey. Due to the low response, the Dean's office (including the Dean herself) tried to contact the remaining graduates by searching for them on social media: Facebook and LinkedIn. They did not manage to identify the social media accounts of 30 graduates. Of the remaining 30, 13 did not react to the messages sent to them via social media and 17 responded and completed the survey (sending responses from private, not the Academy's addresses). Altogether, the survey was completed by 25 people - 14 men and 11 women. 14 respondents graduated from the IT Systems Architecture specialization, and 11 finished the Business Analysis and Application of Big Data Tools specialization.

3.2.2. 2023 Graduate Survey Results

100% of respondents were employed, and all of them were employed in either IT companies, or IT-related departments in various industries (banking, energy, electronics production, pharmaceuticals, media), in positions related to IT creation or management, such as process analyst, system architect, full-stack developer, production engineer, project manager, software tester, Product Owner, Senior Technician, IT administrator/DevOps, junior project manager, or production engineer. 80% of respondents worked in large companies (over 250 employees), 12% in small companies (10-49 employees), and 8% in medium-sized companies (10-249 employees). 4 people provided information on their earnings – they significantly exceeded (over three times) the national average salary in Poland. When asked whether completing Master's studies at the Information Management Faculty had an impact on their professional career, 76% of the interviewees responded positively, indicating that they received a pay rise, were promoted, or changed jobs for better ones. 24% of respondents stated that it was too early for them to make such an assessment. When it comes to assessing the quality of education in PJAIT, 64% of respondents highly rated the substantive knowledge regarding the use of IT tools in management and 68% highly rated the substantive knowledge regarding "soft", "non-engineering" aspects of management. Individual critical remarks concerned individual teachers and the excessive emphasis on teaching Scrum (which was present in several courses), while positive comments emphasized the focus on the practical knowledge and skills. 68% of respondents highly rated the organization of studies and the technical equipment of the Academy. Full-time students in their comments highly valued the organization of classes in the afternoon and the evening, thanks to which they could combine professional work with studies. They also praised good contact with the faculty authorities, high competences of staff and a friendly, individual approach to students. Suggestions for improvement concerned the

installation of air conditioning in all rooms (not only in selected laboratories) and the possibility of introducing a permanent hybrid form of studies, in which part of the classes would be held remotely (studies were conducted remotely only during the COVID-19 pandemic), the organization of a ceremonial graduation and a meeting of alumni after a few years after graduation. Respondents also recommended adding the topics of AI application in business and law in new technologies to the curricula and organizing some certification courses (e.g. in Agile methodologies, PRINCE2, PMI).

4. Conclusions

The main goal of the research was to discuss a case study of graduate employability tracking conducted by an IT-oriented management faculty of a non-public university in Warsaw. Consistent with the literature, this research found that the main challenge of such a project is to try and contact the alumni as most of them do not check their school emails after graduation. It also confirms the usefulness of resorting to social media, especially LinkedIn and Facebook to overcome the problem and find the missing graduates.

The Faculty of Management Information decision-makers carefully analyzed the survey results. They organized a meeting of the Program Council - a body which includes, apart from the Dean and two Vice-Deans, representatives of the Faculty's students and representatives of employers. The survey results were discussed. Students agreed with the suggestions of their senior colleagues regarding the correction of the substantive content of the courses, e.g., concerning the amount of time devoted to the Scrum component. They also suggested changing the order of some courses. Employers offered their suggestions regarding the inclusion of AI topics in most of the courses taught. Most of the recommendations were accepted by the Dean and the Vice Deans of the Faculty. On the whole, they were satisfied with the results of the learning outcomes study, as the information derived both from the ELA system and the graduate survey showed that the Master's studies educational offer of the Faculty did match the requirements of the demanding labor market and the graduates could easily find attractive, well-paid jobs, in line with their education. They also highly valued the constructive critical remarks that showed the room for improvement. The Dean and the Vice-Deans also decided to create and implement the procedure of obtaining written consents from students to contact them after graduation with the use of their private emails on the day of their diploma defense examination to facilitate the future graduate employability tracking process. Finally, they agreed to start working on building a prototype of a computer-assisted employability tracking tool and organizing an alumni club.

Despite the interesting findings and the practical implications, this study is not without limitations. The main weakness is the relatively small sample size of respondents and the scope of a case study. Further studies are needed to explore the topic of finding efficient ways of

increasing survey response rates and combining data on employability derived from different sources to obtain comprehensive and reliable information on the educational outcomes.

In spite of its limitations, the authors believe that the study adds to the growing body of knowledge on tracking down graduate employability and that its findings may be of interest to higher education decision-makers in their attempts to build efficient graduate employability tracking systems.

References

Acero, J. F. C., Velasquez, O. C., Apaza, F. B. C., Callata, L. V., & Lloclla, H. S. (2023). Current Situation of the Monitoring of Graduates and Labor Insertion in the Electrical Mechanical Engineering Career. In: Y. Iano, O. Saotome, G. L. Kemper Vásquez, C. Cotrim Pezzuto, R. Arthur, & G. Gomes De Oliveira (Eds.), *Proceedings of the 7th Brazilian Technology Symposium (BTSym'21)* (Vol. 207, pp. 561–568). Springer International Publishing. https://doi.org/10.1007/978-3-031-04435-9_59

Balogh, G., & Sipos, N. (2020). Is it worth for bachelor graduates to diversify study programme for master level? *International Journal of Educational Management*, *34*(9), 1387–1401. https://doi.org/10.1108/IJEM-01-2020-0020

Cieciora, M. (2014). Changes in the system of higher education in Poland – a historical perspective and present challenges. In: *Human factors of a global society: A system of systems perspective.* (1st ed., pp. 875–883). CRC Press.

Cieciora, M., Pietrzak, P., & Gago, P. (2021). University graduates' skills-and-employability evaluation in Poland—A case study of a faculty of management in Warsaw. *International Journal of Innovation and Learning*, *30*(1), 1. https://doi.org/10.1504/IJIL.2021.116565

Connell, C. J. W., Salkeld, A. J., Wells, C., Verstappen, A. C., Poole, P., Wilkinson, T. J., & Bagg, W. (2023). Sample representativeness and influence of attrition on longitudinal data collected as part of a national medical career tracking project. *BMC Medical Education*, *23*(1), 532. https://doi.org/10.1186/s12909-023-04472-1

ELA. (n.d.). Retrieved 24 January 2025, from https://ela.nauka.gov.pl/.

Gatt, S., Hayek, L., & Huemer, C. (2021). Two sides of the same coin: Political science as professional and civic education. *European Political Science*, *20*(3), 440–452. https://doi.org/10.1057/s41304-020-00280-z

Hojda, P., Roszkowska, S., & Trojak, M. (2022). What drives labour market success? Empirical analysis of university graduates in Poland. *Education + Training*, *64*(5), 619–641. https://doi.org/10.1108/ET-09-2021-0354

Hynninen, T., Knutas, A., & Hujala, M. (2022). What can we learn from recommendations of early-career engineers? Assessing computing and software engineering education using a career monitoring survey. *Proceedings of the 2022 Conference on United Kingdom & Ireland Computing Education Research*, 1–7. https://doi.org/10.1145/3555009.3555017

Jackson, D., & Bridgstock, R. (2018). Evidencing student success in the contemporary world-of-work: Renewing our thinking. *Higher Education Research & Development*, *37*(5), 984–998. https://doi.org/10.1080/07294360.2018.1469603

Jasiński, M., Bożykowski, M., Chłoń-Domińczak, A., Zając, T., & Żołtak, M. (2017). Who gets a job after graduation? Factors affecting the early career employment chances of higher education graduates in Poland. *Edukacja*, *143*(4). https://doi.org/10.24131/3724.170402

Pentang, J. T., Perez, D. R., Cuanan, K. H., Recla, M. B., Dacanay, R. T., Bober, R. M., Dela Cruz, C. E., Egger, S. P., Herrera, R. L., Illescas, C. M., Salmo, J. M., Bucad, Jr., M. L., Agasa, J. V., & Abaca, N. A. (2022). Tracer Study of Teacher Education Graduates of Western Philippines University - Puerto Princesa Campus: Basis for Curriculum Review and Revision. *International Journal of Multidisciplinary: Applied Business and Education Research*, *3*(3), 419–432. https://doi.org/10.11594/ijmaber.03.03.12

Pico-Saltos, R., Bravo-Montero, Lady, Montalván-Burbano, N., Garzás, J., & Redchuk, A. (2021). Career Success in University Graduates: Evidence from an Ecuadorian Study in Los Ríos Province. *Sustainability*, *13*(16), 9337. https://doi.org/10.3390/su13169337

Rocki, M. (2024a). Graduates of non-traditional fields of study on the labour market five years after graduation. *E-Mentor*, *103*(1), 35–44. https://doi.org/10.15219/em103.1645

Rocki, M. (2024b). Ranking szkół wyższych jako predyktor zatrudnialności. *Nauka*, 33–54. https://doi.org/10.24425/nauka.2024.151943

Statistics Poland. (2023). *Higher education and its finances in 2022*. Stat.Gov.Pl. Retrieved from https://stat.gov.pl/en/topics/education/education/higher-education-and-its-finances-in-2022,2,16.html

Tseng, Y.-W., Rowe, F., & Lin, E. S. (2024). An Elon Musk generalist or a specialist? The impacts of interdisciplinary learning on post-graduation outcomes. *Studies in Higher Education*, *49*(4), 782–807. https://doi.org/10.1080/03075079.2023.2252889

Woolley, T., Hays, R., Barnwell, S., Sen Gupta, T., & McCloskey, T. (2015). A successful longitudinal graduate tracking system for monitoring Australian medical school graduate outcomes. *Rural and Remote Health*. https://doi.org/10.22605/RRH3542

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Exploring factors influencing ChatGPT use among students: Evidence from Morocco

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Abstract
This study aims to investigate the key determinants of attitude and intention to use ChatGPT among students in Moroccan universities. Data was collected through a survey of 287 Moroccan respondents and analysed using structural equation modelling. The results revealed that students who perceived ChatGPT as useful ultimately developed a different overall attitude toward the tool compared to those who initially resisted its use. Similarly, students' perceptions of ChatGPT's alignment with academic integrity significantly influenced their attitudes. Interestingly, ethical considerations, religiosity, and digital literacy did not have a statistically significant impact on either attitude or behavioural intention. These findings suggest that perceived usefulness, initial resistance, and concerns about academic integrity are key factors shaping students' overall perceptions and readiness to use ChatGPT among students.

Keywords: *Intention to use; perceived ease of use; perceived credibility, SEM, Morocco.*

1.Introduction

The rapid advancement of artificial intelligence (AI) has significantly influenced the academic landscape, offering students new tools to enhance their academic output and learning experience. One of the most popular tools used by students nowadays is ChatGPT, a language model used to generate text, assist with writing, and answer complex questions. Still, its widespread utilization among students has raised concerns among educators and specialists regarding its impact on academic integrity and the development of independent scholarly skills. In societies where academic achievement is closely tied to social mobility (i.e., Morocco), the use of ChatGPT needs careful examination. In that context, a number of studies have highlighted a growing popularity of ChatGPT in academic settings, with many students reportedly using it to draft assignments and prepare for assessments (Lee & Choi, 2020; Kim & Wong, 2023). These studies have also raised ethical concerns, warning against potential misuse for academic dishonesty (Strzelecki, 2023; Tiwari et al., 2024).

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In the Moroccan context, where academic integrity remains a core value, the unethical use of ChatGPT could pose serious challenges to the educational system. Despite these concerns, there is a notable lack of empirical research exploring how Moroccan students engage with this tool. While global studies have explored various aspects of ChatGPT's use, the cultural, educational, and ethical dimensions specific to Morocco remain underexplored. This ga*p* hinders a comprehensive understanding of the local implications of ChatGPT use in higher education.

The current research paper seeks to address this ga*p* by investigating how Moroccan students use ChatGPT, with a particular focus on the factors influencing their attitude and willingness to adopt the tool. Specifically, it examines the key factors (i.e., perceived usefulness, ease of use, perceived academic integrity, unfair evaluation of students, biases, and ethical values) shaping students' attitudes and intent to use ChatGPT. Furthermore, this research considers the ethical beliefs of students, including the potential moderating role of religiosity. Accordingly, this study addresses the following research questions:

RQ1. What are the determinants of attitudes towards ChatGPT among Moroccan students?
RQ2. How do attitudes towards ChatGPT affect its usage intentions?
RQ3. Does religiosity moderate the link between ChatGPT attitudes and intentions?

2. Literature review

2.1. Theoretical framework

The Unified Theory of Acceptance and Use of Technology (UTAUT) serves as a theoretical framework to understand technology acceptance among students, emphasizing factors like performance expectancy, effort expectancy, and social influence (Venkatesh et al., 2003). In the context of ChatGPT, exploring students' perceptions of its usefulness, ease of use, and resource availability can be used to help students in their assignments and research. Smith & green (2017) emphasises that students are likely to avoid plagiarism if their peers disapprove it. The UTAUT has been widely applied in various educational technology contexts, demonstrating its effectiveness in predicting and explaining user acceptance (Teo, 2011).

2.2. Conceptual Model and hypothesis development

The proposed conceptual model incorporates constructs that have been mainly borrowed from prior literature, and include perceived usefulness, ease of use, perceived academic integrity, unfair evaluation of students, biases, and ethical values. The moderating effect of religiosity in the linkage between attitude and intention to use ChatGPT is also scrutinized.

Based on the Theory of Planned Behavior (Ajzen, 1991), this study hypothesizes that a positive attitude toward ChatGPT significantly predicts an individual's behavioral intention to use it. TPB posits that behavioural intention is influenced by one's attitude toward the behavior, along

with subjective norms and perceived behavioral control. In this context, if users perceive ChatGPT as useful, they are more likely to develop favorable attitudes toward it, which in turn strengthens their intention to use the tool. Therefore, the hypothesis proposes that individuals with more positive attitudes toward ChatGPT will show a higher intention to engage with it.

H1: *Individuals with more positive attitudes toward ChatGPT are more likely to have stronger behavioral intentions to use it.*

ChatGPT resistance refers to the opposition shown by the students towards its use driven by concerns about plagiarism, accuracy and academic integrity (Tiwari et al., 2024). Students can exhibit resistance to using ChatGPT due to uncertainties regarding academic integrity lack of accuracy and fear of plagiarism issues (Zhang and Tur, 2023)). Resistance can also come from the influence of surroundings concerning inaccurate outputs (Ahmed and Sobaih, 2023). Based on the above, we hypothesize that:

H2*. Students' resistance to ChatGPT negatively impacts their Attitude towards using ChatGPT.*

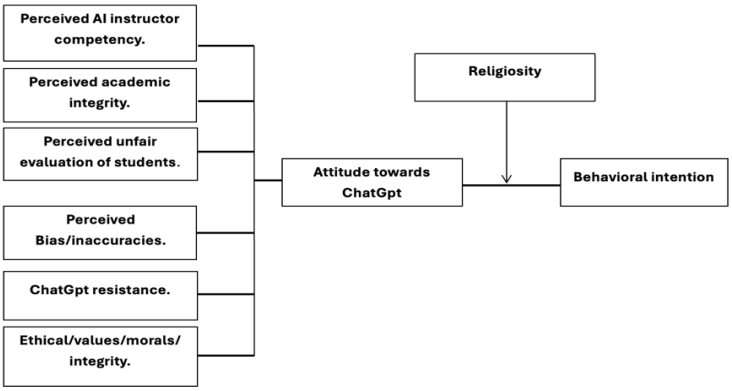


Figure 1 Conceptual model Source (Authors' work)

Ethics reflect the beliefs that can conflict with the use of ChatGPT due to educational integrity concerns (Farhi et al., 2023). Moral values that disagree with ChatGPT's components can direct students to develop negative attitudes regarding utilizing ChatGPT (Lee & Choi, 2020; Martin, 2022). Learners who prioritize ethical considerations in their academic matters may perceive ChatGPT as an immoral tool that compromises educational honesty (Lee & Choi,2023). Hence:

H3*. Students' moral values negatively impact their Attitude towards using ChatGPT.*

Academic integrity is the adherence to academic honesty principles (Bin-Nashwan et al., 2023). Perceiving ChatGPT use as an act of academic dishonesty can be a serious issue impacting students' attitude towards the tool (White & Lee, 2024) . Academic integrity is a fundamental setting in the students' resistance to adopting ChatGPT. It is therefore crucial for students to

understand how to ethically use ChatGPT before integrating it to the academic diaspora. Therefore:

***H4**. Perceived Academic Integrity negatively impact students' Attitude towards using ChatGPT.*

Perceived credibility stands for the extent to which students trust the accuracy and the credibility of the output of the tool, that can influence their willingness to use it in the learning process (Strzelecki, 2023). Perceived credibility of ChatGPT output can impact the student's use of the tool when they observe inaccuracies in the work provided by the tool; leading to not incorporating it in their learning process (Ahmed & Sobaih, 2023). The lack of accuracy can lead to misinformation and confusion resulting in hesitation to adopt ChatGPT, neglecting its potential benefits (Zhang and Tur, 2023). Based on the above, we hypothesize that:

***H5**. Perceived Inaccuracies negatively impact students' Attitudes towards using ChatGPT.*

Instructors' AI competency refers to the level of understanding the educator possesses regarding AI. Instructors understanding of AI can significantly affect the perception of students towards ChatGPT (Smith & Jones, 2023; Brown et al., 2022). If students observe that their instructor is familiar with the tool, they may be encouraged to use it themselves, on the other hand if the instructor is not proficient AI wise, they will fear the instructor disapproval (Smith & Jones, 2023). Hence:

***H6**. Perceived instructors' AI competency negatively impacts students' attitude towards using ChatGPT.*

In academic affairs, the potential of unfair evaluation due to the wide use of ChatGPT during assessments is raising concerns among students (Lee & Choi, 2020; Kim & Wong, 2023; Patel & Singh, 2024; Johnson & Garcia, 2024). Unequal access to ChatGPT and the lack of AI comprehension of the instructor may lead to biased grading without knowing if the work was AI-generated or organic work by the student. These concerns appeal the educational core to implement clear guidelines and AI policies for students' usage to ensure transparency and equitable access chances (Johnson & Garcia, 2024). Students with higher religiosity Hence:

***H7**. Perceived Unfair evaluation of students negatively impacts students' attitude towards using ChatGPT.*

Also:

***H8**. Student religiosity moderates the relationship between attitude toward using ChaGPT and behavioral intent.*

3. Methods

This study used a non-probabilistic sampling approach combining self-selection and snowball sampling due to the exploratory nature and accessibility constraints. A structured questionnaire was used, adapted from validated instruments, and designed to assess constructs using a five-point Likert scale ranging from 'strongly disagree' to 'strongly agree'. Data collection was conducted online, primarily through WhatsApp and social media platforms. The use of Structural Equation Modeling (SEM) for analysis was justified by its ability to simultaneously assess complex relationships between multiple independent and dependent variables, offering strong reliability and validity for model testing in behavioral research. Data collection was conducted over a one-month period, from March 25 to the end of April. A total of 287 participants completed the survey. The responses were assessed for reliability, accuracy, and suitability for hypothesis testing. Given that French is widely spoken in Morocco, the survey was administered in both French and English (Chetioui & Abbar, 2017; Lebdaoui et al., 2021). To ensure linguistic accuracy, a back-translation method was employed to convert the English version into French. The study utilized constructs adapted from established literature (see Appendix), and all variables were measured using a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). Demographic data—including gender, age, city of residence, and education level—were collected at the end of the survey (see Table 1).

4. Results

We used structured equation modeling (SEM) to examine the connections between various variables presented in the conceptual model. Partial Least Squares (PLS) was designated as the appropriate method for this study due to the complexity of relationships among. Our findings demonstrate that the Cronbach's alphas (CA) and composite reliabilities (CR) of all constructs exceed the suggested value of 0.7, indicating acceptable levels of construct reliability; The achieved loading of above 0.7 for all indicators suggests that their reliability has been established. The attainment of convergent validity was established by evaluating the (AVE) for each construct. Our analysis revealed that all constructs had an AVE greater than 0.5, confirming the convergent validity of the proposed conceptual model. The discriminant validity has been assessed through Heterotrait-Monotrait ratio of correlations (HTMT) criterion. It evaluates the extent to which the correlation between two constructs surpasses the correlations between any construct and itself (Chetioui et al., 2023). The 0.9 threshold was not exceeded by any of the HTMT values found (the tables of results are available upon request). Our analysis conveys that the theoretical model can be effectively tested as all constructs have acceptable results in terms of construct reliability, convergent validity, and discriminant validity.

According to Chin (1998), a key indicator for evaluating the structural model is the coefficient of determination (R^2) of the endogenous latent variables. An R^2 value exceeding 0.2 is typically

considered to represent moderate explanatory power. The R^2 of both attitude and intention to use ChatGPT were both above 0.2 and are therefore considered moderate; The findings offer important insights into the factors shaping attitudes toward and behavioral intentions to use ChatGPT. H1 reveals a strong positive relationship between attitude toward ChatGPT and the intention to use it, with a statistically significant beta coefficient of 0.556 ($p < 0.001$). This underscores the critical role of fostering favorable perceptions of ChatGPT to enhance user engagement. In contrast, H2 indicates a significant negative effect of resistance to ChatGPT on user attitudes ($\beta = -0.253$, $p < 0.001$), suggesting that hesitancy—possibly due to unfamiliarity or fears of technological displacement—can erode positive perceptions. This highlights the importance of targeted educational initiatives to reduce resistance and increase acceptance. H3 tested the influence of ethical values, moral principles, or integrity on attitudes toward ChatGPT but found no significant effect ($\beta = 0.018$, $p = 0.734$). This suggests that these factors may not be central concerns for users, potentially due to widespread acceptance of AI technologies or a lack of awareness of their ethical implications. As such, ethical considerations may not significantly influence ChatGPT usage decisions among students. Conversely, H4 shows that perceived academic integrity has a strong positive effect on attitudes ($\beta = 0.531$, $p < 0.001$), indicating that students' confidence in ChatGPT's ability to support academic standards contributes meaningfully to their acceptance of the technology. However, H5 finds that concerns about bias or inaccuracies in ChatGPT do not significantly impact attitudes ($\beta = 0.079$, $p = 0.177$), suggesting either limited awareness of these issues or a lower level of concern among users. Similarly, H6 demonstrates that perceived AI competency of instructors does not significantly influence student attitudes toward ChatGPT ($\beta = 0.033$, $p = 0.586$), implying that students form their views independently of their instructors' technical proficiency. H7 reveals that concerns over unfair student evaluations involving ChatGPT can negatively affect attitudes ($\beta = 0.149$, $p = 0.010$). This highlights the need for transparent policies regarding the use of AI in assessment to preserve trust and foster positive perceptions. Finally, H8 suggests a marginally significant moderating effect of religiosity on the relationship between attitude and intention to use ChatGPT ($\beta = 0.101$, $p = 0.063$), indicating that religious beliefs may subtly shape openness or resistance to AI, although the effect is not pronounced.

Table 1 Direct and indirect effects. Source (Authors' work)

	Relationships	Beta	S.D.	T-statistic	P-value
H1	Attitude towards ChatGpt-> behavioral intention	0.556	0.067	0.869	0.000
H2	ChatGpt resistance -> Attitude towards ChatGpt	-0.253	0.054	0.466	0.000
H3	Ethical/values/morals/integrity -> Attitude towards ChatGpt	0.018	0.053	0.314	0.734
H4	Perceived academic integrity -> Attitude towards ChatGpt	0.531	0.065	0.815	0.000
H5	Perceived bias inaccuracies -> Attitude towards ChatGpt	0.079	0.059	0.135	0.177
H6	Perceived instructor Al competence-> Attitude towards ChatGpt	0.033	0.006	0.544	0.586
H7	Perceived unfair evaluation of students-> Attitude towards ChatGpt	-0.149	0.057	0.589	0.001
Moderating effects					
H8	Attitude towards ChatGPT*religiosity -> Behavioral intention	0.101	0.054	0.875	0.063

5. Discussion and Conclusion

The current research advances the theoretical understanding of technology acceptance by contextualizing it within the framework of artificial intelligence (AI) usage in higher education. First, the strong positive relationship between attitude and behavioral intention reaffirms central tenets of the Technology Acceptance Model (TAM), emphasizing that fostering positive perceptions is essential for adoption. The significant negative impact of resistance contributes to resistance-to-innovation theory, suggesting that emotional and cognitive barriers substantially shape user attitudes. Additionally, the lack of influence from ethical values challenges assumptions in previous literature that morality is a primary determinant in AI-related decisions, particularly in academic contexts. This may indicate a shifting normative baseline where users prioritize functionality and utility over ethical considerations, or a gap in awareness that warrants further exploration. Moreover, the significance of perceived academic integrity highlights a novel driver of positive attitudes towards AI tools in education. The non-significance of perceived bias and instructor AI competence suggests that students may decouple their own engagement with AI tools from concerns over system errors or authority figures' proficiency. Finally, the moderating role of religiosity, although marginal, opens avenues for integrating cultural and spiritual dimensions into AI acceptance theories, particularly in non-Western or religiously influenced educational contexts.

For educators, institutions, and policymakers, these findings offer actionable insights. First, since attitude is a key driver of intention, educational campaigns that highlight ChatGPT's benefits and responsible use can encourage constructive adoption. The negative impact of resistance suggests a need for training and awareness programs to demystify AI tools and alleviate concerns related to job displacement or misuse. The non-significance of ethical values in shaping attitudes indicates a possible disconnect between ethical awareness and AI use. Institutions should therefore consider integrating more explicit discussions on academic ethics and AI into curricula. Concerns about unfair evaluation indicate that transparency in how AI

influences grading and assessment is vital to maintain trust. Finally, the moderating effect of religiosity, though small, suggests that AI adoption strategies should consider cultural and religious values to ensure inclusive implementation.

References

Albrecht, W. S., Albrecht, C. O., & Albrecht, C. C. (2019). Fraud Examination. Cengage Learning.

Blahopoulou, J., & Ortiz-Bonnin, S. (2025). Student perceptions of ChatGPT: benefits, costs, and attitudinal differences between users and non-users toward AI integration in higher education. Education and Information Technologies. https://doi.org/10.1007/s10639-025-13575-9

Bin-Nashwan, S. A., Sadallah, M., & Bouteraa, M. (2023). Use of ChatGPT in academia: Academic integrity hangs in the balance. Technology in Society, 75, 102370. https://doi.org/10.1016/j.techsoc.2023.102370 Bowers, J., Dziuban, C. D., & Moskal, P. D. (2021). The impact of ChatGPT on student learning outcomes. Journal of Educational Technology, 1(1), 1–10.

Chetioui, Youssef & Abbar, Hassan. (2017). Customer Relationship Management (CRM) in service firms: A model proposal to measure the impact of the implementation of CRM dimensions on Hotel Performance. International Journal of Scientific & Engineering Research. Volume 8, Issue 5, May-2017.

Chetioui, Y., Errachid, Y., Lebdaoui, H. (2023), Organizational justice, employee empowerment, and innovative behavior in the post-COVID era: Evidence from SMEs in a majority-muslim country. Research on Islamic Business Concepts. GIMAC 2022. Springer Proceedings in Business and Economics. Springer, Singapore

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319–340.

Farhi, F., Jeljeli, R., Aburezeq, I., Dweikat, F. F., Al-Shami, S. A., & Slamene, R. (2023). Analyzing the students' views, concerns, and perceived ethics about chat GPT usage. Computers and Education Artificial Intelligence, 5, 100180. https://doi.org/10.1016/j.caeai.2023.100180

Javaid, M., Haleem, A., Singh, R. P., Kahn, S., & Khan, I. H. (2023). Unlocking the opportunities through ChatGPT tool towards ameliorating the education system. BenchCouncil Transactions on Benchmarks, Standards, and Evaluation, 3, 100–115.

Johnson, R., & Garcia, E. (2024). Fairness and equity in the use of AI tools in education. International Journal of Educational Technology, 12(4), 167–182.

Kim, L., & Wong, M. (2023). Instructor competence and student attitudes towards AI tools. Journal of Educational Technology Research, 7(2), 89–102.

Lee, J., & Choi, J. (2020). The ethical dimensions of ChatGPT in higher education. Journal of Academic Ethics, 12(1), 22–38.

Lebdaoui, H., El Asri, M. and Chetioui, Y. (2021), "Environmental Kuznets Curve for CO2 emissions an ARDL-based approach for an emerging market", Interdisciplinary Environmental Review, Vol. 21, pp. 269-289, 100443, 2020.

Martin, R. (2022). The impact of generative AI on university learning. Journal of Digital Pedagogy, 9(1), 60–78.

Patel, R., & Singh, A. (2024). The influence of instructor competence on student perceptions of AI tools. International Journal of Educational Technology, 12(3), 145–158.

Smith, L., & Jones, T. (2023). Teacher AI competency and student perceptions of ChatGPT. Education and AI Review, 11(2), 77–94.

Steffensmeier, D., & Steffensmeier, C. (2015). Rationalization of deviance in educational settings. Journal of Ethics in Education, 3(2), 95–112.

Strzelecki, A. (2023). To use or not to use ChatGPT in higher education? A study of students' acceptance and use of technology. Interactive Learning Environments, 32(9), 5142–5155.Smith, J., & Green, P. (2017). Peer influence and academic honesty: A UTAUT perspective. Journal of Educational Research, 10(4), 321–335.

Teo, T. (2011). Factors influencing teachers' intention to use technology: Model development and test. Computers & Education, 57(4), 2432–2440.

Tiwari, C.K., Bhat, M.A., Khan, S.T., Subramaniam, R. and Khan, M.A.I. (2024), "What drives students toward ChatGPT? An investigation of the factors influencing adoption and usage of ChatGPT", Interactive Technology and Smart Education, 21(3), pp. 333-355.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS Quarterly, 27(3), 425–478.

White, R., & Lee, J. (2024). Academic dishonesty and AI: Rethinking integrity. Journal of Higher Education Ethics, 18(2), 55–72.

Williams, A., Patel, N., & Brown, S. (2015). Understanding digital tool integration in classrooms. Educational Research Quarterly, 38(2), 44–59.

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2023). ChatGPT in education: An opportunity or a challenge for the future? Educational Technology Research and Development. https://doi.org/10.1007/s11528-023-00844-y

Zhang, Y., & Tur, G. (2023). Accuracy and transparency in AI tools for education. Journal of Educational Innovation, 9(3), 115–132.

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Creating an International and Multidisciplinary Learning Community in Higher Education

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Abstract

This applied educational research project aimed to establish a multidisciplinary, international learning community in higher education and to bridge the gap between the PXL-Digital and PXL-Business departments of the Belgian PXL University of Applied Sciences and Arts. This was achieved through the introduction of a new course titled Marketing Automation and the organization of two Blended Intensive Programs (BIPs) in collaboration with international partner institutions.

Using a mixed-methods approach, quantitative data were collected via surveys, and qualitative insights were derived from interviews and brainstorming sessions.

The findings indicate that such a learning community is feasible and fosters valuable learning experiences and competence development among students. Despite organizational challenges, the BIPs and the Marketing Automation course were well-received, providing a strong foundation for future program development.

Keywords: *Blended Intensive Programme, Marketing, Applied Informatics, Higher Education, Internationalization*

1. Introduction

Multidisciplinary learning, which integrates diverse perspectives and methodologies such as experiential learning projects, is increasingly recognized for its capacity to foster innovation and creativity in higher education. This approach encourages students to combine analytical and imaginative thinking, leading to enhanced problem-solving skills and the development of novel ideas (Hero & Lindfors, 2019; Joseph-Mathews et al., 2022). Furthermore, international collaboration plays a crucial role in enriching the learning experience by cultivating essential intercultural competence and communication skills. These collaborative environments prepare

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students for an increasingly globalized world and enhance their ability to work effectively with individuals from diverse backgrounds (Guillén-Yparrea & Ramírez-Montoya, 2023).

This paper examines the creation and implementation of an international, multidisciplinary learning community at PXL University of Applied Sciences and Arts (PXL), Belgium. The project aimed to integrate the Applied Informatics (PXL-Digital) and Marketing (PXL-Business) programmes, fostering collaboration between these departments within an international educational setting. This initiative corresponds with the Erasmus+ goal of promoting inter-university cooperation in Europe.

The central research question was as follows: *How to establish a multidisciplinary and international learning community in higher education, specifically for universities of applied sciences?* A central aspect of this initiative involved the design and delivery of two key components: (1) the introduction of a multidisciplinary course titled Marketing Automation at PXL and (2) the organization of two Blended Intensive Programs (BIPs) in collaboration with international partner universities of applied sciences from Croatia and Germany.

2. Methodology

2.1. Quantitative Data

Quantitative data were collected via surveys administered through Google Forms. Participants included two groups: the students who participated in one of the two Blended Intensive Programmes (BIPs), which are short intensive programs that combine international student mobility with innovative learning methods, and Belgian students enrolled in the multidisciplinary Marketing Automation course at PXL. The surveys assessed students' experiences regarding multidisciplinary and international collaboration with fellow students.

Blended Intensive Programs (BIPs): Quantitative data regarding the BIPs were collected via mandatory post-program surveys administered to all participating students. Completion of the survey was mandatory for students to receive credit for their participation. From 2022 to 2024, two BIPs were organized, each time for 14 different students from PXL (specifically targeting students from the PXL-Business and the PXL-Digital departments: seven second-year undergraduate marketing students and seven second-year undergraduate applied informatics students). Both BIPs were organized in collaboration with *Technische Hochschule Rosenheim* from Germany and *Zagreb University of Applied Sciences* from Croatia. Another 16 undergraduate business students from these two universities also participated in each BIP, bringing the total number of students to 30 per BIP.

During a one-week on-campus period, students collaborated on the theme of the metaverse. Students were organized into six mixed groups, each comprising five students drawn from the

three participating universities of applied sciences. The students' objective was to present a new business concept to a jury at the end of the week. Additionally, two online sessions were scheduled before the start of each BIP, which all participating students were required to attend. These sessions covered the theoretical aspects of the metaverse subject, allowing students to concentrate fully on the practical components during the physical BIP week. The BIP was held in Rosenheim (Germany) during the academic year 2022-2023 and in Zagreb (Croatia) during the academic year 2023-2024. The online survey was designed and distributed during both BIPs among the international group of participating students. In the end, a total of 60 students completed the questionnaire, which assessed their experiences collaborating with peers from other international universities and different academic backgrounds.

Marketing Automation: In light of the success of the first BIP, the Marketing Automation course was introduced for the first time during the academic year of 2023-2024 at PXL for students of both the PXL-Digital and PXL-Business departments to maintain the multidisciplinary collaboration between these two departments. In multidisciplinary teams, students were assigned the task of designing a strategic marketing campaign for a Belgian retailer. A total of 73 students took this course and were surveyed about what they liked and disliked about this multidisciplinary course.

2.2. Qualitative Data

Regarding the qualitative data, multiple brainstorming sessions were held with representatives from the participating BIP partner universities, again being *Technische Hochschule Rosenheim* from Germany and *Zagreb University of Applied Sciences* from Croatia, on how to successfully create an international and multidisciplinary learning community. These sessions, which took place online and also offline during the BIPs themselves, allowed findings and experiences from each institution to be shared. Reflections were made on how to effectively set up international and multidisciplinary collaborations and projects for students.

Moreover, before the start of the second BIP in the academic year 2023-2024, an information session was held for interested students, organized by the students who participated in the first BIP. This approach helped to identify areas for improvement, aligning the practical knowledge and experiences of the first BIP with the expectations of the students for the second BIP.

In addition to formal interactions, informal conversations were also facilitated and initiated by students who participated in both the first and second BIP. These informal interactions provided more authentic insights, as students were more likely to express their genuine thoughts and experiences. For example, when a BIP was over, the group of PXL students arranged an informal get-together with their fellow Belgian BIP students and participating supervisors to discuss the strengths and weaknesses of the BIP in a more relaxed setting.

Lastly, to map out the differences and similarities between the PXL-Business and PXL-Digital departments in order to establish an international and multidisciplinary learning community, the ECTS sheets of existing courses from both departments were analyzed.

The insights gained from the activities mentioned above will be further reinforced by similar findings cited in academic literature, which are also referenced throughout the results section.

3. Results

This section presents the key findings, beginning with the promotion of multidisciplinary innovation. Subsequently, the development of core competencies is examined. Finally, organizational and evaluation challenges are discussed.

3.1. Promoting Multidisciplinary Innovation

To develop an international learning community, objectives addressing multidisciplinary collaboration are crucial due to the students' varied academic backgrounds.

Based on the two BIPs and scientific literature, cultural and global competencies should be enhanced by ensuring that diverse cultural (academic) perspectives are consistently addressed. For instance, international partners can contribute by sharing unique cultural and academic habits with students from other institutions, fostering a broader understanding of global diversity (Krebs, 2020; Lourenco, 2018).

Moreover, multidisciplinary collaboration must be promoted by encouraging students from different fields to work together on projects, effectively combining their unique perspectives and skills. To support this process, forming multidisciplinary student groups ahead of time was identified as an effective strategy during both BIPs, and in the literature (Ashby & Exter, 2018).

Survey results from the 60 students across both BIPs indicated that collaborating with individuals from different academic and cultural backgrounds was the most rewarding element. This overall positive sentiment was reflected in their strong willingness to endorse the program: when asked, “How likely are you to recommend this experience to a fellow student?” on a 1-to-10 scale (1 = Not at all, 10 = Extremely likely), the mean response was 9.25.

In addition, critical thinking and problem-solving abilities should be strengthened by engaging students in the analysis and resolution of complex issues using knowledge drawn from multiple disciplines. Each discipline should actively contribute to addressing the problem, relying on the specialized expertise of others (Guaman-Quintanilla et al., 2022).

Finally, innovation and creativity should be prioritized by exposing students to a wide range of ideas and methodologies that transcend disciplinary boundaries. For example, the subject of the metaverse was deliberately selected as the central theme for both BIPs to establish a connection

between multiple disciplines, fostering innovative and creative approaches (Lattuca et al., 2017).

3.2. Competency Development

Within the context of a multidisciplinary, international learning community, various competencies can be developed, encompassing both academic skills and essential soft skills which are important in today's global and multidisciplinary labor market. Again, based on the survey administered after both BIPs to participating students, and based on existing scientific literature, international, multidisciplinary collaborations between students ensure that many different competencies can be developed.

International and multidisciplinary collaboration, the central focus of the BIPs, enabled students to enhance their ability to collaborate and communicate effectively with individuals from various disciplines and academic backgrounds (Spelt et al., 2009). Because of this collaboration, their English language skills were also further developed.

Similarly, intercultural competencies were emphasized, fostering the ability to interact respectfully with individuals from diverse cultural contexts (Klak & Martin, 2003; Levine & Garland, 2015). More specifically, this was done by organizing teambuilding activities for students on the first day of each BIP so each student could get to know the academic and cultural differences of his or her peers.

Moreover, creativity and innovation were also encouraged by promoting the generation of original ideas and solutions through the integration of knowledge from multiple disciplines (Hero & Lindfors, 2019). Digital literacy was another important component, with students gaining proficiency in using digital tools and technologies, particularly through the metaverse theme of both BIPs (Gutiérrez-Angel et al., 2022).

Lastly, self-management and personal leadership are strengthened as students enhance their ability to organize themselves, manage time, and work independently since they had to work within small groups. This also required the students to be adaptive and flexible given they only had one week to finish their project.

These competencies are transferable and valuable in almost any professional context. Effectively integrating these competencies increases the value and impact of education on both the personal and professional levels of students, preparing them for their future careers.

On a more local level, the newly introduced Marketing Automation course for Belgian PXL students again proved that multidisciplinary courses can be enriching. Marketing students gained technical insights, while applied informatics students recognized the value of strategic planning for business objectives. Despite the steep learning curve for marketing students due to complex digital tools, the experience highlighted the necessity of aligning strategic decisions

with technical feasibility. The students' feedback also emphasized the importance of cross-disciplinary communication, collaboration in multidisciplinary teams, and understanding shared terminology.

3.3. Organizational Challenges

Brainstorming sessions with the two international partners, coupled with the practical experience of organizing the two BIPs, highlighted several organizational challenges. Coordinating class schedules among not only two PXL departments, but also two other international partner institutions was particularly challenging, as differences in academic structures, procedures, and internal organization needed to be addressed.

When designing multidisciplinary, international educational activities in which students not only have different academic backgrounds, but are possibly also pursuing a different degree (bachelor or master), it is important to choose a subject that all students are equally (un)familiar with. For example, for the BIPs it was deliberately chosen to work on the theme metaverse, since few to no students had any prior experience with this subject.

While organizational challenges related to class schedules were less significant during the online sessions, these sessions proved less effective for fostering team collaboration. This was because personal interactions were limited in an online format. Consequently, the online sessions were primarily used for preliminary activities, allowing for greater flexibility in the use of time and location.

Given that the BIPs mainly consisted of interactive workshops focused on group assignments, five supervisors proved optimal for managing a group of 30 students. This ensured that there was approximately one supervisor per group to guide students in terms of content and address possible issues. Depending on the content (interactive workshops in small groups or lectures for a bigger group of students), the number of supervisors needed may vary. For traditional lectures one lecturer was deemed sufficient, but for small interactive workshops, it is advisable to have one lecturer per group. Other educational institutions that previously organized a BIP generally followed the same distribution between students and lecturers (Gögele and Kletzenbauer, 2023).

An advisory role from the supervisors was sufficient for students to manage their own practical and logistical matters. During the organization of both BIPs, students received advice on how to reach the foreign partner institutions' campuses, including flight and accommodation suggestions, but the students were free to make their own arrangements. No detailed logistical plan was provided, and students were selected partly based on their previous international experiences, allowing for a minimal practical and logistical framework without issues. A WhatsApp group with the supervisors was available for urgent questions, which showed that students mainly helped each other.

Lastly, it should be noted that the students of the host institution should receive extra motivation to participate in optional social activities. These optional social activities often took place on the hosting institution's own campus, making other activities or returning home after the mandatory classes more attractive for the host institution's students. This was experienced during both BIPs. Therefore, it is recommended that the hosting educational institution considers not organizing all activities solely on its own campus.

3.4. Evaluation Challenges

Harmonization of learning objectives and competencies across participating institutions is essential, despite the variations in educational cultures and methodologies. To ensure fair assessment of the students' performance, a common evaluation framework was agreed upon by all three higher education institutions involved in both BIPs. This included decisions regarding grading and resit possibilities. Furthermore, accreditation requirements from all involved countries and educational authorities must be adhered to. This adherence could create more difficulties in creating a common evaluation framework to grade students.

Lastly, it is crucial that educational professionals possess intercultural competence themselves to effectively communicate and collaborate with colleagues and students from diverse backgrounds and other higher education institutions.

4. Conclusion

In response to the central research question of how to establish a multidisciplinary and international learning community within universities of applied sciences, this project demonstrated a successful approach at PXL University of Applied Sciences and Arts. By strategically implementing a cross-disciplinary Marketing Automation course linking its Digital and Business departments, alongside two international Blended Intensive Programs (BIPs) with partner institutions, it was shown that these interventions effectively enhanced both innovation and vital student competencies, such as international collaboration and intercultural communication. However, significant organizational and evaluation challenges, particularly concerning cross-institutional coordination and harmonization, must be carefully managed to ensure success.

References

Ashby, I., & Exter, M. (2018). Designing for interdisciplinarity in Higher Education: Considerations for instructional Designers. *TechTrends, 63*(2), 202–208. https://doi.org/10.1007/s11528-018-0352-z

Gögele, S., & Kletzenbauer, P. (2023). Blended Intensive Programmes: Promoting internationalization in higher education. *Education and New Developments*. https://doi.org/10.36315/2023v2end086

Guaman-Quintanilla, S., Everaert, P., Chiluiza, K., & Valcke, M. (2022). Impact of design thinking in higher education: a multi-actor perspective on problem solving and creativity. *International Journal of Technology and Design Education, 33*(1), 217–240. https://doi.org/10.1007/s10798-021-09724-z

Guillén-Yparrea, N., & Ramírez-Montoya, M. S. (2023). A review of collaboration through intercultural competencies in higher Education. *Cogent Education, 10*(2). https://doi.org/10.1080/2331186X.2023.2281845

Gutiérrez-Ángel, N., Sánchez-García, J., Mercader-Rubio, I., García-Martín, J., & Brito-Costa, S. (2022). Digital literacy in the university setting: A literature review of empirical studies between 2010 and 2021. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.896800

Hero, L., & Lindfors, E. (2019). Students' learning experience in a multidisciplinary innovation project. *Education + Training, 61*(4), 500–522. https://doi.org/10.1108/et-06-2018-0138

Joseph-Mathews, S. M., Lee, M. A., & Kreidler, N. (2022). Creating a Multidisciplinary Collaboration Service-Learning Experience in Design Education. *Proceedings of the Design Society, 2,* 2293-2302. DOI: 10.1017/pds.2022.232

Klak, T., & Martin, P. (2003). Do university-sponsored international cultural events help students to appreciate "difference"? *International Journal of Intercultural Relations, 27*(4), 445–465. https://doi.org/10.1016/s0147-1767(03)00033-6

Krebs, K.C. (2020). Global, international, and intercultural learning in university classrooms across the disciplines. *Research in Comparative and International Education, 15*(1), 36–51. https://doi.org/10.1177/1745499920901947

Lattuca, L. R., Knight, D., Seifert, T. A., Reason, R. D., & Liu, Q. (2017). Examining the impact of interdisciplinary programs on student learning. *Innovative Higher Education, 42*(4), 337–353. https://doi.org/10.1007/s10755-017-9393-z

Levine, K. J., & Garland, M. E. (2015). Summer Study-Abroad Program as Experiential Learning: Examining similarities and differences in International communication. *Journal of International Students, 5*(2), 175–187. https://doi.org/10.32674/jis.v5i2.433

Lourenço, M. (2018). Global, international and intercultural education: three contemporary approaches to teaching and learning. *On The Horizon the International Journal of Learning Futures, 26*(2), 61–71. https://doi.org/10.1108/oth-06-2018-095

Spelt, E. J. H., Biemans, H. J. A., Tobi, H., Luning, P. A., & Mulder, M. (2009). Teaching and Learning in Interdisciplinary Higher Education: A Systematic review. *Educational Psychology Review, 21*(4), 365–378. https://doi.org/10.1007/s10648-009-9113-z

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Assessing the Impact of Tacit Knowledge Transfer through Storytelling in Educational Settings

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Abstract

Storytelling is an ancient human activity that aids in understanding complex information and facilitating knowledge transfer. It captures and transfers tacit knowledge, often more challenging to formalise and communicate than explicit knowledge. This paper investigates the impact of storytelling as a powerful tool for knowledge sharing in educational institutions. Using a systematic literature review from 1998 to 2023, the research aims to understand how storytelling can enhance tacit knowledge sharing in educational settings. The systematic literature review approach provides a comprehensive and rigorous analysis of existing research findings, enabling conclusions about the effectiveness of storytelling as a knowledge management tool.

The study explores storytelling in educational institutions, proposing a taxonomy for classifying stories and facilitating knowledge sharing. It reveals that traditional and digital storytelling enhance knowledge retention, engagement, and collaborative learning, but maintaining live storytelling quality is crucial.

Keywords: *Storytelling, Tacit Knowledge, Knowledge Transfer, Digital Storytelling, Knowledge Management.*

1. Introduction

In the context of knowledge management (KM), Wilson (2002) emphasises the distinction between personal knowledge, which resides in individuals' minds, and organisational knowledge, which includes documented resources such as patents and videos, as outlined by Bratianu (2010). KM is vital for maintaining competitive advantage and fostering innovation, particularly through the transfer of tacit knowledge that is difficult to articulate. This challenge is exacerbated by the impending retirement of experienced employees (Bratianu, 2010). In South Africa, the education sector exhibits the lowest KM maturity due to a culture of knowledge hoarding, where knowledge is viewed as a strategic asset, contributing to ineffective

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sharing practices. Kruger and Johnson (2009) note that this culture is perpetuated by a lack of knowledge-sharing platforms and a mindset among senior management that undervalues KM, with one manager highlighting the "knowledge is power" syndrome as a barrier to effective collaboration in educational institutions.

Traditional Western approaches to KM focus on analytical methods and documentation, while Eastern philosophies value experiential learning and storytelling for knowledge transfer. According to Tobin and Snyman (2004), storytelling is a powerful medium for conveying meaning and tacit knowledge, with narratives, myths, and fables playing a crucial role in human relationships by engaging reason and emotion. The rise of digital media in education presents new opportunities for enhancing cultural competency and critical thinking through digital storytelling, as Grant and Bolin (2016) noted. This research emphasises how educational institutions can utilise storytelling techniques to preserve and disseminate expertise, thereby improving competitive advantage and fostering a culture of continuous learning and innovation, ultimately contributing to a deeper understanding of KM practices in sustaining organisational wisdom.

2. Methodology

This study employs a systematic literature review (SLR) methodology to investigate the effectiveness of storytelling as a tool for capturing and transferring tacit knowledge within educational institutions. The SLR approach is chosen for its rigour and comprehensive nature, enabling the synthesis of existing research findings to draw well-supported conclusions about the effectiveness of storytelling as a knowledge management tool (Biggam, 2011). This methodology involves a structured process of identifying, evaluating, and synthesising relevant literature, ensuring the review is transparent, reproducible, and objective.

As illustrated in Figure 1 below, a systematic literature review followed a predefined protocol to identify relevant storytelling and tacit knowledge transfer studies. Academic research databases such as Google Scholar, PubMed, Scopus, and Web of Science were utilised to ensure a comprehensive search. Keywords included combinations of terms such as "storytelling," "tacit knowledge," "knowledge management," "education," and "knowledge transfer." Boolean operators (AND, OR) were used to refine the search. Peer-reviewed articles, conference papers, and books published in English. Studies focusing on the use of storytelling in education contexts. Research that addresses the transfer of tacit knowledge. Non-peer-reviewed articles, editorials, and opinion pieces. Studies not directly related to storytelling or tacit knowledge transfer were excluded. The study was limited to articles published between 1998 and 2023 to ensure relevance, and only 25 of the 375 studies evaluated were deemed significant for the research conducted. Most of the literature that was excluded did not address tacit knowledge in

the educational context, but in the generic organisational context, and some was not written in English.

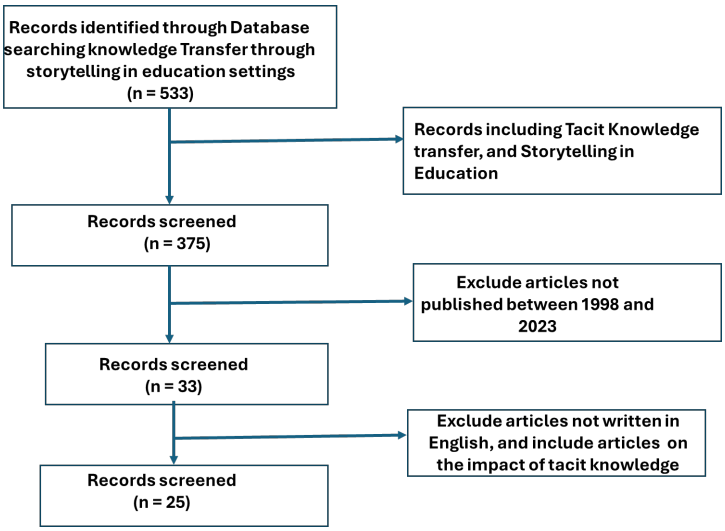


Figure 1: The PRISMA selection process of relevant literature

This literature review addresses the effectiveness of storytelling in capturing and transferring tacit knowledge within corporate and educational environments. By examining critical studies and theories, this review aims to answer the following research questions: What is the practical impact of knowledge sharing through storytelling in education? What are the implications of knowledge sharing through storytelling for educational practice? In the subsequent section, the author will present the research findings.

3. Results

The studies reviewed employ a range of qualitative methods, including narrative inquiry and thematic analysis, to examine participants' experiences with storytelling. Carvalho et al. (2020), Jamissen et al. (2017), Tajeri et al. (2017), and Martinez-Maldonado et al. (2020) focus on the emotional dimensions that enhance student engagement and collaboration. Some research uses mixed-methods approaches to better understand storytelling's impact (Nestor-Baker & Hoy, 2001; Katušáková & Katusak, 2013; Nader, 2023). Specific interventions are explored in case studies by Wijetunge (2012), Kaminskiene & Khetsuriani (2019), and Dvir (2021), while systematic literature reviews by Fischer et al. (2020) and Rodríguez et al. (2021) synthesise the findings on storytelling effectiveness. Additionally, Katušáková (2015) compares oral and digital storytelling formats, and Hayne (2009) utilises experimental designs to evaluate storytelling intervention outcomes.

Nestor-Baker & Hoy (2001), Antunes et al. (2019), Carvalho et al. (2020), and Rodríguez et al. (2021) have all contributed to the understanding of storytelling in various educational settings. Kaminskienė and Khetsuriani (2019) tinted its effectiveness in primary and secondary education, while others focused on higher education. Nestor-Baker & Hoy (2001) highlighted its effectiveness in professional training environments. Antunes et al. (2019) analysed its use in community and organisational contexts for knowledge sharing and collaboration. Digital storytelling (DST) was a key intervention, enhancing learners' engagement and knowledge transfer. Personal narratives were used to enhance emotional engagement and relatability. Collaborative storytelling promoted teamwork, and multimedia integration enhanced engagement (Coulter et al., 2007; Koivula et al., 2019; Martinez-Maldonado et al., 2020).

Dincelli & Chengalur-Smith (2023), Dvir (2021), and Duveskog et al. (2012) have all draw attention to the significance of storytelling in education. They argue that it enhances learning experiences, fosters collaboration, and promotes meaningful knowledge transfer. McLellan (2007) and Denning (1998) emphasized the practicality of digital storytelling in higher education, as it encourages students to be creative and share experiences. Tajeri et al. (2017) and Denning (1998) underscore the importance of storytelling in enhancing learning outcomes and fostering a supportive environment.

4. Practical impact of knowledge sharing through storytelling in education

The systematic literature review highlights the significant role of knowledge sharing through storytelling in education, demonstrating its positive effects on the learning experience. Carvalho et al. (2020) note that digital storytelling enhances student engagement, collaboration, emotional intelligence, and digital literacy, creating a supportive environment for sharing personal narratives. Additionally, Jamissen et al. (2017) emphasise the importance of facilitator expertise and cultural context in storytelling interventions, encouraging active reflection and critical thinking among students.

Farooq et al. (2023) further demonstrate that storytelling enhances reflective learning, reducing distractions and deepening understanding by making complex concepts more relatable through real-life examples. Kaminskienė and Khetsuriani (2019) add that digital storytelling enhances literacy skills and creates personalised learning experiences, promoting creativity and critical thinking. Rodríguez et al. (2021) discuss how digital storytelling develops narrative skills and self-expression and encourages community engagement and inclusivity, making it a valuable tool for addressing social justice issues in education. These studies collectively illustrate how storytelling is an effective pedagogical strategy, enriching the educational landscape and fostering deeper connections between students and their learning material. The following section explores the key differences in storytelling approaches between developed and developing countries.

4.1. Technological Integration

Tajeri et al. (2017) tinted the importance of digital storytelling in developing countries, where traditional oral storytelling is limited due to limited access to technology. They used Adobe Premiere Pro 5 software to teach students how to create storyboards, edit, and sync narration with media. This innovative teaching approach allows students to express themselves creatively and engage with the story. Carvalho et al. (2020) emphasized the benefits of digital storytelling in fostering collaboration, critical thinking, emotional intelligence, and digital literacy. Duveskog et al. (2012) emphasized the need for digital tools in Tanzania.

4.2. Cultural Context

In developed nations, storytelling reflects diverse cultural narratives and promotes themes of social justice. Jamissen et al. (2017) emphasise that interventions in places like Norway and the USA aim to include marginalised voices and foster inclusivity. Conversely, in developing countries, narratives emphasise local traditions and communal values. Farooq et al. (2023) note that telling stories connects educational content with cultural heritage in Pakistan, thereby enhancing student engagement through relatable narratives.

4.3. Educational Frameworks

Developed countries incorporate narrating stories as a pedagogical strategy to enhance critical thinking and reflective learning, with the effectiveness depending on the facilitators' expertise (Jamissen et al., 2017). In developing countries, the focus is primarily on foundational literacy and numeracy, with relating stories often serving as a supplementary tool. Tajeri et al. (2017) found that storytelling improves vocabulary in language classes in India but may not be systematically integrated across all subjects.

The practical impact of sharing expertise through narrating stories in education highlights its potential to foster deeper engagement, enhance understanding, and bridge cultural or contextual gaps in learning environments. The following section examines the implications of experience sharing through telling stories for educational practice, focusing on its potential to transform teaching methodologies and enhance learner outcomes.

5. Implications of knowledge sharing through storytelling for educational practice

The following section presents various implications of knowledge sharing through storytelling for educational practice, revealing critical insights into how storytelling can be effectively integrated into educational settings.

Several studies underscore the significant benefits of telling tales in enhancing learning outcomes and student engagement. Carvalho et al. (2020) found that digital storytelling boosts

engagement, collaboration, digital literacy, and emotional intelligence. Farooq et al. (2023) noted that it fosters critical thinking and curiosity, promoting a deeper understanding of complex concepts. Additionally, Katuščáková (2015) emphasised that storytelling can lead to better retention and comprehension compared to traditional lectures, advocating for its integration into educational practices to create more effective and enjoyable learning experiences.

Tajeri et al. (2017) stressed the importance of telling tales in promoting reflective and transformative learning. They noted that digital storytelling enhances preservice teachers' understanding of pedagogical issues and fosters emotional engagement. They also noted that digital storytelling amplifies marginalised voices and supports social justice, contributing to inclusive education. Koivula et al. (2019) found that telling tales enhances children's emotional expression and social skills, which are crucial for self-regulation and interpersonal interactions. Dickinson-Delaporte et al. (2020) emphasised the role of telling narratives in promoting learner engagement. Nestor-Baker and Hoy (2001) and Denning (1998) stressed its effectiveness in transferring know-how and sharing, which is essential for collaborative learning in educational contexts. McLellan (2007) emphasized the benefits of digital storytelling in language classes, with Tajeri et al. (2017) highlighting its value as a method for vocabulary learning.

The implications of expertise sharing through narratives for educational practice are profound. Telling narratives enhances learning outcomes, promotes reflective and transformative learning, fosters collaborative and inclusive environments, develops social-emotional skills, and facilitates knowledge transfer. Integrating storytelling into educational practices can lead to more engaging, interactive, and practical learning experiences, as supported by various authors in the literature. These findings underscore the potential of storytelling as a powerful pedagogical strategy that can enrich the educational landscape.

6. Conclusion

The literature review underscores storytelling's substantial influence on education, showing that it enhances academic performance, knowledge retention, and comprehension of complex concepts while promoting critical thinking, creativity, and student engagement. Digital storytelling develops essential 21st-century skills such as digital literacy and emotional intelligence, contributing to collaborative and inclusive learning environments. It aids children's emotional expression and self-regulation while facilitating the transfer of tacit knowledge in educational and organisational contexts. The report advocates integrating techniques for telling narratives into knowledge management to enhance learning and reduce knowledge loss. Furthermore, it underscores digital storytelling's role as a research method and teaching tool that can amplify marginalised voices, urging university educators to adopt these practices to foster engagement and promote social change within underrepresented communities.

This study indicates that storytelling applies across various disciplines, but its impact and prevalence vary. The provided paper highlights storytelling as a management tool, including its use in problem-solving, action research, advertisement and knowledge transfer within businesses and educational institutions. Specifically, it is used for informal education, training, and socialisation of new employees and to maintain institutional history and decision-making. In the context of a library, storytelling can transfer tacit knowledge, such as knowledge of the library's culture or past successes and failures. In conclusion, storytelling is a versatile and practical expertise transfer and management method that enhances educational experiences and organisational communication. Its ability to engage emotions and provide context makes it valuable for conveying complex ideas and fostering a deeper understanding of shared expertise.

References

Antunes, P., Pino, J. A., Tate, M., & Barros, A. (2020). Eliciting process knowledge through process stories. *Information Systems Frontiers*, *22*(5), 1179-1201.

Biggam, J. (2011). *Succeeding with your Master's Dissertation- a step-by-step handbook* (2nd ed.). New York: Open University Press.

Bratianu, C. (2010). Organisational knowledge creation. *Management, Marketing Challenges for Knowledge Society*, 41-62.

Carvalho, L. C., Noronha, A. B., & Souza, C. L. D. (Eds.). (2020). *Learning Styles and Strategies for Management Students*. IGI Global.

Cohen, G. (2019). Implementing "Storytelling Ops" in Higher Education. January 31, 2019. https://gathercontent.com/blog/storytelling-ops-higher-education.

Coulter, C., Michael, C., & Poynor, L. (2007). Storytelling as pedagogy: An unexpected outcome of narrative inquiry. *Curriculum Inquiry*, *37*(2), 103-122.

Denning, S. (2002). *The Springboard: How Storytelling Ignites Action in Knowledge-Era Organisations*. Butterworth-Heinemann.

Denning, S. (2006). "Effective storytelling: Strategic business narrative techniques." *Strategy & Leadership*, 34(1), 42-48.

Dincelli, E., & Chengalur-Smith, I. (2020). Choose your own training adventure: designing a gamified SETA artefact for improving information security and privacy through interactive storytelling. *European Journal of Information Systems*, *29*(6), 669-687.

Duveskog, M., Tedre, M., Sedano, C., & Sutinen, E. (2012). "Digital storytelling for HIV and AIDS education in Africa." *Electronic Journal of Information Systems in Developing Countries*, 52(1), 1-17.

Duveskog, M., Tedre, M., Sedano, C. I., & Sutinen, E. (2012). Life planning by digital Storytelling in a primary school in rural Tanzania. *Journal of Educational Technology & Society*, *15*(4), 225-237.

Dvir, N. (2024). Using narrative pedagogy for novice teachers' professional development. *Professional development in education*, *50*(4), 625-637.

Farooq, F., Muhammad, Y., & Mahmood, A. (2023). Effectiveness of storytelling in teaching Qualitative research methods in Zoom meetings: A phenomenological study. *Pakistan Journal of Social Research*, *5*(02), 978-988.

Fischer, D., Selm, H., Sundermann, A., & Storksdieck, M. (2020). Storytelling for Sustainability: A definition and its implications for education and communication. In *Storytelling for Sustainability in Higher Education* (pp. 38-51). Routledge.

Given, L. M., Forcier, E., & Rathi, D. (2013). "Social media and community knowledge: An ideal partnership for non-profit organisations." *ASIST 2013 Annual Meeting*.

Grant, N. S., & Bolin, B. L. (2016). Digital storytelling: A method for engaging students and increasing cultural competency. *Journal of Effective Teaching*, *16*(3), 44-61.

Hayne, S. C. (2009). Using storytelling to enhance information systems knowledge transfer. In *ISOneWorld Conference*.

Kaminskienė, L., & Khetsuriani, N. (2019). Personalisation of learning through digital Storytelling. *Management: journal of contemporary management issues*, *24*(1), 153-166.

Katuscáková, M., & Katuscák, M. (2013, September). The effectiveness of storytelling in Transferring different types of knowledge. In *European Conference on Knowledge Management* (p. 341). Academic Conferences International Limited.

Katuščáková, M. (2015). Sharing scientific knowledge through telling stories and digital storytelling. *ECKM, Italy*.

Koivula, M., Turja, L., & Laakso, M. L. (2020). Using the storytelling method to hear children's perspectives and promote their social-emotional competence. *Journal of Early Intervention*, *42*(2), 163-181.

Kruger, C. J., & Johnson, R. D. (2009, November). Assessment of knowledge management growth: a South Africa perspective. In *Aslib proceedings* (Vol. 61, No. 6, pp. 542-564). Emerald Group Publishing Limited.

Martinez-Maldonado, R., Echeverria, V., Fernandez Nieto, G., & Buckingham Shum, S. (2020, April). From data to insights: A layered storytelling approach for multimodal learning analytics. In *Proceedings of the 2020 Chi Conference on Human Factors in Computing Systems* (pp. 1-15).

McLellan, H. (2007). Digital storytelling in higher education. *Journal of Computing in higher education*, *19*, 65-79.

Nestor-Baker, N. S., & Hoy, W. K. (2001). Tacit knowledge of school superintendents: Its nature, meaning, and content. *Educational Administration Quarterly*, *37*(1), 86-129.

Park, J., Mostafa, N. A., & Han, H. J. (2020). "StoryWeb": A storytelling-based knowledge-sharing application among multiple stakeholders. *Creativity and Innovation Management*, *29*(2), 224-236.

Reissner, S. C. (2004). Learning by story-telling? Narratives in the study of work-based learning. *Journal of Adult and Continuing Education*, *10*(2), 99-113.

Rodríguez, C. L., García-Jiménez, M., Massó-Guijarro, B., & Cruz-González, C. (2021). Digital Storytelling in education: A systematic review of the literature. *Rev. Eur. Stud.*, *13*, 13.

Signes, C. G. (2008). Practical uses of digital storytelling. *Digital Storytelling/Relato Digital*.

Shemy, N. S. (2023). The power of digital storytelling: Students' perceptions about its utilisation in developing practical understanding in an instructional technology context. *International Journal of Information and Education Technology*, *13*(9), 1439-1444.

Swap, W., Leonard, D., Shields, M., & Abrams, L. (2001). Using mentoring and storytelling to transfer knowledge in the workplace. *Journal of Management Information Systems*, *18*(1), 95-114.

Tajeri, M., Syal, P., & Marzban, S. (2017). Enhancing Vocabulary and Writing Skills through Digital Storytelling in Higher Education. *Journal of Educational Technology*, *14*(3), 40-48.

Tobin, P. K., & Snyman, R. (2004). Storytelling and knowledge management: what is the story so far? *Mousaion*, *22*(1), 34-51.

Tobin, P. K., & Snyman, R. (2008, March). Once upon a time in Africa: a case study of storytelling for knowledge sharing. In *Aslib Proceedings* (Vol. 60, No. 2, pp. 130-142). Emerald Group Publishing Limited.

Tyler, J. A. (2007). Incorporating storytelling into practice: How HRD practitioners foster strategic storytelling. *Human resource development quarterly*, *18*(4).

Whyte, W. F., & Classen, J. (2012). "Storytelling: A key to effective communication." *Organisational Dynamics*, 41(3), 206-214.

Wijetunge, P. (2012). Organisational storytelling as a method of tacit-knowledge transfer: Case study from a Sri Lankan university. *The International Information & Library Review*, *44*(4), 212-223.

Wilson, T. (2002). The nonsense of Knowledge management. *Information Research, 8*(1), 1-33.

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"What would you do, if you were Kim?" Using narrative-based method for improving dialogic communication ethics abilities

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Abstract

The purpose of this article is to propose a model for the construction of narratives for the development of competencies related to dialogic communication ethics. A narrative-based approach is a widely used method for training ethical discussions. However, little attention has been paid to how to construct field-based narratives that enable the training of specific sub-competences. In this article, we highlight the components necessary for the construction of narratives and explain, through an example, the possible applications of these components. The specificity of training in dialogic communication ethics is that narratives should be constructed on the basis of the normative discourses of communication, media and journalistic ethics.

Keywords: *dialogic communication; ethics; narrative; civic education.*

1. Introduction

The turbulent times in public communication sphere raises new challenges for communication ethics. The role of dialogic communication in public participation has been emphasized by various authors (Taylor & Kent, 2014; Yang et al., 2015, Escobar, 2011). The theory of dialogic communication ethics (DCE) has been developed by various authors who have focused on the ethical implications of dialogue in communication (e.g. Arnett et al., 2006, Arnett et al., 2009). For applying the concept of DCE in practice, it is important to create didactics for specifically training the relevant competences. We see the didactics for dialogic communication to support the moral/ethical competence and recognize it to be an important component of civic education.

The present article focuses on one didactical approach: a narrative-based method for training the communication ethics competencies. We use the word "narrative," although the terms "scenario" and "vignette" are also used in the scholarship of ethics training. The narrative approach seems to be preferable, as narrative theory typically includes actors who have specific motives and a temporal dimension of actions.

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In this article, we demonstrate the methodology for constructing narratives that can be used to specifically train moral sensitivity and awareness; moral imagination; moral reasoning, and moral decision making. Narrative-based methodologies have been developed to facilitate ethical decision-making by many authors (e.g., Cohen, 1993; Nelson, 1992; Baldor et al., 2001; Bekir et al., 2001; Parder et al., 2024; Dilemma Game, n.d.), however, distinguishing the moral problems concerning communication from general ethical dilemmas (e.g., questions related to abortion where different layers of ethics disciplines are present (medical ethics, research ethics, elements of communication ethics)) is not always easy. It is important to point out that DCE additionally needs motivation and abilities to create and hold a dialogue: e.g. listening, understanding, responding, fair argumentation abilities (e.g., Wolvin, 2010).

In order to find and construct narratives that specifically train the competences of DCE, one needs to be familiar with the main normative discourses related to communication, media, information, and, more generally, communication ethics. The discourses can be found from textbooks, handbooks and various publications that discuss communication, media and journalism ethics. A slightly robust systematization enables to summarize the slightly different variations of recurring discourses (e.g., Duncan, 2023; Eberwein, 2021; Fourie, 2021; Harcup, 2021; Wasserman, 2020; Christians, 2019; Aznar & Castillo-Martin, 2018; Tompkins, 2015; Wasserman, 2015; Plaisance, 2014; MacDonald & O'Regan, 2013; Arnett et al., 2010; Liapri, 2006).

Some of the clusters of values and principles of normative regulation of communication, media and journalism are presented in the list. While this list is not exhaustive, it provides a brief illustrative overview that demonstrates how narratives can be identified from daily practice and categorized according to topical areas.

1. Cluster of truth-telling and honesty: Problems of deception, opposing mis- and disinformation; avoidance of manipulation, balance, impartiality (objectivity); principles of source verification and source attribution; transparency
2. Cluster of a culture of dialog: (Active) listening and engagement; mutual respect; absence of coercive power in communication; equal access to information and freedom to speak out.
3. Cluster of human dignity and autonomy: Principle of compassion and politeness; principle of opposing hate speech; duty to care and minimize harm; principle of informational self-determination and informed consent.
4. Cluster of free speech: Value of different opinions and the right to disagree.
5. Principle of sensitivity to vulnerability and privacy: Understanding and acknowledging the feelings, experiences, and challenges faced by vulnerable population (e.g., children, people with specific health conditions, etc.); principle of avoiding exploitation.

We argue that the narrative approach enables to train five moral sub-competencies: moral sensitivity and moral awareness, moral imagination, moral reasoning, and moral judgment. We

explain how each of these specific competencies can be trained using different types of constructed narratives.

2. The sources of filed-specific narratives

The narrative approach enables learners to exercise their moral competence through field-specific narratives, helping them become aware of aspects they may have previously overlooked. However, it is crucial to first transform daily life experiences into specific cases and then purposefully construct narratives from those cases.

These field-specific cases could be found from frequently debated public issues as well as from academic scholarship in media and communication ethics, as illustrated by the clusters presented in the Introduction.

Public communication as well as the cases that include morally problematic issues happen on five levels: (1) (intra)personal level; (2) interpersonal level; (3) professional and organizational level; (4) public level; and (5) global level. Therefore, the situations which include ethical communication problem and may be turned into narratives may arise at public meetings, e-mails or by means of public media (journalistic publications, social media posts, advertising etc.). These situations can be interpreted into “cases” if anyone is motivated and has moral sensitivity to recognize the moral problems in these situations and describe these situations prom the point of view of any moral actor.

In addition, there are other sources to rely on for inspiration:

- fictional stories (books and films);
- lawsuits, complaints sent to the ethics councils and the relevant decisions;
- media scandals (scandals always include the moral questions and conflict of values);
- narratives provided by people telling stories about their lives or what they experienced (we propose to call this type of source "raw narratives").

The case can be constructed into a narrative for teaching purposes in two different ways. In the first approach, the narrative is told from the perspective of an omniscient narrator, where the learner must discern the characters, their power dynamics and loyalty obligations, the moral choices they face, and how one character's decision impacts others.

In the second approach, which we explore in greater detail in the present article, the narrative is framed from the viewpoints of two (or, in exceptional cases, three) characters. This method particularly enhances the development of moral imagination and empathy of the learner.

A third option involves constructing narratives that present multiple solutions to the learner. In this scenario, the learner's task is to evaluate the behaviors of all the characters and determine

which option appears morally correct to them. This latter approach has been used in games powered targeted to broader public with various moral theories (deontology, teleology, care ethics etc.) serving as the foundation for these choices (see, for example, Parder et al., 2024).

3. Constitutive elements of the narratives

When constructing narratives, there are certain steps to consider. Current method is development from the methodology set out by Parder et al. (2024) and focuses on creating narratives for training the communication ethics competencies.

First, each narrative must contain a principle of value of communication ethics. Such principle or value is described in the narrative as norm (see example in 3.1). As explained in the introduction, background knowledge regarding the normative clusters is beneficial.

Secondly, each narrative contains two or three active characters in the interaction between which a communication ethical conflict or a decision-making moment arises.

Thirdly, the narratives can be presents from the point of view of two (in some cases, three) characters. In the concept of dialogic communication ethics, stepping into the shoes of the other is important, because it develops empathy and moral imagination.

Fourth, since each case presents the point of view of two (or three) characters, it is also important to pay attention to the sequence of the actions of the narrative in time. The narrative presented from the second character's point of view may be a step behind in time compared to the narrative written from the first character's point of view. It is important that each narrative contains minimal background information about the characters' motives and flows over time during a single interaction.

And fifth, each narrative must contain a moment of moral decision-making or moral "cross-road".

In some cases, the decision-making moment reflects a clear violation of a norm of communication ethics. In such case, the question of moral judgement is how to interpret the violation and how to respond to the corresponding interpretation. Some other narratives are not about any violation or a principle of communication ethics but the interpretation of the principle. In such cases, the decision-making moment will be more blurred.

3.1. Example: violation of the general norm of good communication conduct

We present one case where the central narrative is presented from two different perspectives. The narrative starts with a headline that should provide a hint concerning the "cluster" of the communication, media or journalism ethics. This is useful, if the narratives are used for training various target groups.

Offensive expression in the internal list of the organization

Allan is a new employee in the organization. One day he discovers that the regulation, which has been interpreted narrowly at all times within the organization, can also be interpreted in another way. Allan finds it important to report, such as possible error on all employees and makes the corresponding post to the organization list.

Kim, one of the longtime employees, reacts to Allan's post by writing an answer on the public list that he believes Allan has no competence to express such an opinion, given his prior professional experience.

Allan feels that this personal and public attack on him is not acceptable.

What would you do if you were Allan

This narrative is presented from the perspective of first actor Allan. The communication levels that are covered with this situation are interpersonal (between Allan and Kim) and organizational (public communication on an organizational level). The narrative also gives the judgement of Kim's act from Allan's point of view: personal public attack is not acceptable. The judgement indicates what is the "moral crossroads" for Allan – a decision point, they cannot ignore (or point, where ignoring is also a decision in itself). With the last question the person is offered a possibility for moral imagination and their possible solution to it – what would you do? The aim is not to criticize someone else, therefor it is not asked "What should Allan do?".

After the narrative is solved by the learner, they are presented with another perspective of the situation, in this case Kim's perspective.

Kim has worked for many years in a field that implements and interprets regulations concerning X issues. One day, he reads a post by a new employee, Allan, in which Allan claims the regulation has so far been interpreted too narrowly. Kim feels that Allan, as a new employee, is criticizing an area he doesn't know thoroughly. Kim posts a comment in which he says Allan has no competence to express such views. Later Kim receives a phone call from a colleague who says Kim's personal public attack towards Allan was not proportional.

What would you do if you were Kim?

In this case, Kim's motivations are presented: (1) they have extensive expertise in this area; (2) they feel they are being criticized; and Kim's action on how they handle the situation (with a public response). There is a slight difference in the temporal setting of the situation, as Kim gets an additional impulse for making a decision form a colleague (third actor in the situation, who themselves have made a decision to act) who gives a moral judgement to the situation and indicates a violation of communication ethics principle – the feedback makes it a moral crossroads for Kim, a point they cannot ignore.

4. Conclusion

Moral sensitivity and awareness refer to the ability to recognize ethical problems in a given situation. The aim of the narratives is to enhance trainees' moral sensitivity and awareness by providing “clean” stories where ethical decision-making scenarios are clearly presented to the actors of the story. The constructed narrative usually provides circumstances that lead to the communication ethical problem.

Moral imagination involves the capacity to consider diverse perspectives, envision multiple ethical possibilities, and recognize the complexities involved in various situations, such as the ability to imagine the impact of one's decisions on others (Werhane, 1999). In narrative construction, moral imagination is cultivated as narratives can be written from the perspectives of different characters within the story.

Moral reasoning is often defined as an “umbrella” competence that includes moral awareness, moral judgment, and moral motivation. In the present study, we use *moral reasoning* in a more specific sense—it refers to the process of identifying, evaluating, and choosing between different moral principles or values when faced with ethical problems. In some narratives, especially those that involve misconduct, the story explicitly highlights certain values or principles. However, it is also possible to construct a narrative where the values and principles under consideration are embedded within the description of the situation. Moral reasoning can be trained through narratives if the trainee attempts to balance different principles and values to create a hierarchy of their preferences.

Purposefully constructed narrative: (1) enable individuals to apply basic and practical concepts of ethics and dialogic communication theory and normative discourses to a range of communication context, including the media, interpersonal relationships, and political communication; (2) to facilitate the individual learners’ capacity to develop moral sensitivity and moral imaginations, carry out moral reasoning as well as to empower professional groups to engage in moral reasoning; and (3) to encourage the individual learners to apply their comprehension of communication ethics to their personal experience.

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References

Arnett, R., Bell, L., & Fritz, J.H. (2010). Dialogic Learning as First Principle in Communication Ethics. *Atlantic Journal of Communication, 18*(3), 111–126. DOI: 10.1080/15456871003742021.

Arnett, R. C., Fritz, J., & Bell, M. (2009). *Communication ethics literacy: dialogue and difference*. Sage.

Arnett, R., Arneson, P. & Bell, L. (2006). Communication Ethics: The Dialogic Turn. *The Review of Communication, 6*, 62-92. 10.1080/15358590600763334.

Aznar, H., & Castillo-Martín, M. (2018). "Vulnerability" as the key concept of a communicative ethics for the 21st century. *Media Development*, 3, 16–20.

Baldor, R.A., Field, T.S., Gurwitz, J. H. (2001). Using the 'question of scruples' game to teach managed care ethics to students. *Academic Medicine, 76*(5), 510–511.

Bekir, N., Cable, V., Hashimoto, I., Katz, S. (2001). Teaching engineering ethics: a new approach. In: ASEE/IEEE Frontiers in Education Conference.

Dilemma Game: Professionalism and Integrity in Research. (n.d.). https://www.eur.nl/en/about-eur/policy-and-regulations/integrity/research-integrity/dilemma-game. Accessed 31.01.2025.

Duncan, S. (2023). *Ethics for Journalists (3rd ed.)*. Routledge. https://doi.org/10.4324/9780429505386

Christians, C. G. (2019). New digital technology and global communication ethics. *Media Development, 65*(1), 5–12.

Cohen, H. (1993). The citicorp interactive work ethic game: sociological practice use in the classroom. *Clinical Sociological Review, 11*(1), 14.

Eberwein, T. (2021). Journalism ethics and its participatory turn. In L.T. Price, K. Sanders, & W.N. Wyatt (Eds.), The Routledge Companion to Journalism Ethics.

Escobar, O. (2011). Public dialogue and deliberation: A communication perspective for public engagement practitioners. UK Beacons for Public Engagement, Edinburgh.

Fourie, P. (2021). *From journalism ethics to communication ethics*. In L.T. Price, K. Sanders, & W.N. Wyatt (Eds.), The Routledge Companion to Journalism Ethics.

Harcup, T. (2021). *Slow journalism as ethical journalism*. In L.T. Price, K. Sanders, & W.N. Wyatt (Eds.), The Routledge Companion to Journalism Ethics.

MacDonald, M. N. & O'Regan, J. P. (2013). *The Ethics of Intercultural Communication. Educational Philosophy and Theory, 45*(10), 1005-1017, https://doi.org/10.1111/j.1469-5812.2011.00833.x

Nelson, J. (1992). The market ethic: moral dilemmas and microeconomics. *Journal of Business Ethics, 11*, 317–332. https://doi.org/10.1007/BF00872174

Parder, M. L., Tammeleht, A., Juurik, M., Paaver, T., Velbaum, K., Harro-Loit, H. (2024). Digital Discussion Game on Values: Development, Use and Possibilities for Measuring Its Functionality. In: Cheng, Y. P., Pedaste, M., Bardone, E., Huang, Y. M. (eds) *Innovative Technologies and Learning. ICITL 2024. Lecture Notes in Computer Science*, *14785*. Springer, Cham. https://doi.org/10.1007/978-3-031-65881-5_21

Plaisance, P. L. (2014). *Media Ethics: Key Principles for Responsible Practice*. SAGE Publications.

Taylor, M. & Kent, M. L. (2014). Dialogic engagement: clarifying foundational concepts. *Journal of Public Relation Research, 26*(5), 384–398.

Tompkins, P. S. (2015). Acknowledgment, Justice, and Communication Ethics. *Review of Communication, 15*(3), 240–257.

Yang, S.-U., Kang, M. & Cha, H. (2015). A study on dialogic communication, trust, and distrust: testing a scale for measuring organization–public dialogic communication (OPDC). *Journal of Public Relation Research, 27*(2), 175–192.

Wasserman, H. (2020). *The Ethics of Engagement: Media, Conflict and Democracy in Africa*. Oxford Academic. https://doi-org.ezproxy.utlib.ut.ee/10.1093/oso/9780190917333.001.0001.

Wasserman, H. (2015). Listening past difference: Towards a compassionate ethics of communication. *Stellenbosch Theological Journal*, *1*(2). https://doi.org/10.17570/stj.2015.v1n2.a10

Werhane, P. (1999). *Moral Imagination and Management Decision-Making*. Oxford University Press, New York, Oxford.

Wolvin A. D. (2010). *Listening and Human Communication in the 21st Century*. Wiley-Blackwell.

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Promote Dignity in Palliative Care Nursing Education using a narrative pedagogical approach

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Abstract

The education of nursing students encompasses the transmission of knowledge and clinical skills, as well as values, attitudes, and behaviors. In palliative care, it is imperative to uphold and safeguard individuals' dignity. We aimed to explore senior nursing students' perceptions of dignity in care using a narrative approach. Reflection prompts were designed using the ABCDs dignity in care model. Audio recording reflection entries from 18 students were collected and analysed using qualitative content analysis. Three themes were identified: 1) being transformed; 2) the power of narrative to expose personal vulnerability; and 3) connection and detachment in EoL. Our findings indicated that reflection on personal dignity enhances comprehension, fosters the humanization of care, and facilitates acts that can uphold the dignity of patients.

Keywords: *Palliative Care; Dignity; Narrative; Competence; Reflection.*

1. Introduction

Palliative care (PC) has become increasingly significant within healthcare services and may commence upon the diagnosis of a serious illness and continue throughout the care trajectory (Cain et al., 2018). Currently, PC presents a broad set of challenges for communities, institutions, and healthcare professionals, aiming not only to ensure its accessibility but also to enhance its effectiveness (Vitorino et al., 2023). The challenges also extend to academia, highlighting the need to foster and develop fundamental basic competencies in PC among undergraduate nursing students (Martins Pereira et al., 2021).

Teaching palliative care's philosophy, pillars, and bioethics in nursing is essential (Pereira et al., 2022). Upholding the dignity of individuals and their families during the dying process is crucial

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in healthcare, especially for nurses operating in PC units (Chua et al., 2022). The education of nursing students should encompass ethical, humanistic, and scientific principles, grounded in respect for individual dignity, particularly in vulnerable situations (Rojas-Rivera et al., 2023).

Given the vulnerability of individuals in PC, it is crucial to promote authentic dialogues within the framework of diversity and social justice in higher education. Through a 'pedagogy of vulnerability,' this approach enhances student engagement and empowerment by encouraging them to critically assess their own competencies (Christodoulidi, 2024; Farfán-Zúñiga & Jaman-Mewes, 2024; Laranjeira, 2025). Active teaching and learning methodologies place students at the heart of the educational process, fostering deeper understanding and skill development (Chang et al., 2022). Besides, narrative-based interventions positively influence nursing students by enhancing their listening and observational skills, fostering self-reflection and empathy, encouraging alternative perspectives on person care, and serving as effective tools for motivating both professional and personal development (Xue et al., 2023).

Jean Watson posited that the capacity for humanistic care in nursing represents the nurses' manifestation of humanistic literacy within clinical practice, enabling them to serve patients with awareness and creativity (Wu & Volker, 2012). She delineated ten caritas factors/processes, which encompass the cultivation of a humanistic-altruistic value system, the establishment of a trusting human-caring relationship, the instillation and facilitation of faith and hope, and the provision of a supportive, protective, and/or corrective mental, social, and spiritual environment. Consequently, it is imperative to develop nursing students' capacity for humanistic care and their ability to give compassionate patient care (Xue et al., 2023).

Dignity in nursing education is infrequently delineated, and there exists a paucity of standards for nurses to implement in their practice to elevate the dignity of individuals (Crump, 2019a). Therefore, this study aimed to explore senior nursing students' perceptions of dignity in care using a narrative approach. Adapting the well-known mnemonic "airway, breathing, and circulation (ABC)" Chochinov has developed an ABCD framework for dignity conserving care that is easy to remember and understand (Higginson & Hall, 2007). The ABCDs of dignity in care (Chochinov, 2007) examine how attitudes may affect actions, and how people can take conscious steps to adjust those attitudes and behaviors. This framework was developed for everyone who has contact with patients, and who therefore could support the dignity of people who seek help.

2. Methodology

2.1. Study design

This study used a descriptive qualitative design, an excellent approach for gaining insight into a research question and understanding people's perceptions about the phenomena (Kim et al.,

2017). The study was guided by the COREQ reporting guidelines. Ethics approval was granted by the Polytechnic University of Leiria (CE/IPLEIRIA/54/2023).

2.2. Participants and Recruitment

All undergraduate nursing students enrolled in a palliative care course in their third year were invited. Eighteen students responded positively to participate in this study. Incoming international students were excluded. Participants have an average of 22.51 ± 2.83 years of age (range: 20 – 35), and the majority were female (n=15).

2.3. Educational Strategy

Two PC nursing faculty members and two clinical nurses developed the training program which covered four main palliative care pillars: symptom control, effective communication, family care, and interdisciplinary teamwork. Conventional pedagogy has limitations for sensitive topics like death due to its lack of flexibility and interactivity, so narrative pedagogy was used instead based on ABCD model of Dignity-Conserving Care (Chochinov, 2007). The ABCD guides students and professionals in preserving the dignity of patients, particularly in PC, and is based on four core dimensions: 1) Attitude; 2) Behavior; 3) Compassion; and 4) Dialogue (Table 1).

The five-week narrative training included 25 hours: 15 theoretical (eight sessions) and 10 practical (five sessions). Weekly lectures, using expositive and interrogative methodology, addressed values and attitudes towards death and end-of-life (EoL), compassionate communication and management of bad news/family conference, symptom management, comfort measures, spiritual care, bereavement support, teamwork, and self-care. Practical lessons with 8-12 participants used active learning strategies such as reflective journal technique, roleplaying, case-based learning, team-based learning, and autobiographical narratives. Real clinical cases were applied to simulate tasks like bad news communication and EoL care. Each session included prebriefing, activity implementation with narrative materials, and a debriefing phase for reflection.

2.4. Data Collection

The study was conducted from September to November 2024. Students were prompted to reflect on their PC course by providing an audio recording on any aspect of dignity of the person, following an interaction with a former caregiver of a person in PC. Data were collected through reflection prompts guided by ABCDs dignity in care (Chochinov, 2007). These reflection entries incorporated the different aspects addressed throughout the training process.

Table 1. Detail of ABCD framework

ABCD dignity in care	Open questions, that guided self-reflections and critical thinking
A – Atittudes This first step is to exam own personal attitudes, beliefs and assumptions regarding patients	○ How would I feel if I were in this patient's position? ○ What factors are influencing my conclusions? ○ Have I verified whether my assumptions are correct? ○ Am I conscious of how my attitude might be impacting the patient? ○ Could my perspective on the patient be shaped by my own experiences, anxieties, or fears? ○ Does my approach as a healthcare provider facilitate or hinder my ability to build open and empathetic professional relationships with my patients?
B – Behavior When I become aware of my attitudes, I can more easily adjust my behavior towards others.	○ I always act and speak with small active kindness that personalizes my care. ○ All people be worthy and have my full attention? ○ Have I improved my communication skills and the tone of contact?
C – Compassion Deep awareness of the patient's suffering and a genuine desire to alleviate it, conveyed through simple gestures such as a compassionate look or a gentle touch	○ I use an understanding look. ○ I look for ways to identify with those who are ill or suffering. ○ I can spoken or unspoken communication, that acknowledges the person and the human challenges that accompany illness ○ I realize that like patients we are all vulnerable. ○ I can foster a sense of trust, openness and honesty that can increase the likelihood that someone will share important personal details.
D – Dialogue To provide the best care possible, nursing students need to gather accurate details about the whole person, and not just the illness.	○ To assess patient priorities and stressors students can aplly the folllowing questions: ○ What should I know about you as a person to give you the best care possible?" ○ At this time of your life, what's the most important issues to you? ○ Who else do you would like to get involved?

2.5. Data Analysis

The data analysis was performed using the conventional content analysis method (Graneheim & Lundman, 2004). Qualitative content analysis is a research methodology that facilitates the conceptual interpretation of textual material by means of systematic classification, coding, and theme development, or by employing established models to acquire comprehensive, in-depth insights regarding the topic being examined. The transcript of each reflective prompt was examined multiple times. Following a comprehensive understanding of the transcript's content, the researcher conducted an inductive analysis of the data. Significant paragraphs were annotated during the meticulous examination of the transcripts. Each notable phrase or paragraph was designated a code. The codes were categorized based on their commonalities and importance. To evaluate the veracity of the codes, the categories were examined and juxtaposed

with the data. Subsequently, following thorough contemplation and comparative analysis of the categories, the researchers identified the themes. The data analysis was conducted using WebQDA software.

2.6. Rigor

The rigor of the gathered data was evaluated according to the criteria established by Lincoln and Guba (1985). Credibility was assessed via member validation, peer debriefing, and examination of contradictory evidence. To evaluate the reliability and confirmability of the data, the researchers engaged a panel of experts to verify the accuracy of the transcripts, as well as the extracted codes and categories. Transferability was guaranteed through a comprehensive discussion of the research topic, participant characteristics, and data analysis methods, supplemented with samples of participant quotations. The researchers deliberated about data saturation following the individual analysis of the reflective diaries.

3. Findings and Discussion

Three main categories emerged related to the concept of dignity in care of patients in palliative condition: 1) being transformed; 2) the power of narrative to expose personal vulnerability; and 3) connection and detachment in EoL.

1) Being transformed

Students capable of deeply contemplating their experiences, emotions, and the intricate moral dilemmas encountered in EoL care received a genuinely transformative learning experience which according to Briciu (2024) involves dealing with edge emotions. They also recognized that mortality is inevitable for all humans, including themselves, prompting them to consider the circumstances of their own death, including the location, companionship, and manner of their passing.

P2: *Being able to stop and reflect on our development is essential to regulating emotions and thus having meaningful learning. Dignifying care also implies enhancing resilience and commitment to patient-centered care.*
P7: *How important it is to reflect on the place of care and the place of death. After all, we can choose how we want to end our lives.*

Students contemplated the type of nurses they wish to be at a professional level. This thought entailed an examination of their fundamental professional values, considering whether to maintain a distance from their patients or deepen their connection with them.

P11: *Only now, in the third year of the course, have we realized how respect for dignity is the basis on which all care must be developed, and this has made us think about our finitude. After all, we will all need humanized care at a certain stage in our lives.*

2) the power of narrative to expose personal vulnerability

Participants acknowledge the fragility and sensitivity of those nearing death and distinctly recognize the necessity for dignified care. Likewise, students feel that own vulnerability was exposed generating a sense of fear and distress.

P8: *Caring for people at the end of their lives is a huge challenge because we are faced with the fragility of ill people and their families. However, I feel that I am fragile and "naked" without really knowing what to say or do. I think several times, what if it were me...*
P5: *Dealing with death causes me a lot of stress, mostly because I don't know what to say...*

The students emphasized that every act of care must be infused with dignity (Chua et al., 2022; Crump, 2019b). Participants also underscored that respect and dignity stem from collaborative efforts among health professionals, with numerous reflections indicating that a deficiency in mutual respect undermined professionalism. This led to doubts about their competencies and reasoning skills. Those doubts and intense feelings of anguish and insecurity were remarkable during the EoL decision-making process (Ribeiro et al., 2024).

P4: *From my experience in clinical teaching, I realize that sometimes clinical practices are not always aligned with conservative dignity strategies, and this is a lack of professionalism.*

3) Connection and detachment in EoL

While nursing students tend to develop a desire for meaningful connections with their patients some participants point out that detachment as a protective mechanism against "empathy burnout" to preserve their ability to continue providing adequate care despite the moral challenges they were experiencing. P10 stated: *We learned that in therapeutic relationships it is important to work on detachment. It means that this strategy allows us to preserve our identity as well as not having negative implications for the quality of care offered.*
P15: *Detachment is very difficult because involvement in EoL care is very intense... I remember that when I accompanied a patient at the EoL in my first clinical training, I suffered a lot...*

Our findings were consistent with existing research that suggests that constant exposure to suffering patients, and a whirlwind of emotions influenced their need to develop emotional detachment as a coping mechanism (Ribeiro et al., 2024). By disseminating significant EoL care experiences and acknowledging their vulnerability, educators can act as a powerful catalyst for genuine, transparent, and humanized discourse.

3.1. Study limitations

This study has certain limitations, including the sample size and the duration of the educational intervention program, which restricted the depth of content exploration. Furthermore, given the qualitative nature of the research, additional potential limitations should be considered. Specifically, data interpretation may be influenced by the researcher's perceptions, beliefs, and

experiences, which could impact the objectivity of the analysis. Additionally, the data are highly context-dependent, relying on the specific environment and circumstances in which they were collected, which may pose challenges for comparison across different studies.

4. Conclusion

This study affirms that dignity-conserving care encompasses not only the actions taken for the patient but also it perception. This can be implemented through precise and tangible care acts, alongside comprehensive attitudes and behaviors that uphold the patient's dignity. As an innate philosophical construct, dignity is deeply rooted and vital to every individual. This intrinsic dignity becomes increasingly significant during end-of-life (EoL) situations when nursing students confront profound physical and metaphysical obstacles. EoL patients must be honored in the final days of their existence as the essence of their being. This essence must not be undervalued but rather be exalted and revered. This can be achieved by enhancing self-respect as a healthcare professional. To ensure optimal PC, respect must be ingrained in the healthcare environment. Besides, social dignity pertains to the relational dynamics and societal challenges that either enhance or diminish patients' perception of dignity. The reflective process during the PC course heightened understanding of this concept, illustrating the dignity of each individual in caregiving circumstances, and empowering each student to deliver nursing care with dignity consistently. Furthermore, students were capable of recognizing instances of inadequate care that compromised individual dignity.

References

Briciu, B. (2024). Emotions and Meaning in Transformative Learning: Theory U as a Liminal Experience. *Journal of Transformative Education*. https://doi.org/10.1177/15413446241246236/ASSET/IMAGES/LARGE/10.1177_15413446241246236-FIG1.JPEG

Cain, C. L., Surbone, A., Elk, R., & Kagawa-Singer, M. (2018). Culture and Palliative Care: Preferences, Communication, Meaning, and Mutual Decision Making. *Journal of Pain and Symptom Management*, *55*(5), 1408–1419. https://doi.org/https://doi.org/10.1016/j.jpainsymman.2018.01.007

Chang, K. K. P., Chan, E. A., & Chung, B. P. M. (2022). A new pedagogical approach to enhance palliative care and communication learning: A mixed method study. *Nurse Education Today*, *119*, 105568. https://doi.org/10.1016/j.nedt.2022.105568

Chochinov, H. M. (2007). Dignity and the essence of medicine: the A, B, C, and D of dignity conserving care. *BMJ*, *335*(7612), 184–187. https://doi.org/10.1136/bmj.39244.650926.47

Christodoulidi, F. (2024). A pedagogy of vulnerability: Its relevance to diversity teaching and 'humanising' higher education. *Equity in Education & Society*, *3*(2), 101–113. https://doi.org/10.1177/27526461231185834

Chua, K. Z. Y., Quah, E.L., Lim, Y. X., Goh, C. K., Lim, J., Wan, D. … & Krishna, L. (2022). A systematic scoping review on patients' perceptions of dignity. *BMC Palliative Care 2022 21:1*, *21*(1), 1–18. https://doi.org/10.1186/S12904-022-01004-4

Crump, B. (2019a). Exploring oncology nurses' perceptions during end-of-life care. *Clinical Journal of Oncology Nursing*, *23*(3), E46–E51. https://doi.org/10.1188/19.CJON.E46-E51

Crump, B. (2019b). Patient Dignity: Exploring Oncology Nurses' Perceptions During End-of-Life Care. *Clinical Journal of Oncology Nursing*, *23*(3), E46–E51. https://doi.org/10.1188/19.CJON.E46-E51

Farfán-Zúñiga, X., & Jaman-Mewes, P. (2024). Reflections of nursing students on the care of the person's dignity at the end of life: A qualitative study. *Nurse Education Today*, *133*, 106067. https://doi.org/10.1016/j.nedt.2023.106067

Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research: Concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today*, *24*(2), 105–112. https://doi.org/10.1016/j.nedt.2003.10.001

Higginson, I. J., & Hall, S. (2007). Rediscovering dignity at the bedside. *BMJ*, *335*(7612), 167–168. https://doi.org/10.1136/BMJ.39277.847118.2C

Kim, H., Sefcik, J. S., & Bradway, C. (2017). Characteristics of Qualitative Descriptive Studies: A Systematic Review. *Research in Nursing & Health*, *40*(1), 23–42. https://doi.org/10.1002/NUR.21768

Laranjeira, C. (2025). Dignity, Health, and Well-Being. In: Liamputtong, P. (eds) *Handbook of Concepts in Health, Health Behavior and Environmental Health*. Springer, Singapore. https://doi.org/10.1007/978-981-97-0821-5_10-1

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*. SAGE Publications. https://books.google.pt/books?id=2oA9aWlNeooC

Martins Pereira, S., Hernández-Marrero, P., Pasman, H. R., Capelas, M. L., Larkin, P., & Francke, A. L. (2021). Nursing education on palliative care across Europe: Results and recommendations from the EAPC Taskforce on preparation for practice in palliative care nursing across the EU based on an online-survey and country reports. *Palliative Medicine*, *35*(1), 130–141. https://doi.org/10.1177/0269216320956817

Pereira, L. M., Andrade, S. M. O. de, & Theobald, M. R. (2022). Palliative care: challenges for health education. *Revista Bioética*, *30*(1), 149–161. https://doi.org/10.1590/1983-80422022301515en

Ribeiro, D. L., Sacardo, D., Drzazga, G., & Carvalho-Filho, M. A. de. (2024). Connect or detach: A transformative experience for medical students in end-of-life care. *Medical Education*. https://doi.org/10.1111/MEDU.15545

Rojas-Rivera, A., Quiroga, N., Echeverria, A., Muñoz-Larrondo, F., Concha-Gutierrez, C., Galiano, A. … & Herrera, B. S. (2023). Development of a Professional Practice Nursing Model for a University Nursing School and Teaching Hospital: A nursing methodology research. *Nursing Open*, *10*(1), 358–366. https://doi.org/10.1002/NOP2.1308

Vitorino, J. V., Duarte, B. V., & Laranjeira, C. (2023). When to initiate early palliative care? Challenges faced by healthcare providers. *Frontiers in Medicine*, *10*. https://doi.org/10.3389/fmed.2023.1220370

Wu, H. L., & Volker, D. L. (2012). Humanistic Nursing Theory: application to hospice and palliative care. *Journal of Advanced Nursing*, *68*(2), 471–479. https://doi.org/10.1111/J.1365-2648.2011.05770.X

Xue, M., Sun, H., Xue, J., Zhou, J., Qu, J., Ji, S., Bu, Y., & Liu, Y. (2023). Narrative medicine as a teaching strategy for nursing students to developing professionalism, empathy and humanistic caring ability: a randomized controlled trial. *BMC Medical Education*, *23*(1), 1–11. https://doi.org/10.1186/s12909-023-04026-5

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Comparing homogeneous and heterogeneous ability grouping in collaborative computational lab activities in Financial Mathematics

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Abstract

Collaborative learning is an engaging methodology to captivate students in problem-solving activities and inclusive computational lab practices and to foster sensemaking. The knowledge co-construction process can be influenced by group composition. This study aims to investigate how group composition affects knowledge co-construction in student-led computational lab activities in Financial Mathematics. This was done by comparing two different group compositions working within a Computer-Supported Collaborative Learning environment, in two consecutive academic years, namely AY 2020/2021 with internally homogeneous ability groups and AY 2021/2022 with internally heterogeneous ability groups. 572 student responses to a weekly survey were included in the analysis and the adapted Interaction Analysis Model was used to investigate peer interactions.

Keywords: *Collaboration; computational thinking; grouping; mathematics education.*

1. Introduction

Socio-constructivist theories support the idea that knowledge is co-constructed through social interactions, shared experiences, and the exchange of points of view (Lave, 1991). In the context of mathematics education, collaborative learning is useful to effectively engage students in problem-solving activities and to apply theoretical concepts to real-world scenarios. Specifically, introducing collaboration into computational thinking practices is beneficial to promote sensemaking (Odden & Russ, 2019) and facilitate understanding of models and algorithms. This study aims to investigate the knowledge co-construction process within an undergraduate Financial Mathematics (FM) module dealing with mathematical models for finance and computational techniques for pricing financial derivatives, namely the Advanced

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Computational Finance module (ACM30110) offered by the School of Mathematics and Statistics at University College Dublin (UCD). In this research, we focus on the collaborative student-led lab activities timetabled in this module and analyse the impact of group composition (homogeneous vs heterogeneous ability groups) in the knowledge co-construction process in two different academic years, i.e. 2020/2021 and 2021/2022. This paper is organized as follows: Section 2 outlines the theoretical framework; Section 3 covers the research context, data collection, and analysis methods; Section 4 presents the results and explanations; the final section concludes with potential future research directions.

2. Theoretical framework

In recent years, there has been increasing focus on Computational Thinking (CT) and related practices. Wing (2017) defines CT as a skill not restricted to computer science but one that - when integrated into education - fosters problem-solving, critical thinking, and sensemaking (Odden & Russ, 2019). Recognizing its importance, CT is now part of curricula at all levels. Weintrop et al. (2016) outlined how to effectively embed CT in STEM through a taxonomy with four main categories. Indeed, integrating coding and CT practices requires careful consideration of which computational practices to introduce and how to use them. In mathematics education, computational practices extend beyond algorithm manipulation; they include leveraging tools to enhance scientific understanding. These align with the concept of *inclusive computational practices* (Caballero & Hjorth-Jensen, 2018) and underscores the role of technology in STEM subjects. CT practices also support collaboration, enhancing knowledge co-construction (Resta & Laferrière, 2007). Research highlights that collaborative learning is more effective than individual learning for CT development (Chen, Wang & Li, 2022). Technology-enhanced collaborative activities fall under Computer-Supported Collaborative Learning (CSCL), where interactions between peers shape learning (Zabolotna et al., 2023).

To investigate the knowledge co-construction, models like the Interaction Analysis Model (IAM) (Gunawardena et al., 1997) have been developed. The IAM, with its 5 phases and 21 sub-phases, is widely used for analysing online discussions and has been adapted to various contexts (Lucas et al., 2014). Barana, Boetti et al. (2023) modified IAM for Financial Mathematics, structuring it into 6 phases and 16 sub-phases to analyse collaboration in lab activities where CT is a core practice. We refer to this paper for a deeper description of the 6 phases. A key factor in collaborative learning is group composition. While research comparing homogeneous and heterogeneous ability groups is limited, findings suggest that both have advantages. Wyman and Watson (2020) found that students in homogeneous groups performed slightly better, though not significantly so. Homogeneous groups promote equal involvement, enhancing performance (Ge et al., 2018), while heterogeneous groups may benefit low-achieving students but risk turning into peer tutoring (Briggs, 2020). Murphy et al. (2017) found that heterogeneous groups achieved better comprehension, yet low-achieving students were less

engaged. Mesghina et al. (2024) suggest that low-achieving students benefit from cooperative learning regardless of group composition, with learning gains being statistically similar between homogeneous and heterogeneous groups.

3. Setting and Methods

In this study, we aim to answer the following research question: "How does group composition - homogeneous versus heterogeneous ability grouping - affect the co-construction of knowledge in collaborative student-led lab computational activities in Financial Mathematics?". The setting of the research study is the tailored student-led lab designed for an Advanced Computational Finance module (ACM30110, formerly ACM30070), fully described in Perrotta (2021) and Perrotta & Dolphin (2021). The module is offered by the School of Mathematics and Statistics at UCD as a core module for stage 3 students enrolled in the BSc in FM and as an optional for stage 3 students in the BSc in Applied and Computational Mathematics (ACM). The study was conducted in Spring 2021 and Spring 2022. Specifically, in Spring 2021 the module was delivered as a 5-credits module online, due to COVID-19 restrictions, while in Spring 2022 it was redesigned and delivered as a 10 credits face-to-face module. A typical week consists of theoretical lectures, tutorials, and student-led lab activities. While lectures and tutorials were slightly affected by the 2022 redesign, lab materials and assessments were heavily modified. Leveraging on the analyses of 2021 lab practices (Barana, Marchisio, et al., 2023) and the change of the teaching setting from online to face-to-face, activities were adjusted to foster collaboration and tackle student challenges. Specifically, tailored computational practices, such as collaborative debugging (Andersen, 2022) and collaborative coding, were introduced to enhance meaningful collaboration and foster in-depth sensemaking. The computational component, as a pillar of the subject, was further emphasized. Within this context, we investigate the knowledge co-construction process by comparing homogeneous and heterogeneous ability groups in CT practices in FM, focusing on lab activities in Spring 2021 (homogeneous groups) and Spring 2022 (heterogeneous groups). In Spring 2021, the 50 attending students (15 ACM and 35 FM) were divided into 7 internally homogeneous groups, labelled from A to G. Each group consisted of 7 students, except for group D, which had 8 students. Students were grouped according to their grade point average (GPA) to form level groups. Groups A, B, and C consisted of high-achieving students with average GPAs of 3.96, 3.64, and 3.45, respectively. Groups D and E consisted of intermediate-level students with average GPAs of 3.26 and 3.04, respectively. Finally, Groups F and G consisted of low-achieving students with average GPAs of 2.79 and 2.43. Actually, the reported averages exclude two students, which were removed from the dataset: one - initially in group E - who never attended labs, and an Erasmus student in group D. The presence of ACM and FM students was balanced within the groups, and gender and possible minorities were balanced. In Spring 2022, 23 students (3 ACM and 20 FM) enrolled in the module, but only 22 actually attended it, and

they were split into 5 internally heterogeneous groups, labelled from A to E. Groups A and B had 5 components, while groups C, D, and E had 4 students each. Since it was not possible to assign one ACM student to each group, the grouping was solely based on students' GPA. Students were assigned to heterogeneous groups based on GPA: each group had a similar GPA on average, ranging from 3.51 to 3.67. To balance the groups' competences and keep heterogeneity, the two groups with 5 students have a wider dispersion of GPAs around their average (Group A has components whose individual GPAs range from 2.62 to 4.04 and Group B has GPAs ranging from 2.9 to 4.2), while the other three groups were composed of students whose individual GPAs were close to the group average. Similar studies have not reported any difference in sex/gender in the design or analysis phases unless this was needed for the purpose of the research. In our case, data is not analysed according to the sex variable. However, particular attention was given to the sex/gender balance in group composition in this research study. To avoid any sense of discomfort, there were at least two females in each group. Only group D had one female, who freely chose to be the only female student in that group instead of being assigned to another one. As seen in Table 1, the groups in Spring 2021 have a lower standard deviation for the internally homogeneous GPA between students, while in Spring 2022 the standard deviations are higher because the students in the groups have different GPAs. The composition of Spring 2022 groups D and E, featuring intermediate students for ensuring internal heterogeneity, mirrored that of the Spring 2021 groups.

Table 1. Group composition in Spring 2021 and Spring 2022 in terms of GPA mean.

Spring 2021				**Spring 2022**			
Group	N	GPA Mean	St. Dev.	Group	N	GPA Mean	St. Dev.
A	7	3.96	.17	A	5	3.51	.58
B	7	3.64	.13	B	5	3.62	.50
C	7	3.45	.13	C	4	3.63	.35
D	7	3.26	.10	D	4	3.67	.15
E	6	3.04	.08	E	4	3.67	.08
F	7	2.79	.15				
G	7	2.43	.36				

For our study, we analysed the answers to a weekly survey that students attending the module in Spring 2021 and Spring 2022 completed after each lab, with a total of 572 responses (396 for Spring 2021, 176 for Spring 2022). The survey contains both Likert-scale and open questions, which asked students to reflect on the effectiveness of inclusive computational practices and collaboration on improving their understanding. The survey can be found in (Barana, Boetti, et al., 2023). We performed a qualitative analysis of those answers using the IAM framework in its adapted version to the FM context (Barana, Boetti, et al., 2023), classifying them in accordance to the 6 phases, i.e. (0) no evidence of interaction; (1) sharing and comparing of

information; (2) the discovery and exploration of dissonance or inconsistency among ideas, concepts or statements; (3) negotiation of meaning/co-construction of knowledge; (4) testing and modification of proposed synthesis or co-construction; (5) agreement statement(s) / applications of newly constructed meaning. We analysed the students' responses, trying to understand how they moved iteratively through the phases of the knowledge co-construction process, considering that each phase builds on the previous one, and thus trying to identify the final one they were able to reach. We then collected the results in a contingency table and carried out statistical analyses, such as the Fisher-Freeman-Halton exact test based on 10000 tables sampled according to the Monte Carlo method, to investigate possible relationships between the composition of the groups and the phase of the knowledge co-construction process reached.

4. Results and discussion

In Table 2, the results of the qualitative analysis using the adapted IAM phases are shown. We can see that lower phases indicate less interaction and collaboration in the knowledge co-construction process. For both Spring 2021 and Spring 2022, the highest percentages are highlighted in bold. In both years, phase 1 is the most common, which is in line with the other studies, but Spring 2021 resulted in a higher percentage of phase 5 than Spring 2022. As stated in (Barana, Boetti, et al., 2023), it is interesting to observe that in Spring 2021 the three higher phases of the knowledge co-construction process, (3, 4 and 5), occurred in groups with lower GPAs. This means that groups with lower-performing students showed higher engagement in co-construction of knowledge and deeper understanding, whereas high-achieving students in groups tended to be less cooperative, preferring their comfort zone and avoiding pushing their boundaries or challenging themselves. In Spring 2022, the highest phases occurred in groups A, C, and E, which are heterogeneous groups composed respectively of high-low students, medium high-medium low students and intermediate students.

Table 2. percentage of phases occurrence considering the adapted IAM. For each phase and for each Spring semester, the groups registering the highest percentages are highlighted in bold.

	Group	Phase 0	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Spring 2021	A	**6.3%**	27.0%	**15.9%**	33.3%	3.2%	14.3%
	B	**7.0%**	38.6%	5.3%	35.1%	0.0%	14.0%
	C	3.0%	**59.1%**	6.1%	19.7%	3.0%	9.1%
	D	0.0%	**50.8%**	10.2%	30.5%	3.4%	5.1%
	E	4.5%	29.5%	9.1%	**40.9%**	**6.8%**	9.1%
	F	0.0%	26.0%	**14.0%**	**38.0%**	0.0%	**22.0%**
	G	1.8%	45.6%	**14.0%**	21.1%	1.8%	**15.8%**
	Total	3.3%	40.4%	10.6%	30.6%	2.5%	12.6%
Spring 2022	A	0.0%	34.2%	18.4%	26.3%	**10.5%**	10.5%
	B	**7.3%**	**56.1%**	9.8%	22.0%	2.4%	2.4%

C	0.0%	34.4%	9.4%	37.5%	3.1%	**15.6%**
D	**9.7%**	**51.6%**	16.1%	16.1%	3.2%	3.2%
E	0.0%	29.4%	**23.5%**	**44.1%**	0.0%	2.9%
Total	3.4%	41.5%	15.3%	29.0%	4.0%	6.8%

The Fisher-Freeman-Halton exact test results for Spring 2021 and Spring 2022 provide a statistical foundation to argue that the composition of student groups, whether homogeneous or heterogeneous, significantly influences collaborative learning dynamics. In Spring 2021, when students were divided into homogeneous ability groups, the test value of 48.292 ($p=0.005$) indicates a strong and statistically significant association between group composition and the knowledge co-construction process. The test value for Spring 2022 was lower at 30.499 ($p=0.021$), but still significant, pointing to a meaningful impact of group composition even with heterogeneous groups. Therefore, we cannot say that the difference in group composition is the only statistically significant factor in stimulating the process of knowledge co-construction, but there are some considerations to make. Firstly, due to the pandemic, the collaboration was online in Spring 2021. With the return to in-person teaching in Spring 2022, in-class observations indicated increased students' motivation to work with peers. Secondly, in Spring 2021, the computational practices were calibrated in such a way that during the lab activities the students could discuss tasks and codes they had already worked on individually prior to the lab. In Spring 2022, being returned to in-person teaching, individual coding followed by collective discussion was replaced by collaborative coding and collaborative debugging: this inevitably led to different and more active ways of collaborating. Finally, students in Spring 2022 were, on average, slightly higher achieving than students in Spring 2021 and the levels between them were more similar. Indeed, the average GPA of the class was 3.23, with a standard deviation of 0.52 in Spring 2021, versus 3.61, with a standard deviation of 0.37 in Spring 2022. Spring 2021 students' GPAs ranged from 1.76 to 4.16, with around 33% of students having a GPA below 3. Spring 2022 students' GPAs ranged from 2.2 to 4.2, with around 9% of students having a GPA below 3. These inherent variations in the labs' characteristics (teaching delivery, practices design and class composition) between the two years likely had a significant effect on the ways students interacted and co-constructed knowledge, regardless of group composition, and should therefore be factored into the evaluation of the results.

5. Conclusion

In this research study, we investigated how group composition affects the co-construction of knowledge in collaborative student-led computational lab activities in Financial Mathematics. We considered two different academic years, i.e., 2020/2021 and 2021/2022, and two different group compositions, respectively internally homogeneous and heterogeneous groups, by considering students' GPAs. By using the adapted IAM (Barana, Boetti et al., 2023), we analysed peer interactions in the knowledge co-construction process. Our analysis found no

statistically significant differences based on group composition. However, changes in teaching settings and redesigned lab practices over the two years might have influenced collaboration. For this reason, we have further investigated the effect of the setting and the lab redesign in the knowledge co-construction process, and we have identified some factors which are responsible for the improvement of collaborative knowledge construction in 2022 (Barana et al., submitted). Thus, we now plan to compare the Spring 2022 and Spring 2024 groups since, in 2024 the groups were homogenous like in 2021, while the lab activities and the teaching environment were the same of 2022 (face-to-face and same inclusive CT practices). Since this study is limited by its use of weekly survey responses instead of direct observation, future work will make use of video recordings and discussion transcripts.

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References

Andersen, R. (2022). Block-based programming and computational thinking in a collaborative setting: A case study of integrating programming into a maths subject. Ac*ta Didactica Norden*, 16(4).

Barana, A., Boetti, G., Marchisio, M., Perrotta, A., & Sacchet, M. (2023). Investigating the Knowledge Co-Construction Process in Homogeneous Ability Groups during Computational Lab Activities in Financial Mathematics. *Sustainability*, 15(18), 13466. https://doi.org/10.3390/su151813466

Barana, A., Marchisio, M., Perrotta, A., & Sacchet, M. (2023). Collaborative knowledge construction during computational lab activities in Financial Mathematics. *9th International Conference on Higher Education Advances (HEAd'23),* 1021–1028. http://dx.doi.org/10.4995/HEAd23.2023.16227

Barana, A., Boetti, G., Marchisio Conte, M., & Perrotta, A., submitted. Rethinking computational practices in Financial Mathematics to boost collaboration: a comparative analysis to explore the redesign of lab activities and its impact on the knowledge co-construction process.

Briggs, M. (2020). Comparing Academically Homogeneous and Heterogeneous Groups in an Active Learning Physics Class. *Journal of College Science Teaching*, 49(6), 76–82. https://doi.org/10.1080/0047231X.2020.12290667

Caballero, M. D., & Hjorth-Jensen, M. (2018). Integrating a Computational Perspective in Physics Courses. In S. Magazù (Ed.), *New Trends in Physics Education Research*, 47–76. Nova Sciences Publisher. http://arxiv.org/abs/1802.08871

Chen, Y., Wang, Y., & Li, Y. (2022). The Effectiveness of Teaching Approaches in Computational Thinking Education: A Meta-Analysis. *Proceedings of the 14th International Conference on Education Technology and Computers*, 386–392. https://doi.org/10.1145/3572549.3572611

Ge, Z., Qi, Z., & Yang, L. (2018). A Literature Review of Grouping Solutions in Collaborative Learning. 2018 *IEEE International Conference on Progress in Informatics and Computing* (PIC), 393–397. https://doi.org/10.1109/PIC.2018.8706326

Gunawardena, C. N., Lowe, C. A., & Anderson, T. (1997). Analysis of a Global Online Debate and the Development of an Interaction Analysis Model for Examining Social Construction of Knowledge in Computer Conferencing. *Journal of Educational Computing Research,* 17(4), 397–431. https://doi.org/10.2190/7MQV-X9UJ-C7Q3-NRAG

Lave, J. (1991). Situating Learning in Communities of Practice. In Perspectives on socially shared cognition. Resnick, L.B., Levine, J.M., Teasley, S.D., Eds.; *American Psychological Association*: Washington. 63–82 ISBN 978-1-55798-121-9.

Lucas, M., Gunawardena, C., & Moreira, A. (2014). Assessing social construction of knowledge online: A critique of the interaction analysis model. *Computers in Human Behavior*, 30, 574–582. https://doi.org/10.1016/j.chb.2013.07.050

Mesghina, A., Hong, G., & Durrell, A. (2024). Cooperative Learning in Introductory Statistics: Assessing Students' Perceptions, Performance, and Learning in Heterogeneous and Homogeneous Groups. *Journal of Statistics and Data Science Education*, 1–26. https://doi.org/10.1080/26939169.2024.2302175

Murphy, P. K., Greene, J. A., Firetto, C. M., Li, M., Lobczowski, N. G., Duke, R. F., Wei, L., & Croninger, R. M. V. (2017). Exploring the influence of homogeneous versus heterogeneous grouping on students' text-based discussions and comprehension. *Contemporary Educational Psychology*, 51, 336–355. https://doi.org/10.1016/j.cedpsych.2017.09.003

Odden, T. O. B., & Russ, R. S. (2019). Defining sensemaking: Bringing clarity to a fragmented theoretical construct. *Science Education*, 103(1), 187–205. https://doi.org/10.1002/sce.21452

Perrotta, A. (2021). A learner-centered approach to design a Computational Finance module in higher education. *7th International Conference on Higher Education Advances (HEAd'21).* Seventh International Conference on Higher Education Advances. https://doi.org/10.4995/HEAd21.2021.12955

Perrotta, A., & Dolphin, R. (2021). Combining student-led lab activities with computational practices to promote sensemaking in financial mathematics. *Proceedings of the Eighth Conference on Research in Mathematics Education in Ireland* (MEI 8), 348–355. https://doi.org/10.5281/ZENODO.5636984

Resta, P., & Laferrière, T. (2007). Technology in Support of Collaborative Learning. *Educational Psychology Review*, 19(1), 65–83. https://doi.org/10.1007/s10648-007-9042-7

Weintrop, D., Beheshti, E., Horn, M., Orton, K., Jona, K., Trouille, L., & Wilensky, U. (2016). Defining Computational Thinking for Mathematics and Science Classrooms. *Journal of Science Education and Technology*, 25(1), 127–147. https://doi.org/10.1007/s10956-015-9581-5

Wing, J. (2017). Computational Thinking's Influence on Research and Education for All. *Italian Journal of Educational Technology*, 25(2), 7–14. https://doi.org/10.17471/2499-4324/922

Wyman, P. J., & Watson, S. B. (2020). Academic achievement with cooperative learning using homogeneous and heterogeneous groups. *School Science and Mathematics*, 120(6), 356–363. https://doi.org/10.1111/ssm.12427

Zabolotna, K., Malmberg, J., & Järvenoja, H. (2023). Examining the interplay of knowledge construction and group-level regulation in a computer-supported collaborative learning physics task. *Computers in Human Behavior*, 138, 107494. https://doi.org/10.1016/j.chb.2022.107494

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From Campus to Real-World Contexts: Transforming Higher Education with GamBLe EduCache

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Abstract

This paper presents GamBLe EduCache, an innovative educational initiative that integrates geocaching and gamification elements into university teaching. The project supports first-year students while promoting active learning and interdisciplinary engagement. Students analyze materials and processes at industrial and historical sites through cache-based activities, enhancing their digital competencies via a digital learning platform while supplementing traditional coursework with practical, location-based experiences. The project operates on two levels: providing structured learning opportunities for first-year students through pre-designed caches, and engaging advanced students in creating their own educational caches. The gamification approach incorporates competitive elements to motivate teamwork and active participation. Initial evaluation results show positive outcomes, with high rates of reported learning success and strong support for the gamification approach. Through partnerships with museums and archives, GamBLe EduCache creates a broader educational network that bridges academic theory with practical heritage work while making materials available as OER.

Keywords: *Interdisciplinary; geocaching; experiential learning; digital competencies; collaboration; open educational resources (OER).*

1. Engaging minds and shaping education: A collaborative approach to university challenges

The interdisciplinary project *GamBLe EduCache*, funded by the Ministry of Culture and Science in North Rhine-Westphalia, is an innovative educational initiative that enriches university teaching through integration of extracurricular learning spaces in the Rhine-Ruhr area. Developed through a collaboration between the TU Dortmund University, Ruhr-

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University of Bochum, and the University of Duisburg-Essen, this edu-caching-based educational concept, that combines learning activities with geocaching, brings together diverse departments, including Mechanical Engineering, Architecture and Civil Engineering, Geography, History, and Technology Didactics to create an engaging learning environment that promotes early course material engagement and fosters relevant future skills. This interdisciplinary approach addresses several critical challenges in higher education, particularly the difficulties first-year students face during their transition from secondary education. In mandatory courses attended by hundreds of students each semester, traditional teaching methods often struggle to facilitate meaningful interaction and maintain student engagement throughout the term (Baumann, 2016). Many students postpone their learning efforts until shortly before examinations, leading to suboptimal outcomes and persistent knowledge gaps that may extend into advanced studies. Since the Bologna Process, self-study has become increasingly important, accounting for approximately two-thirds of the total workload in foundational subjects. A recent survey revealed that 70% of lecturers see a need to support students in their self-study efforts (Kleß, 2017), particularly during the critical initial phase of university studies. Thus, the project *GamBLe EduCache* implements a unique combination of playful and practical engagement with subject-related content, supplementing traditional coursework through interaction with physical spaces. The project incorporates gamification elements such as different levels and a points system, fostering motivation and strengthening teamwork skills as students compete in small groups to earn points through various activities what was analysed by Kettler & Kauffeld (2019) or Cózar-Gutiérrez & Sáez-López (2016). These topic-specific caches align with course curricula and offer additional examination points for achieving certain goals, creating tangible incentives for active participation. During the conceptualization of the caches, standardized templates were developed in advance to ensure the provision of accessible teaching materials and activities. Furthermore, the team-based participation model was designed to account for potential limitations faced by students with dissabilities, recognizing that not all tasks may be independently executable by every participant. Consequently, it suffices for selected team members to perform specific tasks while receiving support from their peers. Additionally, individual tasks can be omitted without compromising the acquisition of core learning content. Beyond first-year students, the project actively involves advanced students in designing learning processes, allowing them to create their own caches while developing key competencies in teamwork, target group analysis, media literacy, inclusion, and accessibility. Students analyze materials, technologies, and explore spatial, historical, and geographical processes on-site, creating direct connections between theoretical knowledge and real-world applications. This approach not only enhances practical relevance but also motivates continuous and reflective engagement with subject content. The project's digital infrastructure, built on the *Moodle* learning management system, allows for temporal independence and broader accessibility, with all materials available as *Open Educational Resources* (OER).

2. The didactic framework for engagement and collaboration

The central idea of our project lies in integrating students as active designers of and participants in their learning processes across two complementary levels: (1) We provide the caches to first-year students who are navigating their new learning environment with its various challenges. The transition from school to university often brings uncertainties and new demands. The caches offer a low-threshold opportunity to playfully engage with complex and unfamiliar topics while fostering a sense of self-efficacy. Students can learn at their own pace, gradually working through the content, which eases their transition to university and enhances their intrinsic motivation. Studies have shown that gamification positively impacts learners' intrinsic motivation and attitudes toward educational content. According to Zeybek and Saygı (2024), most studies report increased motivation and engagement among learners, primarily attributed to the playful elements of gamified learning environments. Furthermore, gamification promotes interaction and collaboration, as cooperative learning processes enhance participants' willingness to actively engage and work together. These cooperative elements are particularly valuable for first-year students, creating opportunities for social interaction and fostering initial peer connections and friendships. Through group activities and shared challenges, students connect with classmates, building a sense of community and belonging essential for their university experience. These early connections support both academic collaboration and provide a social foundation that helps students navigate their new environment more confidently. Consequently, our project emphasizes "friendly competition" (Cavus et al., 2023) as a key element to foster both motivation and social interaction among students. The points-based system and levels within the caches encourage students to challenge themselves and their peers in a supportive environment. This gamified learning approach not only motivates participants to engage with the content but also strengthens team dynamics and collaboration. Working in small groups, students combine their strengths, share ideas, and solve problems together, naturally building trust and camaraderie. The competitive aspect remains balanced, emphasizing shared success and learning rather than creating pressure. Moreover, we create an extrinsic incentive that can provide secondary motivation for students: We award points to cache completers that can be applied to their grade in the module's examination. Thus, they can slightly improve their achieved grade. This approach offers students an additional opportunity to engage more deeply with the course material, providing a tangible reward for their active participation and learning efforts beyond the traditional assessment methods. Through these interactive learning environments, students also develop digital competence, preparing them for the demands of higher education. Cache-based learning allows them to apply theoretical content practically while promoting independent learning and problem-solving skills. Additionally, the gamified structure breaks down complex topics into manageable steps, lowering the threshold for tackling challenging material.

(2) The second key aspect involves advanced students actively creating their own EduCaches. This process demands strategic planning, logical reasoning, and critical reflection while also fostering motivation and key skills in target group analysis and media competence. By independently creating EduCaches, the students deepen their subject knowledge in various fields and introduce creative approaches to teaching. Their engagement with digital platforms and tools enables them to create interactive formats and strategically use multimedia content. This peer-to-peer model encourages dynamic, practice-oriented exchange tailored to specific target groups, including fellow students and prospectively, pupils and school classes. Team collaboration strengthens social competencies like communication, conflict resolution, and cooperation. Students maintain an ongoing dialogue with lecturers and tutors, seeking guidance and feedback. This continuous dialogue deepens their understanding while refining methodological and analytical skills. By combining independent work, teamwork, and professional guidance, the project fosters a holistic learning process that builds knowledge while strengthening students' sense of responsibility and capacity for reflection. The iterative development process, where students test, evaluate, and refine existing EduCaches, ensures quality while increasing awareness of knowledge transfer complexities. This process emphasizes inclusion, accessibility, and sustainable design, with materials available as OER for broad, long-term access for reuse by other educators from diverse fields.

The particularly distinctive feature of the GamBLe EduCache project is its integration of real-world locations into university teaching. By conducting caches at industrial and historically significant sites within the Ruhr area, students have the unique opportunity to engage with authentic environments that are closely tied to the subject matter they are studying. This approach moves learning beyond abstract classroom concepts into real-world contexts, where students can directly experience and analyze materials, technologies, and processes in situ. This hands-on engagement bridges the gap between academic theory and practical application (Bouchrika, 2025). On-site learning sharpens observational and analytical skills while connecting theoretical knowledge to practical applications, which has a demonstrably positive effect on their learning process as Ohl & Neeb (2012) have proven. The physical connection to locations adds relevance and immediacy to learning, making it more engaging and memorable. Ciprina et al (2025) have shown that site-specific learning develops critical awareness of the surrounding environment, prompting reflection on broader societal and industrial issues like sustainable development, urban transformation, and historical significance. This immersive experience fosters curiosity and exploration, motivating active environmental interaction. Thematically, the project utilises different locations of the Ruhr's industrial heritage. One example illustrates the different perspectives of the disciplines involved: The examination of a former blast furnace allows e.g., geography to address questions about the choice of location and the necessary infrastructure, which was needed to produce iron. Additionally, students in the engineering field gain practical insights into the processes of metallurgy and manufacturing.

From the perspective of historical studies, sites such as former blast furnaces offer valuable opportunities to engage with the socio-economic and cultural dimensions of industrialization. The variety of locations ensures dynamic, multi-faceted learning that emphasizes interdisciplinary connections. Combined with gamification elements, the use of real-world locations creates an educational experience that is both academically enriching and deeply impactful, preparing students to approach future challenges with practical, reflective, and well-rounded perspectives. Moreover, the interdisciplinary collaboration creates synergies between different disciplines and universities. Overall, more than 1000 students benefit directly from this initiative as the learning game is embedded in 14 subjects. The close cooperation among various disciplines allows students to gain insights beyond the confines of their own fields. This initiative enables students to autonomously utilize learning materials from other disciplines, thereby fostering a deeper engagement with the respective non-university learning location and enhancing their understanding of its unique characteristics from different perspectives.

In the civil engineering curriculum, students explore a comprehensive material cycle to understand construction materials' life cycles. Engaging learning methods like quizzes, videos, and podcasts enhance their grasp of the content. Initially, they focus on material origins, such as blast furnaces, and learn fundamental production processes while examining structures that use these materials. As they advance, students create EduCaches in an elective course to investigate building damages and analyze real-life examples for repair concepts. They also develop various teaching materials for their peers. The curriculum addresses material recycling, promoting sustainable practices in civil engineering and efficient resource use. The following chapter will present the learning outcomes from the students' perspective.

3. Future perspectives and first brief insights into evaluation results

GamBLe EduCache offers promising potential for advancing modern teaching and learning formats. Given the ever-changing demands in higher education, developing innovative approaches that effectively combine digital and analog elements is crucial. Through continuous integration of technologies and interactive methods, teaching formats can be created that facilitate learning and foster creativity, problem-solving skills, and sustainable delivery of complex educational content. The experiences gained from this project can serve as a foundation for future initiatives to create dynamic and adaptable learning environments. Therefore, having a comprehensive evaluation concept is essential to measure the effectiveness and success of *GamBLe EduCache*. Evaluation serves not only to assess goal achievement but also to improve teaching and learning formats continuously. Student surveys are and will be conducted to gather feedback and share experiences to draw well-founded conclusions about the project’s impact.

In the first pilot phase of the project in the summer semester of 2024, 98 architecture and civil engineering students completed the project in teams. After the exam, 84 students voluntarily

participated in the evaluation and shared their experiences and opinions. The evaluation questions were published in the digital course room and included various items based on a Likert scale. This scale allowed students to provide their assessments in a structured format, thereby yielding valuable insights into their perceptions of the course and the exam content. Participation in this evaluation not only offers a platform for feedback but also contributes to the continuous improvement of EduCaches. Figure 1 shows that most students experienced learning success and improved their knowledge. The interdisciplinary addition from other subject areas was also perceived positively. About 74% indicated that they found the non-subject-related content meaningful and helpful. For nearly 40%, the non-subject-related content sparked interest in the corresponding topic. Another brief insight into the survey results gives hope for the upcoming evaluation results from other departments, as 89% stated that they would recommend to other instructors to incorporate a gamification approach into their courses.

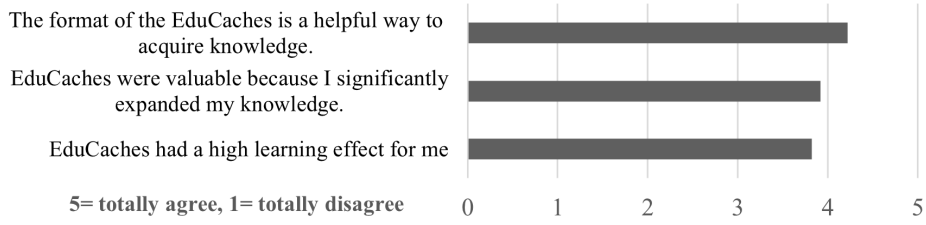


Figure 1. First evaluation results from the field of architecture and civil engineering.

To ensure the long-term success and continuous improvement of *GamBLe EduCache*, we are currently developing a comprehensive evaluation strategy that will assess the project's impact through both quantitative and qualitative analyses, enabling a deeper understanding of student engagement, learning outcomes, and the effectiveness of gamification elements. Our planned quantitative methods will include standardized surveys to measure intrinsic and extrinsic student motivation before, during, and after using the EduCaches, while we also intend to track usage statistics – such as activity levels, completed tasks, and earned points – via learning platform log data. This systematic data collection approach should allow us to identify behavioural patterns, such as engagement levels during competition phases or at specific game levels, potentially providing valuable insights into student participation and learning progress. Complementing these quantitative metrics, we are designing qualitative approaches to explore students' perceptions of the gamified learning environment through planned interviews and focus groups, where students will be encouraged to reflect on motivational factors, team dynamics, and the overall learning experience. We anticipate these insights will help determine which game elements are most effective in fostering engagement and collaboration. As part of our comprehensive approach, we are developing a framework for comparative analysis to examine the relationship between engagement levels and learning outcomes, which should provide a data-driven basis for optimizing the didactic design, while planned iterative feedback

loops will ensure the concept evolves based on empirical findings. Additionally, we are exploring the integration of OER to enhance accessibility and sustainability, with the goal of making materials widely available for future adaptation. By strategically integrating various evaluation methods, *GamBLe EduCache* seeks to create a solid framework for evaluating and enhancing its approach. This effort will ultimately support the development of innovative, data-driven teaching strategies in higher education. Currently, the creation of these evaluation tools and methodologies is in progress for implementation in future project phases.

Another long-term goal of this project is increasing accessibility to OER while promoting sustainable knowledge networking and collaboration with local partners. Through partnerships with museums and archives at industrial sites, we can tap into existing historical collections and expertise while making these resources more widely accessible. Given that museums have already established successful gamification practices in their educational programs (Holmes, 2020, p. 106), future collaborations will focus on combining and enhancing these existing approaches. Rather than treating heritage interpretation as a mere transfer of knowledge, this approach recognizes cultural legacy as an "open, subjective and ever-changing reflexive exercise" that engages with questions of "identity, inheritance, narrativity and belonging" (Marques et al., 2023). OER provides valuable resources for students and lecturers by freely making high-quality educational content available. Creating a network for disseminating these resources can help break down barriers while improving access to education for all. By actively involving museum curators and archivists, we enrich the cross-disciplinary networking experience by opening up new perspectives and connecting academic theory with practical heritage work. This active questioning of traditional frameworks allows for more dynamic and interpretative approaches to cultural heritage. Gotrian (2024) proves that digital media and collaborative tools enable us to bridge the traditional divide between popular and academic historical narratives, creating more inclusive and diverse approaches to historical interpretation. For reuse, the created content will be uploaded to ORCA and can be used by other lecturers individually without the geocaching component or as a complete concept. The modular structure not only allows it to be tailored for use across multiple disciplines but also enables seamless integration of museum and archive resources into various educational contexts, supporting a reflexive dialogue with cultural heritage rather than one-directional knowledge transfer. Overall, the project aims to address current challenges in higher education and make a long-term contribution to transforming the education sector.

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References

Baumann, M. (2016). Hallo, ich spreche auch zu Ihnen da hinten!: wie man große Gruppen nicht nur „belehren", sondern auch mit ihnen arbeiten kann. In B. Behrendt (Eds.), Neues Handbuch Hochschullehre: Lehren und Lernen effizient gestalten (pp. 39-59) Raabe. ISBN: 978-3818302061

Bouchrika, I. (2025). The Educational Value of Field Trips in 2025: Advantages and Disadvantages. https://research.com/education/The-educational-value-of-field-trips#1

Cavus, N., Ibrahim, I., Ogbonna Okonkwo, M., Bode Ayansina, N. & Modupeola, T. (2023). The Effects of Gamification in Education: A Systematic Literature Review. *Brain Broad Research in Artificial Intelligence and Neuroscience*, 14(2), 211-241. https://doi.org/10.18662/brain/14.2/452.

Ciprina, S., Schmalor, H. & Jebbink, K. (2025). Exkursionen im Geographieunterricht. In H. Schmalor, S. Ciprina & K. Jebbink (Eds.), Diercke Methoden – Exkursionen im Geographieunterricht (pp. 5-16). Westermann. ISBN: 978-3-14-100922-4

Cózar-Gutiérrez, R. & Sáez-López, J.M., Game-based learning and gamification in initial teacher training in the social sciences: An experiment with minecraftEdu. *International Journal of Educational Technology in Higher Education*, 13(1), 1-11. DOI 10.1186/s41239-016-0003-4

Grotrian, E. (2024). Geschichtsvermittlung mit digitalen Medien. Public History im Netz. In M. Großmann, T. Hellmuth, M. Tschiggerl & T. Walach (Eds.), Go Public! Zugänge zur Public History (pp. 327-343). Springer. https://doi.org/10.1007/978-3-658-45416-6_20

Holmes, L. (2020). The Heritage Game. In A. von Lünen, K. J. Lewis, B. Litherland & P. Cullum (Eds.), Historia Ludens. The Playing Historian (pp. 105-118). Routledge. ISBN: 978-0-367-36386-4

Kettler, C., & Kauffeld, S. (2019). Game-based Learning. In: Kauffeld, S.; Othmer, J.: Handbuch Innovative Lehre. pp. 209-222. https://doi.org/10.1007/978-3-658-22797-5_15.

Kleß, A. (2017). Einstellung von Lehrenden zum Selbststudium. die hochschullehre, 3, 1-14. https://dx.doi.org/10.3278/HSL1701W Van Vugt, M., Hogan, R., & Kaiser, R. B. (2008). Leadership, followership, and evolution: Some lessons from the past. *American Psychologist*, 63(3), 182-196. https://doi.org/fw5s2b.

Marques, C. G., Pedro, J. P., & Araújo, I. (2023). A Systematic Literature Rewiev of Gamification in/for Cultural Heritage: Leveling up, Going Beyond. *Heritage*, 6, 5935-5951. https://doi.org/10.3390/heritage6080312

Ohl, U. & Neeb, K. (2012). Exkursionsdidaktik: Methodenvielfalt im Spektrum von Kognitivismus und Konstruktivismus. In J.-B. Haversath (Ed.), Geographiedidaktik (pp. 259-288). Westermann. ISBN: 978-3-14-160359-0

Zeybek, N. & Saygı, E. (2024). Gamification in Education: Why, Where, When, and How? – A Systematic Review. *Games and Culture*, 19(2), 237-264. https://doi.org/10.1177/15554120231158625

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AI-proof Active Assessment and Future Skills Training with NoCode-Edu Escape Rooms

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Abstract

This study explores the implementation of NoCode-Educational Escape Rooms (EERs) as a robust assessment format in higher education, particularly in the context of artificial intelligence (AI). EERs, integrated within challenge-based learning frameworks, foster both subject-specific and transversal competencies. The study highlights the dual role of EERs in enhancing knowledge acquisition and future skills development, despite the presence of AI tools. Through practical engagement in creating EERs, students demonstrated significant improvements in subject-specific knowledge, critical thinking, and AI literacy. The necessity of independent content creation, beyond AI-generated assistance, emphasizes the importance of autonomous problem-solving. Moreover, the collaborative nature of EER development strengthened project management and teamwork skills. Overall, the findings suggest that EERs effectively prepare students for an AI-driven future by balancing AI utilization with the cultivation of essential cognitive skills.

Keywords: *AI-proofAssessment; EducationalEscapeRoom; CBL; NoCodeEscapeGame FutureSkillsTraining.*

1. Introduction

Higher education should move beyond merely transmitting knowledge and traditional skills, prioritizing instead the development of future skills (Ehlers, 2020). Learning processes must be more individualized and tailored to student needs (Kopp & Mandl, 2011; Veldkamp et al., 2020). Student agency and thus the experience of self-efficacy are key to academic success (Blaschke, 2017). In this context, challenge-based learning is recognized as an effective approach for fostering competency (Gallagher & Savage, 2020; Membrillo-Hernández et al., 2023).

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However, students might rely too heavily on chatbots to complete tasks, thus risking de-skilling. This calls for assessment formats that are resistant to AI assistance yet promote AI literacy and future skills (Deng et al, 2024).

As both "learning by doing" and game-based learning scenarios support competency development (Hagedorn & Meinel, 2022; Schutz & Schwarz, 2022), NoCode-Educational Escape Room (NoCode-EER) present a promising for learning and assessment.

This experimental study shows that designing EERs within a challenge-based framework enhances subject-specific competencies and future skills, including AI literacy. Despite AI tool usage, the reflective process required to create an EER supports its use as an alternative assessment format.

2. Theoretical Foundation

Given the existence of slightly differing definitions, this section outlines the conceptual understanding of Educational Escape Room, NoCode-Edu Esacape Room and Challenge-based learning, which form the basis of the subsequent analysis.

2.1. The Use of EERs in Higher Education

Educational Escape Rooms combine game-based elements with didactic goals, requiring players to acquire and apply knowledge to progress – whether escaping a room or unlocking a new level (Buchner, 2022). Interactive mechanics foster self-directed learning, enabling exploration, problem-solving and competence devvelopment (Hoblitz, 2015). Furthermore, perspective-taking within these games promotes critical thinking (Bilbao et al., 2019), making EERs motivating and accessible learning formats.

NoCode Educational Escape Rooms (NoCode-EERs) are a subtype of EERs that require no programming skills and are free to create. They serve dual purposes: engaging content delivery (Wiemker et al., 2015) and formative assessment though tasks that hinge on correctly applying knowledge (Le & Weber, 2011). Integrated feedback and reward systems support active learning (Solomovich, 2020), and although extrinsic motivation incentives are debated (Hagedorn & Meinel, 2022), learner autonomy boosts intrinsic motivation (Krapp, 1999). Positive emotions such as ambition and curiosity enhance content retention (Marr, 2010), making EERs effective for asynchronous belnded learning. They can also serve as memory palaces, with content strategically distributed across different rooms to facilitate knowledge organization and retrieval (Huttner et al., 2018).

The dual function of EERs – as learning and assessing tools – makes NoCode-EERs especially valuable when created by students. Designing EERs supports deep engagement, peer learning, and competency development within a challenge-based framework.

2.2. Challenge-based Learning in Higher Education

Challenge-Based Learning (CBL) involves collaboratively solving real-world problems based on relevant scenarios (Membrillo-Hernández et al., 2023). It promotes core skills such as teamwork and time management, and interdisciplinary competencies like critical thinking and problem-solving. Depending on the task, students acquire subject-specific competencies independently (Lara-Prieto et al., 2019), preparing them for future careers. Combining CBL with the "learning by teaching" approach enables students to process and communicate complex content effectively (Schuhladen, 2020), benefitting both education and STEM fields (Čujdíková & Vanikúš, 2023). This integration can be implemented with minimal organizational effort.

Though CBL fosters AI competencies, overreliance on AI tools may hinder subject-specific learning. However, this study further highlights that creating NoCode-EERs based on seminar topics encouraged the development and assessment of subject-specific learning, interdisciplinary, and AI-related competencies whilst resisting deception by undisclosed AI assistance.

3. Participants and Methodology

In the seminars "Pedagogical Aspects of Digital Learning Environments" (conducted in the winter semesters of 2022 with 10 students, 2023 with 8 students, and 2024 with 9 students) and "Fields of Action in Vocational Education" (offered in the summer semesters of 2023 with 37 students and 2024 with 28 students). Both Bachelor's and Master's students were free to enroll in the courses depending on their curriculum and their preferences, resulting in a heterogeneous group with different levels of prior knowledge. Consequently, a flexible seminar design was necessary. Challenge-based learning proved to be an approach to adapt to these different learning needs. Therefore, all student groups worked on interactive information units – mostly EERs on a specific seminar topic.

3.1. Seminar Structure

The seminar structure evolved over time to incorporate emerging technologies and pedagogical strategies. In winter semester of 2022, the seminar curriculum introduced the students to general media didactics, digital learning materials and their advantages and motivational theory, accompanied by practical sessions on creating interactive content using H5P. In subsequent semesters, the seminar curriculum was expanded to include AI exploration with a focus on prompt design and AI's role in content creation.

The summer semesters introduced students to various vocational education fields and the impact of AI on learning and working, further supplemented by exercises in using generative AI for research and content creation.

At the beginning of each seminar, fundamental content was introduced during three to five weeks. Starting in the summer semester of 2023, targeted exercises on AI usage were incorporated – such as Socratic dialogues, self-tests, or reflection tasks. By the end of this input phase, the students revised some example projects and received a training in H5P for interactive content creation. Moreover, they had a brief introduction to Kanban and MS Teams for collaboration.

3.2. Tasks and Creation Process

After the theoretical phase, students (in groups of three to four) were then given eight weeks to collaboratively deepen their understanding of a selected seminar topic, e. g. “industry 4.0”. In the following, they were to develop digital interactive learning materials for the other groups, such as EERs, e-books or scrollytelling projects. These projects were selected via a booking pool. The students received project outlines that detailed key topic points.

The creation process required them to develop a narrative structure with the thematically relevant content, including tasks and puzzles that needed to be solved within the EER to ensure progression. Throughout this challenge phase, students worked in groups. They were free to choose to come to the seminar room to ask, present, and get feedback or do their groupwork via Teams – or both.

3.3. The Use of AI in the Seminar

Beginning in the summer semester of 2023, the integration of AI became a core component of the seminars. Students engaged in hands-on exercises in prompt design and explored specific use cases, such as summarization or Socratic dialogues. Later iterations introduced analysis, targeted content alignment or HTML code creation, reflecting the advancing capabilities of various tools, e.g. Copilot in comparison to ChatGPT.

3.4. Assessment and Evaluation

Assessment strategies included initial and final surveys to evaluate AI usage, perceived carreer relevance, and self-rated AI competencies on a 0-10 scale. At the beginning of the semester, the students rated their skills at 3.2 and by the end 7.3 on average. Throughout the semester, there were One Minute Papers to further document their competency growth. Upon completion of the project phase, the seminar content was re-evaluated by dialogical assessments.

A significant number of students (a total of 46) was re-evaluated after 6-12 months. In this follow-up study, students provided another self- assessment of their learning progress. Problem-centered interviews (Witzel, 2000) were also conducted to evaluate the retention of subject-specific knowledge and the consolidation of acquired competencies.

4. Results and Findings

On the basis of the interviews and enquiries above-mentioned, as well as observations during the seminar, the following competencies and skill got developed – due to or despite of the usage of generative AI.

4.1. Subject-specific Competence

At the beginning of the experiment, subject-specific competencies related to the seminar topics were expectedly low, given the heterogeneity of the participants. However, by the end of the semester, all participants rated their subject-specific competence in the seminar topic as high. In comparison to traditional seminar formats, such as oral presentations, they perceived a significant advantage in independently developing digital products.

Interviews conducted several months after the seminar confirmed that students' self-assessments corresponded to reality: The skills and competencies acquired closely aligned with the assessments made during the semester, demonstrating the sustainable impact of the EER creation process. Notably, the competencies acquired by students who had created an Educational Escape Room (EER) were more consolidated and transferable than those who had chosen other digital products as their challenge. This knowledge acquisition can be attributed to the development of tasks and model solutions, which required a deep engagement with the content, critical evaluation, and alignment with the learning objectives of the escape room. Since generative AI tools were useful for formulation but not fully sufficient for content development, students had to create a significant portion of the content independently.

Additionally, students found engaging with other groups' EERs particularly effective. The gamified approach increased motivation and significantly extended net learning time, as many students spent more than the designated 90 minutes per week interacting with EERs. Moreover, competencies gained through role-playing and case studies within the EERs were perceived as transferable to other scenarios within the same subject domain.

4.2. AI Competence

At the beginning of the semester, survey results indicated that students primarily used generative AI for entertainment and initial topic exploration. In the summer semester of 2023, none of the students had productive experience with generative AI. By the winter semester of 2023, more students were using AI for specific purposes, although with largely unsatisfactory results. By the summer semester of 2024, all students had used generative AI productively before the seminar, although satisfaction with AI-generated results varied significantly depending on the tool. The use of ChatGPT and Copilot was frequently deemed inadequate in terms of output quality and workflow efficiency, whereas specialized tools like Elicit were considered beneficial. Similar findings emerged in the winter semester of 2024.

Over the course of all semesters, the use of generative AI tools led to a substantial increase in AI competence. Students learned how to leverage AI productively, particularly for brainstorming and drafting content for their digital products. AI tools were used primarily for storyline development, content structuring, and audience-appropriate wording. With increasing experience, students refined their prompts, leading to higher-quality results.

Most EER groups incorporated case studies into their storylines and experimented with various role assignments for AI, deepening their understanding of goal-oriented and effective prompting. One group reported using a chatbot for decision-making when disagreements arose within the team.

4.3. Transversal Competences and Core Skills

At the beginning of the seminar, students rated their transversal skills, like self- and time-management, as low. Their self-assessments of problem-solving, team organization, and critical thinking varied but were generally on the lower end. By the end of the semester, survey results indicated that students perceived significant improvements in all these competencies.

Follow-up interviews further highlighted notable developments in problem-solving, critical thinking, and team organization. Particularly among the groups that had created an EER, it became evident that the complexity of the production process limited the possibility of excessive task division. Consequently, the experience improved students' ability to manage group dynamics and time effectively. Collaborative work on NoCode-EERs enhanced transversal competencies such as teamwork and problem-solving, with the escape room format particularly reinforcing these skills.

5. Conclusion

The integration of Educational Escape Rooms (EERs) in university seminars has proven to be an effective didactic method for fostering both subject-specific and transversal competencies, as well as a relevant assessment format in the age of artificial intelligence. The findings, listed above, indicate that independently creating digital products, particularly EERs, significantly enhances students' subject-specific knowledge. This is primarily due to the intensive engagement with content, the need for critical evaluation, and alignment with learning objectives. The challenge of designing tasks and puzzles led to a deeper understanding and better consolidation of knowledge, which was also perceived as transferable to other thematic contexts.

The examination of AI competence revealed a significant learning curve in handling generative AI tools. While AI was initially used primarily for information retrieval, students gradually developed a more productive approach. They learned to craft precise prompts and strategically

employ AI tools to support content creation and structural organization. However, the study also demonstrated that relying solely on AI was insufficient to meet the requirements of EER development, necessitating independent thinking and problem-solving.

Furthermore, a considerable increase in transversal competencies, particularly in self-management, problem-solving, and team organization, was observed. The collaborative nature of NoCode-EER development enhanced students' ability to work effectively in teams and navigate group dynamics. The complexity of the task required coordinated collaboration, leading to improved teamwork and time management skills.

Overall, the study's findings suggest that incorporating EERs into higher education not only deepens subject knowledge but also supports the development of future skills. These competencies are particularly relevant in today's AI-driven world, as they enable students to leverage AI's advantages while simultaneously strengthening their own cognitive and problem-solving abilities.

References

Bilbao, N.; López de la Serna, A.; Romero, A.; Tejada Garitano, E. (2021) Developing Visible Thinking and Motivati9on Through the Curricular Design of an Escape Room in Higher Education. In: *Revista Electrónica Educare 25(3)*: 1-20. 10.15359/ree.25-3.27

Blaschke, L. M. (2017). Self-determined Learning (Heutagogy) and Digital Media Creating integrated Educational Environments for Developing Lifelong Learning Skills. In Springer eBooks (pp. 129–140). https://doi.org/10.1007/978-3-658-19925-8_10

Buchner, J. (2022). Lernen mit einem Augmented Reality Escape Game: Der Einfluss didaktischer Variationen auf den Lernerfolg und das Immersionserleben. [Dissertation, Universität Duisburg-Essen]. https://doi.org/10.17185/duepublico/75994

Čujdíková, M.; Vanikús, P. (2023) Design of an Educational Escape Room by Future Teachers. In: *European Conference on Games Based Learning (ECGBL17)*:135-143. Graz, Austria, 5-6 October 2017.

Deng, R.; Maoli, J.; Yu, X.; Lu, Y. (2024) Does ChatGPT enhance student learning? A systematic review and meta-analysis of experimental studies. In: Computers & Education 227:105224. DOI:10.1016/j.compedu.2024.105224

Ehlers, U. D. (2020) *Future Skills: Lernen der Zukunft – Hochschule der Zukunft*. Wiesbaden: Springer.

Gallagher, S. E., & Savage, T. (2020). Challenge-based learning in higher education: an exploratory literature review. *Teaching in Higher Education*, *28*(6), 1135–1157. https://doi.org/10.1080/13562517.2020.1863354

Hagedorn, C., Meinel, C. (2022) Gamification – nur Brokkoli mit Schokoladenüberzug oder doch mehr?. In: *Wirtschaftsinformatik & Management 14*, 415-421. https://doi.org/10.1365/s35764-022-00435-1

Hoblitz, A. (2015). Spielend Lernen im Flow. In: *Springer eBooks*. https://doi.org/10.1007/978-3-658-11376-6

Huttner, J. P.; Karaduman, M.; Sprengler, E. (2018). EduPalace. Die Gestaltung eines virtuellen Gedächtnispalastes. In Die Präsenzhochschule und digitale Transformation, 208-214. https://doi.org/10.25656/01:17941

Kopp, B., & Mandl, H. (2011). Selbstgesteuertes Lernen. In: *Fachportal Pädagogik. Juventa*. https://www.fachportal-paedagogik.de/literatur/vollanzeige.html?FId=3136577

Krapp, A. (1999). Intrinsische Lernmotivation und Interesse. Forschungsansätze und Überlegungen. In: *Zeitschrift für Pädagogik*, 45 (3), 387-406. https://www.pedocs.de/volltexte/2012/5958/pdf/ZfPaed_1999_3_Krapp_Intrinsische_Lernmotivation.pdf

Lara-Prieto, V.; Arrambide-Leal, E. J.; García-García; R. M.; Membrillo-Hernández, J. (2019) "Challenge Based Learning: Competencies Development Through the Design of a Cable Transportation System Prototype," In: *IEEE 11th International Conference on Engineering Education (ICEED)*, Kanazawa, Japan, 2019, pp. 11-15, **DOI:** 10.1109/ICEED47294.2019.8994958

Le, Son & Weber, Peter (2011). Game-based Learning. In: *TUGraz. Online* https://l3t.tugraz.at/index.php/LehrbuchEbner10/article/view/79/38

Marr, A. C.; Kaiser, R. (2010). Serious Games für die Informations- und Wissensvermittlung – Bibliotheken auf neuen Wegen. In: *Fachportal Pädagogik*. Dinges & Frick GmbH, Wiesbaden. ISBN 978-3-934997-31-8. Online: https://www.fachportal-paedagogik.de/literatur/vollanzeige.html?FId=3287011

Membrillo-Hernández, J.; López Caudana, E.; Vázquez VVillegas, P. (2023) Callenge-based Learning: An Essentional Tool for Fostering Future Engineering Competencies. In: *World Engineering Education Forum – Global Engineering Deans Council (WEEF-GEDC)*. Monterrey, Mexico, 23-27 October 2023. DOI: 10.1109/WEEF-GEDC59520.2023.10344051

Schuhladen, I. (2020) Lernen durch Lehren: Ein agiles Konzept. In: *Agilität und Bildung. Visual Books*.135-144.

Schutz, T.; Schwarz, D. (2022). Digital Game-based Learning. Springer, Wiesbaden.

Solomovich, Lior (2020). Studying big data using virtual escape rooms. In: *International Journal of Advanced Statistics and IT&c for Economics and Life Sciences*, 10(1), 23-30. Online https://EconPapers.repec.org/RePEc:vrs:ijsiel:v:10:y:2020:i:1:p:23-30:n:1

Veldkamp, A.; Van De Grint, L.; Knippels, M. C. P. J.; Van Joolingen, W. R. (2020). Escape education: A systematic review on escape rooms in education. Educational Research Review, 31. https://doi.org/10.1016/j.edurev.2020.100364

Wiemker, M.; Elumir, E.; Clare, A. (2015). Escape Room Games: "Can you transform an unpleasant situation into a pleasant one?". Online: https://www.researchgate.net/publication/348870975_Escape_Room_Games_Can_you_transform_an_unpleasant_situation_into_a_pleasant_one

Witzel, A. (2000). The Problem-centered Interview. *Forum Qualitative Sozialforschung Forum: Qualitative Social Research*, *1*(1). https://doi.org/10.17169/fqs-1.1.1132

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A pilot escape room to improve database knowledge consolidation

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Abstract

Gamification strategies have proven to be effective in increasing student engagement and improving learning outcomes. In this study, we present an escape room activity designed for a database course in the Computer Science degree at our university. It serves as an innovative approach to reinforce key concepts presented during the semester, while enjoying the challenges proposed. The concepts covered include connecting to database servers, developing SQL basic and advanced queries, and auditing. Additionally, the activity reinforces essential workplace competencies, such as teamwork and performing under pressure due to the game's countdown mechanism.

To evaluate the activity's effectiveness, we conducted a survey analyzing the students' perceptions of it, its impact on their understanding of course topics, and its influence on transversal skills such as teamwork. The results provide insights into the pedagogical value of game-based learning in database education and its potential to enhance both conceptual knowledge and professional skills.

Keywords: *Databases; escape room; engagement; teamwork.*

1. Introduction

In computing, technical expertise remains crucial, but it is no longer enough. Employers now prioritize soft skills, particularly collaboration and problem solving, as key to success in dynamic, multidisciplinary environments. The Organisation for Economic Co-operation and Development Learning Compass 2030 (OECD, 2019) highlights the need for a balanced skill set that integrates cognitive, social-emotional and practical skills to support lifelong learning. By fostering both technical and interpersonal skills, institutions can better prepare students to tackle complex challenges and adapt to evolving professional demands. To achieve this, higher education is moving towards active learning strategies such as flipped classrooms and project-based learning (PBL) (Rao, 2018). These methods enhance technical expertise while fostering

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key soft skills. By engaging students in interactive, hands-on activities, they promote critical thinking, personal responsibility and practical problem solving, ensuring that graduates are well prepared for their future careers (Romanenko, 2024).

One particularly impactful method for fostering both technical expertise and soft skills is through the use of gamified learning activities, such as escape rooms (Borrego, 2017; Fotaris, 2019). These activities provide a dynamic and immersive environment where students must solve complex problems, collaborate effectively, and manage time under pressure to achieve a common goal. Escape rooms simulate real-world challenges by requiring participants to think critically, share responsibilities, and communicate clearly within a team. This format not only reinforces the technical knowledge taught in the curriculum but also provides a practical context for students to develop essential soft skills (Gordillo, 2024).

The objective of this paper is to describe the implementation of an escape room as an innovative learning tool in two advanced database courses of the Computer Science curriculum at the Jaume I University: Database System Design and Database System Design and Implementation. Both courses currently use the PBL methodology, developed as part of the educational innovation project "Fostering Active Learning through Computational Sustainability Projects in Advanced Database Courses". The Escape Room was specifically designed to reinforce and apply advanced database concepts through a series of interrelated tasks and activities aligned with key course topics. These activities include solving complex queries and interpreting advanced SQL operations, with each solution unlocking the next step. These challenges test students' technical skills while fostering critical soft skills, providing a hands-on, engaging and collaborative learning experience.

This work highlights the benefits of escape rooms in education, showcasing their success in fostering engagement and soft skills while preparing students for collaborative, multidisciplinary challenges. It also emphasizes the significant effort required to design detailed and well-structured activities, ensuring clarity in instructions and alignment with learning objectives. Careful planning is essential to guide students effectively, allowing them to focus on problem-solving and fully engage in the learning experience.

The main target of this work can be disclosed in the following objectives: 1) Assess if escape rooms can improve students' knowledge acquisition; 2) Enhance students' soft skills such as working in group, problem solving and leadership, and 3) Determine whether escape rooms are enjoyable and engaging for participants, beyond the learning outcomes achieved. This paper is structured as follows. This section introduces the topic and objectives of the work. Section 2 provides a detailed description of the implemented escape room. Section 3 presents the results of the activity. Finally, Section 4 summarizes the conclusions drawn from the activity and outlines possible directions for future work.

2. Escape Room

The escape room was designed and implemented with two main objectives: (1) to enhance students' learning process in advanced databases and (2) to develop their soft skills, particularly teamwork, leadership, working under time constraints and critical thinking. The activity was conducted during the 12th week of the semester, after students had completed both the theoretical content and most of the practical components of the course. Participation in the escape room was voluntary and took place during a regular two-and-a-half-hour theoretical session.

For its implementation, students were divided into small groups, simulating real-world collaborative scenarios, and tasked with navigating the escape room by applying their database knowledge to progress through the tasks.

2.1. Storyline

The storyline is based on the theft of a chemical component by a hacker and the need to identify to which warehouses it has been shipped with other labelling and in which possible shipments this component can be found.

The escape room incorporated various elements for the different challenges, including a cryptex, ultraviolet (UV) flashlights, and various types of padlocks. The clues required to solve the challenges were derived from applying the knowledge acquired in the course to the real-world scenario and others related to simple computer science aspects.

2.2. Learning activities

The technical structure of the escape room consisted of two database servers, each containing a fully populated database along with several scripts that simulated real-time interactions with the databases. These components were designed to create a realistic and dynamic environment for the participants.

Next, following the storyline, the different challenges and learning activities are described.

1. Students were required to audit a database to identify fake database connections.
    a. Learning outcomes: 1) Establishing a database connection to an external server using its hostname and 2) Developing a SQL audit trigger to detect fake connections.
    b. Result: the identification of the hacker and their last date of access.
2. Using the last date of access, students can open the cryptex where they can find new instructions to continue with the game. A challenge to look for the new user and password using a computer science question (translate a binary number) and the ultraviolet flashlight is included in this challenge.

   a. Learning outcomes: 1) Establishing a new database connection to an external server using the console tool and the IP and 2) Developing a complex SQL query to obtain new information about the hacker.
   b. Result: a number to open a padlock.
3. Using the number obtained from the previous challenge, students opened a box containing additional clues, including partial information about the database model. However, key components of the model were missing. Students were then required to locate the stolen component.
   a. Learning outcomes: 1) Analysis of design of database models to understand the relationships and dependencies between tables, 2) Developing a complex SQL query to identify the missing component, and 3) Writing an INSERT SQL query to update the database and analyzing the resulting changes.
   b. Result: The identification (id) of the missing component.
4. At this stage, students have identified both the id of the hacker and the stolen component, so they can track the hacker's movements on the database.
   a. Learning outcomes: 1) Writing a SQL trigger to block ships associated to the hacker and the targeted component, 2) Writing a DELETE SQL query to remove the unwanted shipments from the component and 3) Writing an INSERT SQL query to update the database and analyzing the resulting changes.
   b. Result: a number to open the final box

This code unlocked a final box containing instructions to block a simulated "explosive", which they needed to deactivate to successfully complete the mission.

3. Results

At the conclusion of the escape room activity, the students answered a survey we had prepared to assess students' enjoyment of the game and its perceived educational impact. The questionnaire aimed to gauge the level of engagement and motivation generated by the activity, as well as to determine whether it contributed to reinforcing key database concepts covered in the course. By collecting students' feedback, we sought to evaluate the effectiveness of the game-based learning approach in enhancing their understanding of fundamental theoretical and practical aspects of database management.

In addition to course-specific learning outcomes, the survey also explored the impact of the game on transversal competencies fostered through the activity. Specifically, we investigated improvements in skills related to teamwork, which is essential for academic and professional success. By analyzing the students' responses, we aimed to determine whether the escape room format effectively facilitated the acquisition of both technical knowledge and transferable skills.

The survey included several questions where different answers where offered (we indicate them in parenthesis in the following list) regarding their perspective of the experience, and its impact in the course contents and teamwork:

1. How many escape rooms had you played before today's activity? (None; 5 or less; more than 5)
2. Did you enjoy the activity? (I didn't like it at all; I liked it a little; I felt indifferent; I liked it; I liked it a lot)
3. Would you like to have more activities like today's in this or other courses? (I don't want to do anything like this again; I would rather not have more activities like this; I don't mind/I'm indifferent; I would like to; I would love to)
4. Do you think the game helped you better assimilate the course concepts? (No, I was focused on the game; Yes, but only in very few aspects; Yes, in all those covered in the game)
5. Mark the concepts that became clearer to you after playing the game (Access to database servers; SELECT, INSERT, and DELETE statements; Table creation; Trigger creation; Auditing)
6. How was your experience working in a team? (I didn't like it at all; I liked it a little; I felt indifferent; I liked it; I liked it a lot)
7. How would you rate your participation in the team? (Not active at all; Slightly active; Moderately active; Quite active; Very active)
8. How would you rate your teammates' participation in the team? (Not active at all; Slightly active; Moderately active; Quite active; Very active)

Figure 1 illustrates the results for the questions related to escape room itself; a total of 35 answers were collected. Regarding the students' experience of such games, more than 60% of them (see Figure 1 top left) had played an escape room at least once (which indicates that they are interested in such games), and more than 90% of them stated that they had fun playing (see Figure 1 top right) and would like to have similar activities on other courses (see Figure 1 bottom left). Regarding the course concepts involved in the game (see Figure 1 bottom right), except for one student, all agree that the game contributed to clarifying them, either in all the aspects covered (63%) or at least in some (31%).

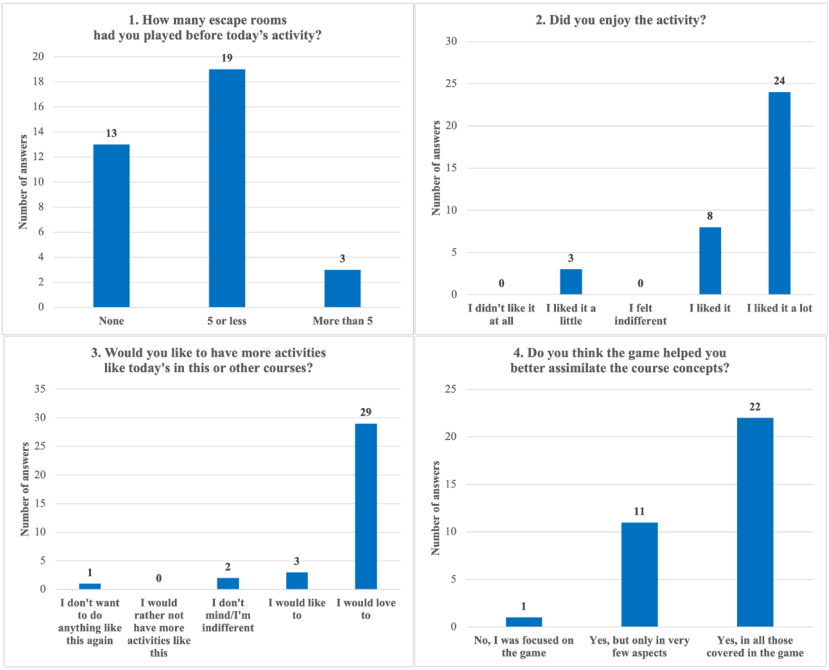


Figure 1.- Results associated with the survey questions.

Figure 2 presents the results considering the traversal teamwork skills, concretely improving their contribution degree (74%), their attitude (80%), responsibility (69%), leadership (69%), communication (77%), and conflict resolution (77%). Besides, more than 70% recognize they have actively participated in the game, and 91% affirm the same regarding the involvement of the other members of their team.

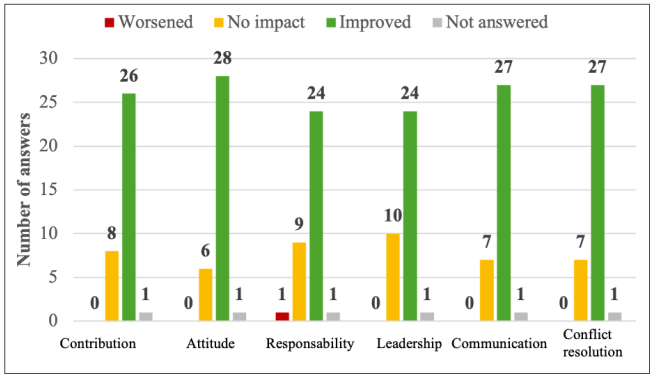


Figure 2.- Impact of the scape room in teamwork skills

Finally, Figure 3 is focused on questions related to the participation of students in team .Considering the different database related concepts addressed in the game (see Figure 2 top left), the auditing was the one that benefit more (71% of the students understood it better thanks to the game), and the table creation was the least benefited (48% of the students understood it better thanks to the game), which is reasonable considering the complexity of the auditing compared to simply creating tables. Around 60% of the students said that they improved on accessing database servers, using statements such as INSERT, SELECT, and DELETE, and creating triggers.

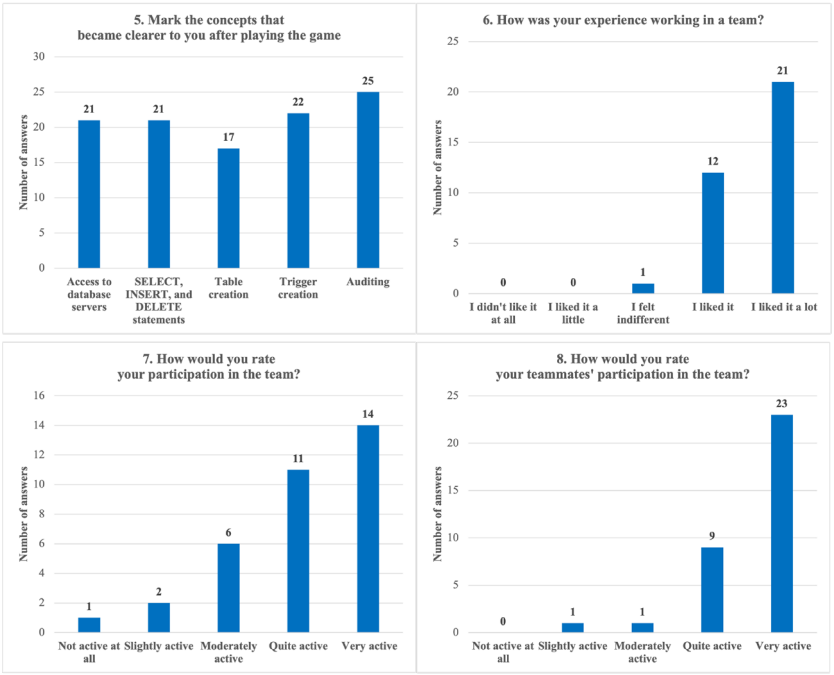


Figure 3.- Results associated to the Escape room results and team performance.

4. Conclusion

Using escape rooms as a learning activity has proved to be a useful tool to promote the students' engagement and actively contribute to their knowledge consolidation. Moreover, transversal competencies highly valued at the labor market, such as teamwork, leadership skills, working under time constraints and critical thinking are reinforced. In the particular context of the database courses, this activity has successfully combined the learning outcomes pursued regarding the theoretical and practical contents, with the dynamics typically employed in escape rooms to design the challenges, such as padlocks and cryptex. The students' opinions reveal that they both enjoyed the game while improving knowledge of the targeted concepts.

These positive results have encouraged the teachers to continue using the escape room as a teaching activity. For this reason, we are working on the development of an escape room for another subject, as well as on the creation of guidelines for the use of escape rooms as a teaching activity.

Acknowledgements

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References

Borrego, C., Fernández, C., Blanes, I., Robles, S. (2017). Room escape at class: Escape games activities to facilitate the motivation and learning in computer science. JOTSE, 7(2), 162-171.

Fotaris, P., Mastoras, T. (2019).Escape rooms for learning: A systematic review. *Proceedings of the European Conference on Games-based Learning*, 2019-October, pp. 235 – 243. doi: 10.34190/GBL.19.179

Gordillo, A., López-Fernández, D. (2024) Are Educational Escape Rooms More Effective Than Traditional Lectures for Teaching Software Engineering? A Randomized Controlled Trial. *IEEE Transactions on Education*, vol. 67, no. 5, pp. 660-668, Oct. 2024, doi: 10.1109/TE.2024.3403913.

OECD (2019). Future of education and skills 2030. *OECD learning compass 2030*.

Rao, P. R. M., Chugh, K. L., Prasad K. S., Shekar. K. (2018). Impact of Active Learning in Engineering Education. In: *IEEE 6th International Conference on MOOCs, Innovation and Technology in Education (MITE)*, Hyderabad, India, doi: 10.1109/MITE.2018.8747038.

Romanenko, Y.N., Stepanova, M., Maksimenko, N. (2024). Soft skills: students and employers crave. *Humanit Soc Sci Commun* 11, 931. https://doi.org/10.1057/s41599-024-03250-8

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CURE for Undergraduate Education: How Course-based Undergraduate Research Experiences (CUREs) can scale innovative practices in STEM education and assessment

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Abstract

As part of a large effort to study educational innovation, we developed, implemented, and assessed the effectiveness of Course-based Undergraduate Research Experiences (CUREs) across five large universities in the USA. We developed five semester-long STEM courses to offer undergraduates the opportunity to conduct cutting-edge and team-based original research projects. To assess the effectiveness of the CUREs in meeting overarching teaching and learning objectives, we conducted paired pre- and post- surveys of >2,500 undergraduate participants (including students in non-CURE control courses). We found statistically significant increases in interdisciplinary thinking, confidence in scientific skills, sense of science identity, intention to pursue STEM careers, and teamwork satisfaction. These gains were greater in CURE courses than in non-CURE control courses - and greater still for underrepresented minority and first-generation college student. We highlight the value of CUREs for increasing student engagement, belonging, and retention in STEM fields.

Keywords: *educational innovation; active learning; STEM education, team-based learning, program assessment, comparative education.*

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1. Introduction

Many studies in higher education have shown that early research experiences increase student persistence in STEM fields (e.g., Seymour et al. 2004, Russell et al. 2007, Lopatto 2007). This is especially true for students from historically underrepresented groups (Jones et al. 2010, Espinosa 2011, Hernandez et al. 2013). However, opportunities for students to gain research experiences are not widely accessible, even at the undergraduate level (Wei & Woodin 2011). Laboratory courses typically provide exposure to "cookbook" - rather than original - research approaches. Moreover, relatively few students obtain one-on-one mentored research experiences outside the classroom. Thus, it can be difficult to scale best practices in STEM education and provide meaningful research experiences to large numbers of undergraduate students.

One solution to this challenge is to embed mentored research experiences within standard university courses. Because the opportunity to conduct original research increases persistence of undergraduate students in STEM, both the President's Council of Advisors on Science and Technology and the American Association for the Advancement of Science recommend replacing standard undergraduate lab courses with discovery-based research courses. Course-based Undergraduate Research Experiences (CUREs) can reach large numbers of students and satisfy the need for early research exposure within the curriculum. Additional innovation within the CURE framework – like team-based research approaches – can further scale the impact of research experiences for undergraduates.

As part of a large, multi-university Biology Integration Institute (sponsored by the US National Science Foundation), we developed, implemented, and assessed five semester-long undergraduate CURE courses. We focused specifically on scaling the reach of our courses using a team-research approach, whereby students work in small groups on original research projects. We measured student outcomes in CURE courses versus standard lab-based courses in multiple demographic groups across five different US universities. Below we describe our universal design principles, assessment approach, teaching and learning outcomes, and recommendations for incorporating more discovery-based research approaches into STEM curricula.

2. Methods

2.1. Course design

We used an established CURE model (Auchincloss et al. 2014. Bangera & Brownell 2014) to create interdisciplinary courses to allow groups of undergraduate students to investigate original research questions of broad scientific importance. We designed our CURE courses to explicitly engage students in the five features of work that define a CURE:

(1) employs multiple scientific practices (e.g., proposing hypotheses, analyzing data, communicating findings)
(2) leads to scientific discovery (e.g., the outcome is unknown to student and instructor)
(3) has meaning beyond the course (e.g., to the broader scientific community)
(4) is collaborative (e.g., team-based)
(5) is iterative (e.g., builds on other work or uses multiple interdependent approaches)

Thematically, our US National Science Foundation funded Biology Integration Institute focuses on the theme of *Biodiversity Resilience*, specifically the decline and rebound of amphibians around the world. Therefore, our CURE courses generally focus on studying local amphibian populations near our focal universities.

- At the **University of Pittsburgh** and **Vanderbilt University**, the "*Frog Slime CURE"* offers students an opportunity to investigate amphibian defenses against pathogens. Students use samples of amphibian skin mucus to generate research questions and test hypotheses about the role of constituents, like antimicrobial peptides and the microbiome, as antifungal defenses. Students use techniques in disease ecology, microbiology, cell biology, chemistry, and bioinformatics to identify defensive compounds, test hypotheses about antifungal defenses, and build predictions about fungal pathogens and their hosts. In a separate Organic Chemistry *"Antimicrobials Discovery CURE"* at Pittsburgh, students perform chemical extractions and separations from slime bacteria to isolate and identify antifungal compounds.
- At the **University of Mississippi**, the "*Conservation Physiology CURE"* offers students an opportunity to investigate the impacts of interacting stressors on amphibian resilience using physiological tools. Students design and propose research projects focused on examining the effects of abiotic and biotic variables on ectotherm physiology, including thermal traits and immune function, in both lab and field settings, to test hypotheses about how climate and disease interact to affect resilience. Students then collect, analyze, and interpret their data as a group, culminating in a poster presentation to the biology department.
- At the **University of California, Berkeley**, the "*Genomics of Amphibian Declines CURE*" offers students an opportunity to evaluate pathogen presence in local amphibian populations and waterways. Students are guided through all stages of the scientific research process from reading the primary literature and forming hypotheses to designing field experiments, to collecting and analyzing DNA samples, to statistical analysis and scientific communication. Students integrate ecological and molecular biology to test hypotheses about factors effecting pathogen presence in local amphibians and present their results at a culminating showcase.

- At the **University of Massachusetts** the "*Microbiome CURE*" offers students an opportunity to investigate the contribution of the skin microbiome to amphibian resilience. Using non-invasive skin swab samples, students apply cutting-edge tools in molecular biology and microbiology to test hypotheses about the microbiome's role in amphibian resilience.

Thus, the content of each course is unique, but the principles underlying their design is shared, particularly with regard to course assessment.

2.2. Course assessment

We designed two types of assessments for our CURE courses. First, we assessed student progress and performance following best practices to ensure alignment of learning objectives, course activities, and assessments (Shortlidge & Brownell 2016). Assessments in this first category included scaffolded student papers, presentations, and reflection exercises and were unique to each institution. Second, we assessed higher level learning objectives of our courses using programmatic assessment tools. Assessments in this second category included pre- and post- course surveys and were shared across all institutions.

Our matched pre- and post-assessments provided students an opportunity to self-assess - on a five-point scale from "strongly disagree" to "strongly agree" - on the following topics:

- Interdisciplinary thinking*:* 7 questions, e.g., "*I can use what I have learned in one field in another setting", "I see connections between ideas in biology and ideas in the humanities and social sciences"*, and "*I enjoy thinking about how different fields approach the same problem in different ways*" (Lattuca et al. 2012).

- Science efficacy: 6 questions, e.g., "*I am confident I can use technical tools, instruments, and techniques*", "*I am confident I can generate a research questions to answer", "I am confident I can use scientific literature to guide my research*" (Hanauer et al. 2017).

- Science identity*;* 5 questions; e.g., "*I think of myself as a scientist", "I see myself as a science communicator*", and "*I feel like I belong in the field of science*" (Hanauer et al. 2017).

- Career intention: 5 questions; e.g., "*I intend to pursue a science-related career", "I intend to enroll in a science related graduate program*", and "*In the future, I would like to be a research scientist*" (Camacho et al. 2021).

- Teamwork satisfaction*:* 3 questions; e.g., "*I have found that working as part of a team to be a valuable experience", "In most of the teams I have been on, the team has*

worked well together", and *"I have found teamwork to be a productive use of course time*", and "*I have found that working with a team has enhanced my sense of who I am*" (Gallegos et al.2011).

Surveys were administered through Qualtrics (goshenconsulting.qualtrics.com) with control and normalizing features such as mid-survey attention checks. In addition to surveying CURE participants, we also surveyed students in thematically related biology courses lacking an original research project (i.e., non-CUREs). We used these non-discovery courses as controls. Results were analyzed using standard paired statistical approaches.

3. Results

We analyzed matched pre- and post-survey data from 2,689 students enrolled in our courses between 2020-2024 across five universities. 2,052 of these students participated in one of our CURE courses, while 611 students participated in one of our "control" courses (STEM courses with traditional labs but no original team-based research projects). We also looked separately at the subset of students who self-identified as underrepresented minorities (137 students) or first-generation college students (196 students). We present here the results of our pooled analyses across all universities (Figure 1, Figure 2).

Overall, students in both traditional lab courses and CURE courses self-reported significantly increased skills, confidence, and belonging in all categories measured (i.e., interdisciplinary thinking, science efficacy, science identity, career intention, teamwork satisfaction) over the course of one semester (Figure 1). However, students in CURE courses exhibited greater gains and higher ending scores than students in non-CURE courses (Figure 1, Figure 2). Specifically, students in the CURE courses exhibited greater gains in *all* categories measured compared to students in traditional laboratory courses. Similarly, in all categories except "teamwork satisfaction", students in CURE courses had higher ending scores than students in traditional lab courses (it is worth noting, that "teamwork satisfaction" was the category with the lowest scores overall, reflecting undergraduate student ambivalence toward working in teams).

Beyond, demonstrating an overall positive impact of CURE courses, our data also suggest that under-represented minorities (URM) and first-generation college students (First-Gen) benefitted disproportionately. URM or First-Gen students showed the highest gains (delta pre-post scores) in all categories except career intention. Gains in these student demographics are particularly notable given lower statistical power from smaller sample sizes. Because demographic questions were optional to answer, the proportion of URM and First-Gen students in the total sample pool is also likely larger than documented here. It is also important to note that the slight numerical decrease is career intention for URM students is not statistically different from zero.

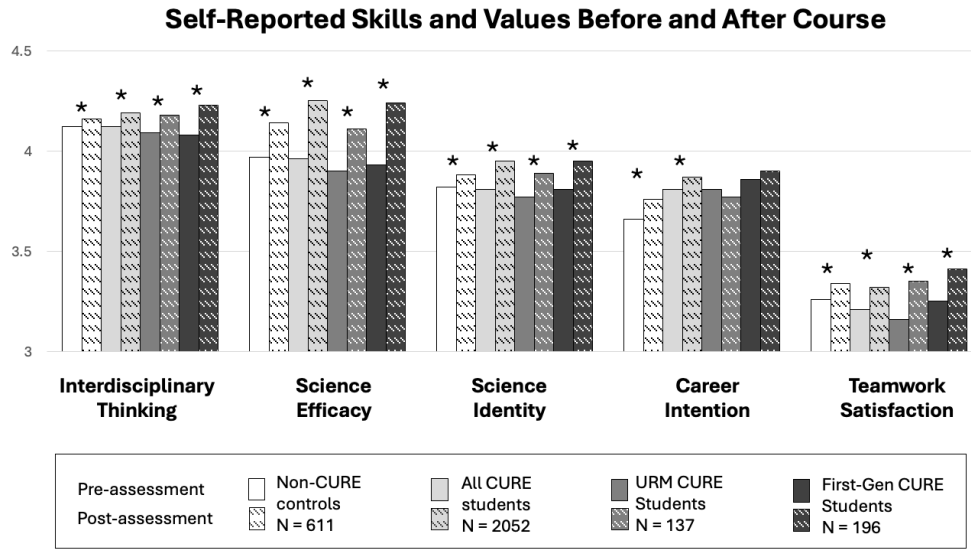


Figure 1. Average scores from paired self-assessment from 2,689 students across five US universities. Students responded to the same questions at the beginning (pre) and end (post) of the semester on a five-point scale (1 = "strongly disagree". 2 = "disagree", 3 = "neither agree nor disagree", 4 = "agree" and 5 = "strongly agree"). All averages were above 3, so the y-axis is scaled accordingly. Students in both CURE and non-CURE courses showed a significant increase in all categories, but CURE students exhibited higher ending scores in all arenas except "teamwork satisfaction". Students self-reporting as under-represented minorities (URM) or first-generation (First-Gen) were evaluated independently. Asterisks indicate statistically significant differences between pre and post averages within categories.

4. Discussion

Fostering a sense of belonging and STEM identity for undergraduates at large universities can be challenging. However, our results suggested that CUREs, particularly those that employ teamwork, can have significant impacts on key STEM learning outcomes. Moreover, CUREs can be particularly effective in increasing the sense of belonging for under-represented minorities and first-generation students, especially when these students enter the semester with a lower sense of belonging than their peers. The positive impact of discovery programs on historically marginalized student populations is consistent with other recent research (Gillen-O'Neel, 2019; Murphy and Zirkel, 2015) and the important finding that sense of belonging is associated with numerous positive outcomes for historically marginalized students, including metrics of GPA, retention, and health outcomes (Murphy et al., 2020; Walton and Cohen, 2011).

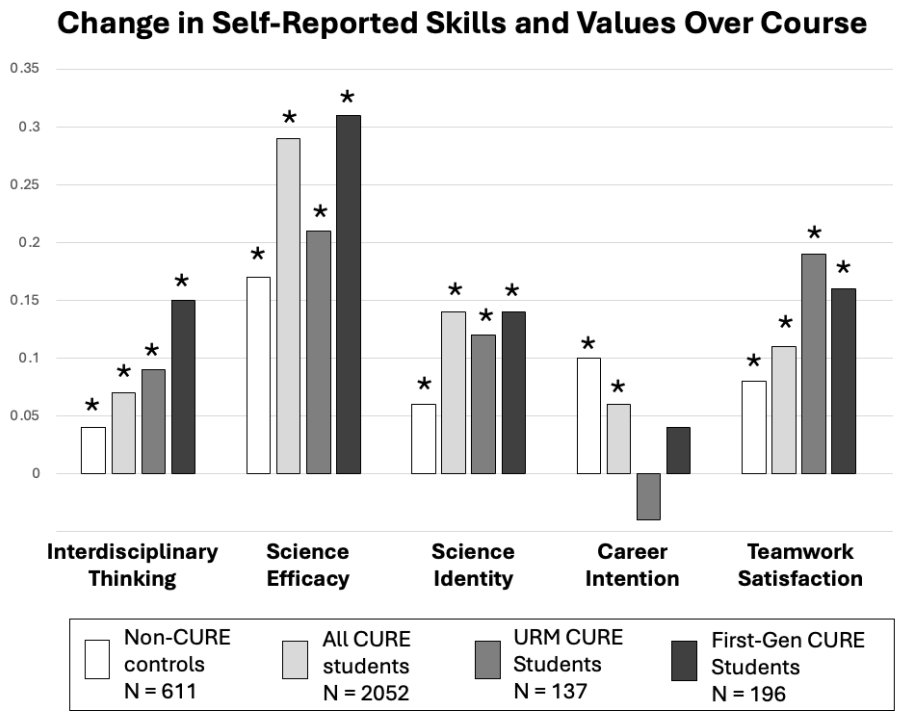


Figure 2. Average change in scores between pre- and post- self-assessment across 2,689 students across five US universities. Students in both CURE and non-CURE courses showed a significant increase in all categories, but CURE students showed a greater change in all arenas except "career intention". URM and/or First-Gen students reported the greatest gains in all categories except "career intention". Asterisks indicate statistically significant differences between pre and post averages within categories.

One limitation of this study is that students were only surveyed over the course of the semester when they participated in a CURE. We do not know whether student sense of STEM belonging or confidence persists over longer timescales. Future studies should employ surveys that are administered multiple times with anonymous identifiers to track student experience before, during, and after CURE interventions. A more longitudinal study of the same students could reveal the changing needs of students over time and how mentored research interventions can be tailored to different times in the educational lifecycle.

Ultimately, CUREs offer a high-value, relatively low-cost opportunity to increase STEM educational outcomes at universities of any size. CURE courses embedded within the curriculum allow many students to have an original research experience – rather than only those that obtain a mentored extra-curricular research opportunity. Moreover, structuring CURE courses with a team-based science approach allows best practices in STEM education to be scaled to more students. In team-based CUREs, students naturally experience more peer-based

mentorship, reducing the demands on instructors. In conclusion, we suggest that our CURE model – and our assessment strategy - could be easily adapted at other institutions, ultimately contributing to a revitalized discovery ethos in higher education.

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References

Auchincloss, L. C., Laursen, S. L., Branchaw, J. L., Eagan, K., Graham, M., Hanauer, D. I., Lawrie, G., McLinn, C. M., Pelaez, N. & Rowland, S. (2014) Assessment of course-based undergraduate research experiences: a meeting report. *CBE— Life Sciences Education* 13, 29-40.

Bangera, G. & Brownell, S. E. (2014) Course-based undergraduate research experiences can make scientific research more inclusive. *CBE—Life Sciences Education* 13, 602-606.

Camacho, T. C., Vasquez-Salgado, Y., Chavira, G., Boyns, D., Appelrouth, S., Saetermoe, C., & Khachikian, C. (2021). Science identity among Latinx students in the biomedical sciences: The role of a critical race theory–informed undergraduate research experience. CBE—Life Sciences Education, 20, ar23.

Espinosa, L. (2011) Pipelines and pathways: Women of color in undergraduate STEM majors and the college experiences that contribute to persistence. *Harvard Educational Review* 81, 209-241.

Gallegos, P. J., & Peeters, J. M. (2011). A measure of teamwork perceptions for team-based learning. Currents in Pharmacy Teaching and Learning, 3, 30-35.

Gillen-O'Neel, C. (2019) Sense of belonging and student engagement: A daily study of first- and continuing-generation college students. *Res. High. Educ.* https://doi.org/10.1007/s11162-019-09570-y.

Hanauer, D. I., Graham, M. J., & Hatfull, G. F. (2016). A measure of college student persistence in the sciences (PITS). CBE—Life Sciences Education, 15, ar54.

Hernandez, P. R., Schultz, P., Estrada, M., Woodcock, A. & Chance, R. C. (2013) Sustaining optimal motivation: A longitudinal analysis of interventions to broaden participation of underrepresented students in STEM. *Journal of Educational Psychology* 105, 89.

Jones, M. T., Barlow, A. E. & Villarejo, M. (2010) Importance of undergraduate research for minority persistence and achievement in biology. *The Journal of Higher Education* 81-115.

Lattuca, L. R., Knight, D. B., & Bergom, I. M. (2012) Developing a measure of interdisciplinary competence for engineers. ASEE annual conference & exposition, pp. 25-415.

Lopatto, D. (2007) Undergraduate research experiences support science career decisions and active learning. *CBE—Life Sciences Education* 6, 297-306.

Murphy, M., Zirkel, S. (2015) Race and belonging in school: How anticipated and experienced belonging affect choice, persistence, and performance. *Teach. Coll. Rec.* 117.

Murphy, M.C., Gopalan, M., Carter, E.R., Emerson, K.T.U., Bottoms, B.L., Walton, G.M. (2020) A customized belonging intervention improves retention of socially disadvantaged students at a broad-access university. *Sci. Adv.* 6, eaba4677. https://doi.org/10.1126/sciadv.aba4677.

Russell, S. H., Hancock, M. P. & McCullough, J. (2007) Benefits of undergraduate research experiences. *Science* 316, 548-549.

Seymour, E., Hunter, A. B., Laursen, S. L. & DeAntoni, T. (2004) Establishing the benefits of research experiences for *Science Education* 88, 493-534.

Walton, G.M., Cohen, G.L. (2007) A question of belonging: Race, social fit, and achievement. *J. Pers. Soc. Psychol.* 92, 82–96. https://doi.org/10.1037/0022-3514.92.1.82.

Wei, C. A. & Woodin, T. (2011) Undergraduate research experiences in biology: alternatives to the apprenticeship model. *CBE—Life Sciences Education* 10, 123-131.

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Fostering Engagement and Inclusion in CURE for Hong Kong health professional undergraduate students: The Impact of the Design2Data (D2D) Approach on Student Attitudes and Contributions to Scientific Research

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Abstract

This study explores the impact of the Design2Data (D2D) approach on student attitudes, dispositions, and sense of belonging within Course-Based Undergraduate Research Experiences (CURE) in Hong Kong. By examining student feedback and engagement, we found that the D2D approach significantly enhances positive attitudes and fosters an inclusive environment, which is essential for effective participation in research activities. Students reported higher levels of motivation and persistence, leading to meaningful contributions to scientific research. Additionally, follow-up discussions indicated an increased awareness of the significance of AI in the field of protein structure and design, highlighting the importance of addressing current trends and issues in the discipline. This supportive educational framework not only enriches students' academic experiences but also equips them with vital skills and mindsets for future success in their academic and professional endeavours.

Keywords: *Course-based undergraduate research experience (CURE); Design2Data (D2D); Health professional undergraduate students*

1. Introduction

Course-based undergraduate research experience (CURE) is an innovative pedagogical approach that integrates research experiences into the undergraduate curriculum. This method enables students to engage in authentic research projects as part of their coursework, fostering

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a deeper understanding of scientific inquiry and enhancing their critical thinking and problem-solving skills. By participating in CURE, students not only gain valuable hands-on experience but also develop a sense of ownership over their learning, which can lead to increased motivation and retention in their academic pursuits.

In Hong Kong, however, implementing CURE presents unique challenges (Yau et al., 2022; Yau et al., 2024). As a relatively new approach in this educational context, institutions face difficulties in adapting established models. Faculty members may encounter obstacles in designing research projects that effectively align with course objectives while accommodating the diverse abilities and backgrounds of students. Additionally, limited resources, time constraints, and the need for interdisciplinary collaboration can complicate the execution of successful CURE initiatives.

In this study, we summarize the experiences of adapting various strategies from well-developed CURE projects in the USA and modifying them for use in the Hong Kong setting. By recognizing both the potential rewards and the obstacles associated with course-based undergraduate research, we aim to provide insights that can help educators create enriching learning environments tailored to the unique context of Hong Kong, empowering students to thrive as researchers and critical thinkers in their fields.

2. Methodology

This study employed a systematic approach to investigate CURE models from various universities in the United States, with the goal of adapting these strategies for implementation in the Hong Kong educational context. The methodology consisted of the following steps:

1. Identification of CURE Projects: We began by utilizing CUREnet (networking among faculty developing, teaching, and assessing CURE) and CURE related grants funded by universities or US government, a comprehensive network dedicated to course-based undergraduate research, to identify existing CURE projects and teaching models at various universities across the USA. This platform provided valuable insights into a range of successful CURE implementations.
2. Exploration of Collaborative Opportunities: After identifying potential CURE projects, we sought opportunities to engage with these institutions. This involved reaching out to faculty members and program coordinators to learn about their CURE initiatives, the challenges they faced, and the strategies they employed to enhance student engagement and learning outcomes.
3. Contacting Selected Institutions: Through our outreach efforts, we successfully established contact with two universities that had well-developed CURE programs. We arranged for discussions and, where possible, virtual visits to gain a deeper

understanding of their operational frameworks, assessment methods, and best practices.

4. Comparative Analysis: We conducted a comparative analysis of the selected CURE models, focusing on aspects such as project structure, faculty involvement, student engagement strategies, and assessment criteria. This analysis allowed us to identify key elements that could be adapted for the Hong Kong setting.
5. Implementation in Hong Kong: Finally, we adapted the insights gained from the comparative analysis to develop and implement CURE initiatives in the Hong Kong educational context. This involved modifying project designs, incorporating local resources, and considering the specific needs and backgrounds of Hong Kong students.

3. Results and Discussion

3.1. CURE Project Identification and Collaboration Process

After the screening process around 20 US universities, we had the opportunity to join briefing sessions for two CURE projects, allowing us to further explore the opportunity to join their workshops. The two projects are Design2Data (D2D) (Carlin et al., 2017), led by the Siegel Lab at UC Davis, and Surveillance and Monitoring of Amphibian Pathogens (SNAPs), supported by the US Geological Survey and Environment and Climate Change Canada (Perez Jennifer, 2023). Details for implementing the D2D project, including the lab manual and workflow, are available at the following D2D Lab Manual webpage (2022). Information on running SNAPs in the classroom can be accessed here: SNAPs Classroom online Resources (2025).

3.2. Comparative Analysis

The nature of these projects is markedly different. D2D focuses on investigating the sequence-structure-function relationship of proteins. Through this initiative, students engage in a research workflow that mirrors cutting-edge biotechnology training, equipping them with valuable skills that are in high demand by employers. A distinctive feature of D2D is its integration with the RosettaCommons protein modeling community, which utilizes student-generated data to enhance functionally predictive enzyme-design algorithms.

In contrast, SNAPs addresses the emerging threat posed by the fungal pathogen *Batrachochytrium salamandrivorans* (*Bsal*), which endangers salamander populations in Europe and North America. Although *Bsal* has not yet been detected in North America, its potential introduction makes early detection crucial. The SNAPs initiative leverages student involvement to implement ongoing and cost-effective *Bsal* surveillance, integrating this critical work into the undergraduate curriculum. This project is part of the Surveillance Working Group of the North American *Bsal* Task Force and highlights the importance of broad and long-term

monitoring efforts, despite the inherent challenges of surveillance. We formed focus groups with local university faculty and experienced CURE teachers from the USA to discuss the pros and cons of these projects for urban university students, particularly in Hong Kong.

SNAPs project presents unique advantages and challenges for these students. On the positive side, SNAPs actively engage students in critical ecological research that addresses the urgent threat posed by the fungal pathogen *Bsal* to amphibians. However, number of SNAPs projects at USA have found no *Bsal* in their samples, leading to disappointment among students. While *Bsal* can be found in the wild areas of Hong Kong (Chen et al., 2023), this hands-on involvement fosters a sense of responsibility and civic engagement, allowing students to contribute to real-world conservation efforts. By integrating surveillance into the undergraduate curriculum, students can apply their learning in meaningful ways, enhancing their educational experience. Additionally, the project promotes teamwork and collaboration among students, fostering a supportive learning environment. On the downside, students must navigate a complex approval process that includes obtaining licenses for handling wild animals. This paperwork can be time-consuming and may deter participation. Moreover, students may need to spend extended periods outside the university to conduct fieldwork, with limited opportunities for follow-up experiments, as identifying microorganisms requires sending samples to the U.S. for analysis. Sending the samples add further hurdles to the identification process and potentially delaying results.

In contrast, D2D offers several benefits for urban university students. It provides hands-on experience in protein biochemistry, equipping students with valuable laboratory skills and knowledge in a high-demand field. The project aligns with current biotechnology trends, making participants more attractive to potential employers. Additionally, collaboration with the RosettaCommons protein modeling community allows students to network with professionals and gain insights into the broader scientific landscape. Furthermore, D2D encourages interdisciplinary learning by integrating concepts from biology, chemistry, and computer science, fostering a comprehensive educational experience. Nonetheless, there are challenges associated with D2D. The project can be resource-intensive, requiring access to specialized equipment and materials.

3.3. Implementation in Hong Kong universities

We integrated the D2D elements into the practical sections of the course related to cell biology and biochemistry for second-year undergraduate students. The protocol is largely the same as that provided by the Siegel Lab; however, due to the challenges of shipping single-strain DNA templates for mutation from the USA to Hong Kong, we purchased the plasmids with the desired mutations directly from local biotech companies. A total of 42 students completed the feedback questionnaires via MS Forms, and the results are presented in Figure 1.



Figure 1. Student Feedback Results on the Integration of D2D Elements in Cell Biology and Biochemistry Practical Sections of Hong Kong health professional undergraduate students

In general, the students' feedback was very positive across all five areas addressed. They expressed high expectations to (1) build knowledge and skills, (2) develop attitudes and dispositions, (3) cultivate a problem-solving mindset and research interest, (4) feel included and have a sense of belonging, and (5) explore or clarify their educational and career pursuits for this CURE activity.

It is noteworthy that, following the activity, more students reported feeling a decrease in their sense of achievement despite acquiring knowledge and skills. This may be attributed to the relatively straightforward nature of the experiment, which may not have posed significant challenges for them. In contrast, students indicated that their achievements in cultivating a

problem-solving mindset, developing research interests, and exploring or clarifying their educational and career pursuits met their expectations.

Interestingly, a larger number of students recognized that the D2D approach positively influenced their attitudes and dispositions, while also fostering a sense of inclusion and belonging. These elements are particularly crucial for CURE students, as positive attitudes and dispositions enhance engagement, motivation, and persistence in research activities. When students feel included and have a sense of belonging, they are more likely to participate actively, collaborate effectively, and make meaningful contributions to scientific research. This supportive environment not only enriches their educational experiences but also promotes the development of skills and mindsets essential for success in their future academic and professional pursuits.

In a follow-up face-to-face discussion, students also expressed their awareness of this year's Nobel Prize winner, David Baker, who focused on computational protein design, underscoring the significance of AI in recent years, which greatly enhanced their interest and awareness of the importance of participating in this D2D CURE activity.

3.4. Limitations of the Study

This study has several limitations that should be acknowledged. The sample size of students and institutions involved may limit the generalizability of the findings, as the results may not fully capture the diversity of experiences across different universities. Additionally, the assessment primarily focused on short-term outcomes, such as immediate changes in knowledge, skills, and self-efficacy, without exploring the long-term impacts on career progression, research contributions, or sustained interest in STEM fields. Furthermore, differences in the implementation of CURE activities across institutions, such as variations in teaching methods, resources, and faculty expertise, may have influenced the outcomes, making it challenging to attribute the observed impacts solely to the CURE model. Finally, some findings rely on self-reported data from surveys and focus group discussions, which are subject to potential biases, such as social desirability bias and recall bias. Future studies should consider incorporating objective measures of student performance and engagement to address these limitations and provide deeper insights.

3.5. Perspectives and Challenges

A key perspective for the future is the development of interdisciplinary CURE projects that integrate health sciences with emerging fields such as data analytics and AI. These interdisciplinary approaches reflect the evolving landscape of healthcare, which increasingly demands expertise spanning multiple domains. Introducing such projects would not only enrich students' learning experiences but also better prepare them to address the complexities of

modern professional environments. However, to ensure the success of these initiatives, it is essential to consider resource constraints, such as funding, faculty expertise, and infrastructure, which may limit the scalability and impact of interdisciplinary CURE programs.

To create a sustainable and impactful framework for CURE in Hong Kong, universities should also prioritize the development of robust and standardized evaluation mechanisms. These mechanisms could include longitudinal tracking of student outcomes, such as research competencies, academic achievements, and career trajectories, to assess the long-term effectiveness of these initiatives. Addressing the limitations of relying on self-reported data, future evaluation efforts should incorporate objective measures of student performance and engagement.

Furthermore, offering faculty development workshops on designing, implementing, and assessing CURE programs would empower educators to overcome challenges related to variability in implementation. This would also enable the creation of consistent and scalable models across institutions. By addressing these perspectives and limitations, Hong Kong universities can foster a more inclusive and impactful research environment for undergraduate health professional students. This approach will equip them with the interdisciplinary skills, practical experiences, and professional insights necessary for future academic and career success.

4. Conclusion

In summary, implementing CURE provides a practical and effective way to engage health professional undergraduate students in research while addressing the diverse needs of individual projects. Given the manpower required for personalized research experiences, integrating CURE elements into the practical sections of undergraduate courses is a more feasible solution. We hope that disseminating our approach will assist those looking to incorporate CURE elements into their curriculum in identifying effective strategies for their specific context.

In addition, the D2D approach not only facilitates the study of enzyme structure and model prediction for beta-galactosidase but can also be adapted to investigate various enzymes and protein-protein interactions, such as those involving hormones and receptors. This method is particularly beneficial when combined with straightforward measurement outcomes, enhancing the learning experience and promoting a deeper understanding of biochemical principles among students.

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Ethical approval

This study (HSEARS20200826002) was approved by the institutional review board of the Hong Kong Polytechnic University.

References

Carlin, D. A., Hapig-Ward, S., Chan, B. W., Damrau, N., Riley, M., Caster, R. W., Bethards, B., & Siegel, J. B. (2017). Thermal stability and kinetic constants for 129 variants of a family 1 glycoside hydrolase reveal that enzyme activity and stability can be separately designed. PLoS One, 12(5), e0176255. https://doi.org/10.1371/journal.pone.0176255

Chen, G., Lau, A., Wan, B., Poon, E. S. K., Fung, H. S., Lee, W. H., Sung, Y. H., & Sin, S. Y. W. (2023). Occurrence of Pathogenic Chytrid Fungi *Batrachochytrium Salamandrivorans* and *Batrachochytrium Dendrobatidis* in the Hong Kong Newt (*Paramesotriton Hongkongensis*) and Other Wild and Imported Amphibians in a Subtropical Asian Region. J Wildl Dis, 59(4), 709-721. https://doi.org/10.7589/JWD-D-22-00145

D2D Lab Manual. (2022). Design2Data with β-glucosidase lab manual & workflow. University of California, Davis. Retrieved from https://d2d.ucdavis.edu/d2d-lab-manual

Perez, Jennifer (2023) "Surveillance and monitoring of amphibian pathogens and evaluating the impacts of an associated Course-based Undergraduate Research Experience (CURE)" EWU Masters Thesis Collection. 879. https://dc.ewu.edu/theses/879

SNAPS Classroom Resources. (2025). In the classroom - Student Network for Amphibian Pathogen Surveillance. Retrieved from https://snaps.amphibiandisease.org/in-the-classroom/

Yau, Y. C. M., Cheung, T. S. E., Chen, X. F., & Wong, C.-M. (2022). Use of course-based undergraduate research experiences model to enhance research interest of Hong Kong health professional undergraduate students.In 8th International Conference on Higher Education Advances (HEAd'22), Editorial Universitat Politècnica de València. 773-779. https://doi.org/10.4995/HEAd22.2022.14498

Yau, M.; Chan, C-P.; Chan, K-M.; Tam, B.; Wong C-M. (2024) The challenges of implementing Course-Based Undergraduate Research Experiences (CURE) in Hong Kong universities for healthcare-related professional students. In: 10th International Conference on Higher Education Advances (HEAd'24). Valencia, 18-21 June 2024. https://doi.org/10.4995/HEAd24.2024.17043

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Teaching Health Data Science through Experiential Learning: The Datathon Approach

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Abstract

This paper describes the design and implementation of an annual health data science datathon aimed at teaching practical skills in health analytics to undergraduate and postgraduate university students. Datathons provide an experiential learning environment where students work in teams to analyse real-world health data and propose solutions to current challenges in the field. The steps to design and execute the datathon are outlined, covering data, partnerships, task design, and rubric development. We discuss the educational benefits of formalising research questions, working in groups, programming, and presenting findings. Growing access to electronic health data combined with the availability of free and opensource analysis platforms and libraries, and cheap cloud compute power make datathons a universally accessible learning experience.

Keywords*: Health data science; datathon; experiential learning; student engagement.*

1. Introduction

Health data science is an emerging discipline sitting at the nexus of (i) medicine and health, (ii) computer science, and (iii) statistics and artificial intelligence (AI). This highly applied and inherently interdisciplinary subject attracts a broad range of students with diverse educational and career trajectories, ranging from working health professionals with vast domain knowledge but limited coding skills to undergraduate computer science students familiar with cutting-edge algorithms, but lacking contextual experience.

Experiential learning has been identified as an effective approach to engage diverse student cohorts (Amat et al., 2021; Rohani et al., 2024). Hackathons and datathons are examples of pedagogical approaches which offer such experiential learning (Silver et al., 2016). A hackathon is a social coding event where groups of individuals come together to work intensively (often competitively) on a practical problem over a short period of time. These events emerged from

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the tech industry and have gained popularity as an educational tool internationally and across multiple disciplines (Garcia, 2023). Datathons follow a similar model to hackathons, but with a stronger focus on the analysis and interpretation of data. While academic interest in datathons has lagged that of hackathons, data-orientated events are catching up in popularity (see Figure 1), likely facilitated by the increasing availability of large open data repositories (Anslow et al., 2016).

The practical nature of these events forces students to engage with pragmatic challenges which are often de-emphasised in more traditional pedagogical approaches, for example navigating data documentation and handling missing or ineligible data. The team-based nature of these events also encourages students to build soft-skills including teamwork, communication, project management and community engagement (Anslow et al., 2016). A recent systematic review of 30 studies describing results from hackathons and datathons has confirmed their educative benefits, including enhanced learning and increased student engagement and motivation (Oyetade et al., 2024). Datathons can also be relatively low-cost events, making them widely accessible learning experiences (Kuter & Wedrychowicz, 2021). This accessibility is facilitated by the widespread availability of free, opensource analysis platforms and libraries, opensource data, including synthetic electronic health records (Kuo et al., 2024), and free cloud compute power for students.

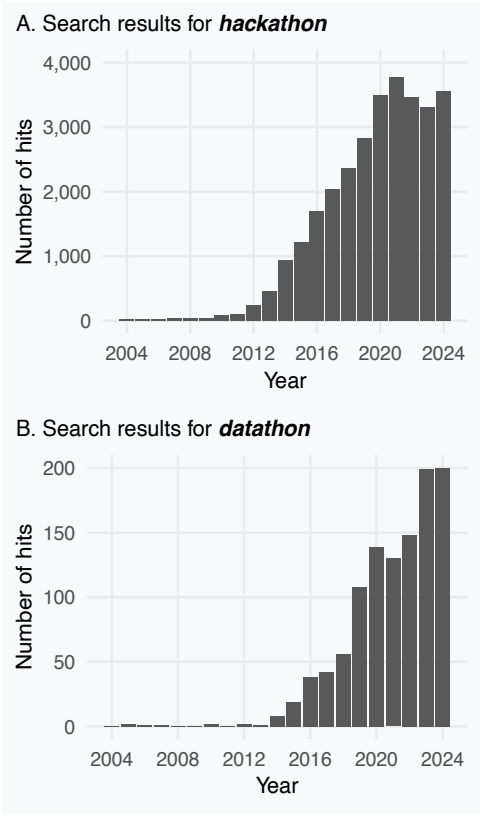


Figure 1. Number of Google Scholar search results for (A) Hackathon and (B) Datathon by year, 2004 - 2024.

The educational benefits of datathons are clear, but there are also many practical challenges to their successful delivery. While there are many open datasets available, an appropriate datathon dataset must balance sufficient complexity with being reasonably analysis-ready given the short timeframe (Mougan et al., 2024). Cultural diversity and varied skill levels among team members can be a challenge to effective teamwork (Oyetade et al., 2024). There are also the everyday logistical challenges of planning and promoting the event, securing an appropriate venue, providing IT support, engaging industry partners, and the financial cost of these activities (Kuter & Wedrychowicz, 2021).

This paper describes our experience organizing two annual datathons at the University of New South Wales, Sydney (UNSW) in 2023 and 2024. The datathons aimed to provide undergraduate and postgraduate students with an experiential learning activity where they could apply the methods they have been learning to real-world problems. We outline the design and execution process, highlighting the educational impact and lessons learned.

2. The Datathons

The learning objectives of our datathon events were to engage students in applied health data science through experiential learning; strengthen teamwork and communication by working in groups; build technical skills in data analysis and programming; foster critical thinking by tackling real-world data challenges; and provide exposure to the complexities of working with real-world health data. These objectives aimed to ensure that students not only developed technical proficiency but also gained essential soft skills and a deeper appreciation of health data science in practice.

To illustrate how these objectives were achieved, we describe the execution and outcomes of our datathons held in 2023 and 2024.

2.1. Year 1 (2023)

The first UNSW Health Data Science datathon took place in May 2023. This one-day event saw the participation of 22 Masters of Science in Health Data Science students working in six teams, five on campus and one hybrid online/on-campus team. The event focused on the Antiretroviral Therapy in HIV dataset, a realistic synthetic dataset comprising demographic details and longitudinal clinical data on viral loads, CD4 counts, and drug regimens for 8,916 patients with HIV (See Figure 2). This is a free and opensource dataset, generated using AI as part of the Health Gym project, which aims to provide clinically realistic datasets while avoiding the usual disclosure risks associated with health data (Kuo et al., 2022).

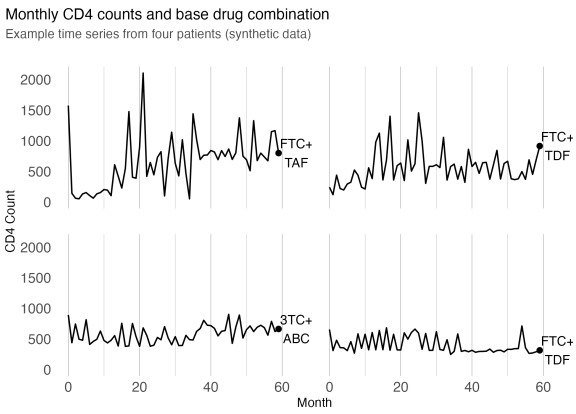


Figure 2. CD4 counts over time and base drug combination for four randomly selected patients from the Antiretroviral Therapy in HIV dataset.

Teams were challenged to pose a research question and develop a solution using their health context expertise and analytic skills. Five experts were on hand to guide the teams, aiding them

in crafting their research questions and executing their proposed solutions effectively. This included applied researchers with content expertise in HIV medications and machine learning, and Health Informaticians from New South Wales Health, Sydney Local Health District. At the end of the day, each team gave a short presentation, summarizing their research question, analytic approach and results. A team of independent judges assessed the teams based on a structured rubric (described below) and winning teams were awarded small cash prizes (max $150 AUD per student) in the form of gift vouchers.

2.2. Year 2 (2024)

Following the success of the 2023 datathon, the second UNSW Health Data Science Datathon expanded to include over 50 UNSW students from 12 different schools and research centers for a two-day event in December 2024. There were 13 teams in total, with one team again working as a hybrid online/on-campus team. Participants analyzed infectious disease data from EPIWATCH®, an AI-driven system that provides near real-time global monitoring of a range of infectious diseases and syndromes by scanning open-source online news sources. (MacIntyre et al., 2023). Each record in the dataset represents a news article mentioning an infectious disease or syndrome (See Figure 3). Minimum data includes the disease or syndrome(s) in question, the timing and location of the report, as well as the title and link to the original online article.

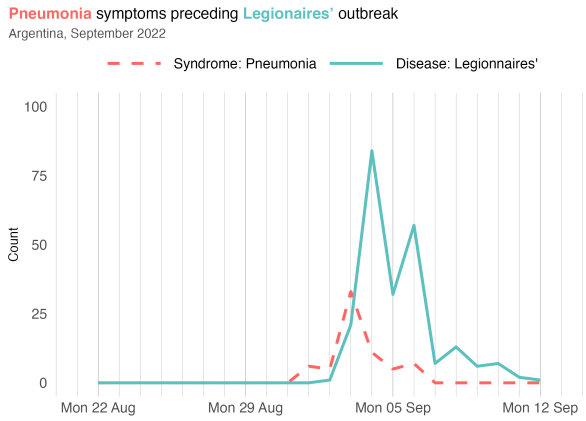


Figure 3. EPIWATCH® data showing counts of news articles mentioning pneumonia syndromes or Legionnaires' Disease in Argentina, August-September 2022. Note that publicly available online reports of unexplained pneumonia symptoms preceded the identification of Legionnaires' disease as the source of the outbreak.

On day 1 of the event, participants were challenged to use the EPIWATCH® data to design a data science pipeline (including data processing and analysis) with the aim of predicting emerging infectious disease outbreaks. On day 2 of the event, the EPIWATCH® data was incrementally updated with an additional day of data every 5 minutes over the course of 90 minutes. This exercise was designed to simulate the experience of real-time surveillance and allow students to test and demonstrate the effectiveness of the data cleaning and analysis pipelines they had developed on day 1. The larger number of teams in this running meant that it was not practical for every team to present their work. Instead, the judging panel made an initial selection of eight teams based on qualitative review of their progress and their performance in the simulation exercise. The shortlisted teams presented their

approaches formally and were reviewed based on a structured rubric. Again, winning teams were presented with small cash prizes in the form of gift vouchers.

3. Designing the datathon

3.1. Data and Partnerships

In our experience, acquiring relevant and high-quality datasets is the most practical starting point to designing a datathon event. The available data dictate the types of questions or challenges that can be posed, the access requirements and computational needs for participants, and the necessary domain knowledge input that will be needed. Suitable datasets for a datathon must meet several requirements to ensure the success of the event: 1) **Complexity**: The dataset should be challenging enough to push participants to think critically and apply advanced analytical methods; 2) **Big Data Characteristics**: The dataset should include a sufficient number of records or a volume of information that allows for the application of algorithms and enables participants to draw meaningful conclusions; 3) **Relevance and Motivation**: The dataset should be interesting and relevant to participants, aligning with current health challenges. This ensures that students remain motivated throughout the datathon and feel a sense of purpose by recognising the potential impact of their analyses.

Given the inherent sensitivity of patient data, finding suitably large and accessible datasets was a particular challenge. We overcame this by drawing on opensource, synthetic data in 2023, and EPIWATCH® surveillance data, comprising news article data rather than patient data, in 2024. For both editions, the data was released a week before the event, along with a data dictionary and a brief online session. This session provided an overview of the data and included a Q&A on the dataset and the datathon.

In both cases, building partnerships with data custodians and domain experts was essential. In 2023, we partnered with the creators of the synthetic dataset, an HIV medication expert and data specialists from a local Sydney hospital to provide participants with insights into HIV treatment and the complexities of health data. In the 2024 datathon, we partnered directly with the EPIWATCH® team, who facilitated data access, shared their expertise, and mentored students in their analytic approaches during the datathon. These insights helped participants gain a deeper understanding of how real-world infectious disease surveillance systems operate and how health-driven analytics are used to monitor and respond to global health threats.

3.2. Research Question Design

Crafting research questions that align with both educational and practical objectives is essential. Examples include tasks involving disease prediction and anomaly detection, which foster critical thinking and technical skills. We adopted contrasting approaches in the 2023 and 2024

datathons. In 2023, formulating a research question was built in as part of the datathon challenge. This enabled participants to explore a variety of questions and analytical approaches, such as predictive modeling (e.g., estimating the probability of a patient having a low CD4 count given a specific drug combination) and causal inference (e.g., identifying factors influencing time-to-event outcomes using Cox regression) (Kuo et al., 2024). By leaving the research question open, participants were encouraged to think critically about the data's structure, its potential for answering different types of health-related questions, and how to design a question that can be translated into an operationalizable analysis.

In contrast, for the 2024 edition, the research question was less open ended, and students were required to focus specifically on predicting future outbreaks. While this provided a clear analytical direction, it also introduced an additional layer of complexity—participants first had to define what constitutes an outbreak. This was a non-trivial task, as outbreak definitions can vary depending on the disease. For instance, an influenza outbreak might be defined by a rapid increase in cases over a short period, whereas an Ebola outbreak could be characterized by even a small number of cases due to its severity. This ambiguity required participants to engage deeply with epidemiological concepts before proceeding with modelling, reflecting the real-world challenges of outbreak detection and biosurveillance.

3.3. Software and Infrastructure

In both iterations of the datathon, participants were provided with links to downloadable comma-separated values (CSV) text files containing the challenge datasets. These datasets had the dual advantages of being (i) reasonably small (42.6MB in 2023 and 15.3MB in 2024) and (ii) non-sensitive, meaning that neither additional computational resources nor secure analytic environments were required. Students worked on their own laptops and were allowed to use any analysis software they preferred. Popular statistical packages included Python and R.

3.4. Rubric Development

The open-ended nature of the challenge questions precluded the use of standard methods for quantifying predictive accuracy. Instead, we designed a structured rubric that offered a comprehensive evaluation of team performance. For example, for the 2024 event, assessment was divided into three equally weighted categories: analytic approach, surveillance quality, and communication of results. The analytic approach criterion assessed the robustness of participants' data handling and methodological choices, ensuring that data preparation and modeling techniques were both appropriate and reproducible. Surveillance quality focused on the effectiveness of outbreak detection, considering the timeliness and accuracy of predictions while minimizing false alarms. Finally, communication of results evaluated how well teams articulated their methods and findings through visualizations, presentations, and the overall clarity of their insights.

4. Outcomes and Lessons Learned

Participant feedback was overwhelming positive with 100% of post-event survey respondents agreeing with the statement *Based on your experience at the datathon, would you recommend it to other students?* Qualitative feedback highlighted the value of teamwork. For example, participants in 2004 wrote: 1) *"I very much enjoyed working with my team members to brainstorm how to convert complex and messy datasets into well-organised formats for data visualisation."*; 2) *"I particularly enjoyed working with my team and hearing others' approaches."* Respondents also positively emphasized the hands-on nature of the events: *"I loved getting to work with really complicated data based on real situations."*



A. Analysing the data.



B. Brainstorming with content experts.

Figure 4. Students participating in the UNSW Health Data Science Datathon, 2024.

Following the 2023 datathon, several teams co-authored a peer-reviewed academic paper with the Antiretroviral Therapy in HIV dataset developers and the datathon organizers, providing the students with a tangible output from the event (Kuo et al., 2024).

Essential to the success of both datathon iterations was the active participation of content experts from partner organizations, who provided students with valuable insights into data structures and their use in real-world settings. Another important contributor to the event's success was the early release of the dataset and the information session held one week prior, where domain experts were available to answer questions. This gave students time to explore the data in advance and seek clarification as needed. We found it practical to start with a relatively small one-day event with students from our own faculty before scaling up to a two-day event with students from across the university. Open-ended questions offered students an engaging challenge but also required the development of a structured rubric. In contrast, focusing on a more narrowly defined prediction or classification task could allow for automatic assessment using standard metrics, which may be preferable for larger events.

A major challenge in both iterations was securing a suitable dataset. In both 2023 and 2024, we were able to draw on data resources developed at UNSW which helped to facilitate access. To continue to provide suitable datasets for an annual event will require expanding beyond the

university to publicly or privately held data assets. A second major challenge was securing financial support, which in our case was provided through the UNSW Faculty of Medicine and Health.

5. Conclusion

The datathon model provides a relatively low cost and accessible model for teaching data science through experiential learning. Future iterations will aim to incorporate more diverse datasets and explore opportunities to collaborate with public and private data holders.

References

Amat, M., Duralde, E. R., Lam, B. D., Lipcsey, M., Persaud, B. K., & Celi, L. A. (2021). Hacking the hackathon: insights from hosting a novel trainee-oriented multidisciplinary event. *BMJ Innovations*, 7(3). https://doi.org/10.1136/bmjinnov-2020-000583

Anslow, C., Brosz, J., Maurer, F., & Boyes, M. (2016). Datathons: An experience report of data hackathons for data science education. *Proceedings of the 47th ACM Technical Symposium on Computing Science Education*. https://doi.org/10.1145/2839509.2844568

Garcia, M. B. (2023). Fostering an innovation culture in the education sector: A scoping review and bibliometric analysis of hackathon research. *Innovative Higher Education*, 48(4). https://doi.org/10.1007/s10755-023-09651-y

Kuo, N. I.-H., Perez-Concha, O., Hanly, M., Mnatzaganian, E., Hao, B., Di Sipio, M., Yu, G., Vanjara, J., & Valerie, I. C. (2024). Enriching Data Science and Health Care Education: Application and Impact of Synthetic Data Sets Through the Health Gym Project. *JMIR Medical Education*, 10(1). https://doi.org/10.2196/51388

Kuo, N. I.-H., Polizzotto, M. N., Finfer, S., Garcia, F., Sönnerborg, A., Zazzi, M., Böhm, M., Kaiser, R., Jorm, L., & Barbieri, S. (2022). The Health Gym: synthetic health-related datasets for the development of reinforcement learning algorithms. *Scientific data,* 9(1). https://doi.org/10.1038/s41597-022-01784-7

Kuter, K., & Wedrychowicz, C. (2021). Hosting a data science hackathon with limited resources. *Stat*, 10(1). https://doi.org/10.1002/sta4.338

MacIntyre, C. R., Chen, X., Kunasekaran, M., Quigley, A., Lim, S., Stone, H., Paik, H.-y., Yao, L., Heslop, D., & Wei, W. (2023). Artificial intelligence in public health: the potential of epidemic early warning systems. *Journal of International Medical Research*, 51(3). https://doi.org/10.1177/03000605231159335.

Mougan, C., Plant, R., Teng, C., Bazzi, M., Cabrejas Egea, A., Chan, R., Salvador Jasin, D., Stoffel, M., Whitaker, K., & Manser, J. (2024). How to data in datathons. *Advances in Neural Information Processing Systems*, 36.

Oyetade, K., Zuva, T., & Harmse, A. (2024). Evaluation of the impact of hackathons in education. *Cogent Education*, 11(1). https://doi.org/10.1080/2331186X.2024.2392420

Rohani, N., Gal, K., Gallagher, M., & Manataki, A. J. B. M. E. (2024). Providing insights into health data science education through artificial intelligence. *BMC Med Educ* 24(1). https://doi.org/10.1186/s12909-024-05555-3

Silver, J. K., Binder, D. S., Zubcevik, N., & Zafonte, R. D. (2016). Healthcare hackathons provide educational and innovation opportunities: a case study and best practice recommendations. *Journal of medical systems*, 40. https://doi.org/ 10.1007/s10916-016-0532-3

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Promoting competency-based education through the development of a competency model: lessons learned from a change perspective

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Abstract

Competency-based education is linked to a shift from content to competencies. This shift does not happen automatically but requires a change process with corresponding strategies. Based on a case study it is outlined and linked to change strategies how developing a competency model can be a necessary and worthwhile step in this change process towards competency-based education. Main lessons learned include the support of management, a project team with a mandate and a joint, iterative development process as key success factors. Moreover, implementation needs at least as much effort and energy as the development and is an ongoing task including faculty development and taking visible actions. The lessons learned from this case support previous findings of successful change strategies for higher-education institutions.

Keywords: *competency model; competency-based education (CBE); organisational change management strategies; organisational sensemaking; stakeholder management*

1. Introduction

In addition to the structural standardisation of higher education, the aim of Bologna has been to focus higher education on competencies and no longer exclusively on content. However, evaluation studies have shown that this shift from content to competencies has not yet been fully implemented in many higher education institutions (Wehr, 2011, p. 9) and requires a change process.

Kezar and Eckel (2002) identify strategies for effective change in higher education institutions and stress the importance of processes that allow members of these institutions to engage in organisational sensemaking. These strategies are:

- Senior administrative/leadership support: support of those with authority over budgets, staffing, institutional priorities

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- Collaborative Leadership: individuals with both positional and non-positional power (different stakeholder groups) collaborate and are involved in the change initiative from conception to implementation
- Robust design: consistency with the overall vision and culture of the institution
- Staff development: opportunities to learn related to the change effort
- Taking visible actions: making implementation activities visible and emphasizing the importance of the change through publications or transparent discussions to build and maintain momentum for the change

In addition, Dee and Leisyte (2017, p. 359) point out the importance for organizational development to jointly produce knowledge and to identify common interests, which can be achieved for example through the development of models and prototypes or the participation in pilot projects that involve members from different units.

Based on the case of the School of Business of the University of Applied Sciences Northwestern Switzerland (FHNW), this paper explores how developing a competency model can be a necessary and worthwhile step developing the organisation towards competency-based education. In this paper the chosen approach will be outlined and discussed as well as the lessons learned. In addition, an outlook on further implementation steps will be given. The focus will be less on competency-based education itself and whether and why these are the "right" competencies developed for the School of Business, but rather on how the competencies were derived, negotiated as an organisation and subsequently implemented from a change and organizational development perspective referring to Kezar and Eckel (2002) proposed strategies.

2. Developing a competency model

The FHNW and its School of Business have committed themselves to competency-based education (CBE). Initial discussions back in 2018 about competencies and competency-based education resulted in using Heyse and Erpenbeck's competency explorer (2004) to select competencies that were used in competency grids for study programmes. However, a common understanding that led to a jointly supported competency model and a broadly supported integration of the selected competencies in teaching did not take place. So, it was necessary to further develop the understanding of competencies and competency-based teaching and learning and to better implement them in strategy, structure and culture of the institution. Moreover, to ensure that the curricula and teaching are meeting the changing requirements of the job market and society, it was critical to regularly question the status quo. The starting point of the change process described in this case, was an assignment given by the management board "What competencies must our graduates have (developed) upon completion (of their studies) in order to be successful on the job market?".

2.1. Development process

With the assignment and support of the management board a project team of eight members was built representing different departments, functions (e.g. lecturer, quality management, study programme heads, representative continuing education), all genders, disciplines and tenure in the organisation. The project team had the mandate to drive and orchestrate the project. The formation and composition of the project team was already an initial measure to bring relevant stakeholders on board.

The development process itself can be divided into two phases a) explore and collect b) decide and design. In the explore and collect phase the aim was to lay the foundation for a shared understanding. This included the clarification of the concept of competency, competence and competency-based education as there are different and conflicting definitions and informed and considered discussion have to take place (Holmes et al., 2021). Therefore, to clarify and develop a shared understanding was an important step. As result we followed Weinert (2001; p. 47) defining competence as *"the cognitive abilities and skills existing within individuals or which can be learned by them to solve certain problems as well as the motivational, volitional, and social dispositions and abilities to be able to use problem solutions in variable situations successively and in a responsible way."* In this phase also strategy, mission and preliminary internal work like the competency grids, further relevant studies (e.g. Ehlers, 2020; Sterel, 2018) and future requirements were collected, analysed and discussed with internal and external stakeholders (e.g. future employers of our graduates) as part of various events like annual development weeks, summer schools and workshops.

Using the results from the explore and collect phase, the project team derived in the decide and design phase an initial prototype from the wealth of material available. The resulting prototype was extensively sounded with different stakeholders (e.g. management board, programme heads, faculty etc.) based on key questions like "Are important competencies missing in your view, and if so, which ones and why?", "Are competencies obsolete and if so, which ones and why?", "Are the competencies and the descriptions understandable? If not, what is unclear? Are there missing aspects in the competency descriptions/possible behavioural anchors that are particularly important to you?" Based on the feedback received, the model was further developed in several iterations and finally approved by the management board end of 2023. The following figure 1 summarizes the development process.

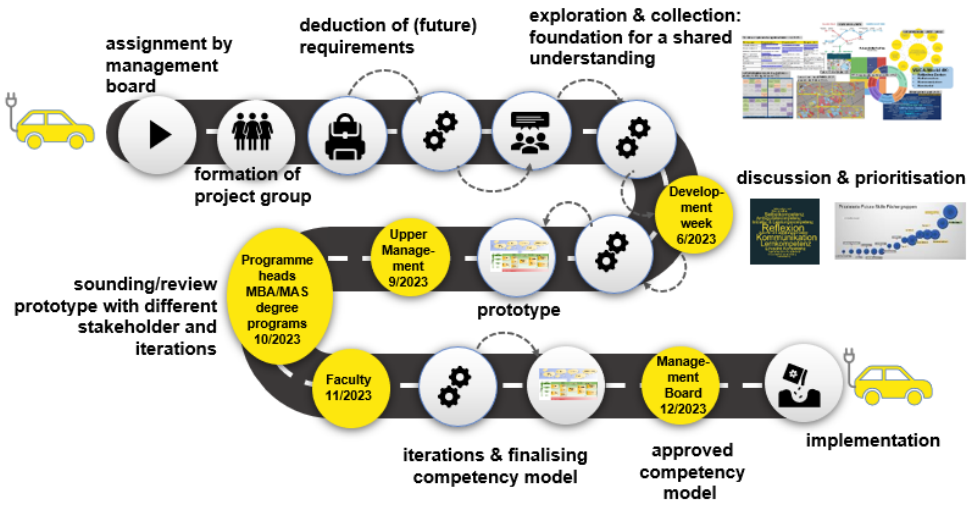


Figure 1. Overview development process

2.2. The competency model

The approved and visualised model is illustrated in the following figure 2.



Figure 2. The developed competency model

The competency model contains ten **self and social competencies** that are critical to success, e.g. reflect, learn or think critically (white bubbles). Each of these competencies were named, defined and provided with so-called behavioural anchors. These behavioural anchors can be used to determine how the competencies can be observed in different situations (e.g. classroom setting/assessment, everyday life). Table 1 provides the competency "communicate" as an example.

Table 1. Definition and examples of behavioural anchors for the competency "communicate"

Communicate	
Definition	...is the ability to convey information in a way that is appropriate to the audience, context and credibility, to listen and to ask questions.
Behavioural anchors	e.g. communicates in analogue and/or digital form, in words and/or pictures, in a way that is appropriate to the purpose, situation and audience. listens actively and ensures mutual understanding by asking questions argues coherently and persuasively

Ethical, digital and sustainable are so-called **cross-cutting topics** that need to be considered in all competencies (e.g. ethical aspects of decision-making).

Professional and methodological competencies also have a placeholder (yellow) in the model. These are more (discipline) specific competencies and must be defined and specified for the respective degree programme and module. The definition and specification cannot be done by a project team or top down by management but by all lecturers based on the constructive alignment concept (Biggs, 1996). In a nutshell, the constructive alignment concept focuses the learning design and assessment on the intended outcomes. The following questions must hereby be answered and possible answers from the module "Organisational Behaviour and Human Resource Management" are used as examples:

- What are the professional competencies that must be taught e.g. in the module, the respective lesson? (e.g. recruitment, compensation, retention etc.)
- What are the specific methods to be used or taught? (e.g. group work, case study)
- Which of the self and social competencies does the module or course contribute to? e.g. "decide": Where are decisions relevant in the discipline (e.g. selection decisions, promotion decisions)? What contribution can be made to develop and promote this competency (e.g. identifying perception errors, "unconscious bias")?

3. Status quo implementation process

Implementation started in 2024. First, the model was professionally visualized and translated into English. The finalised model was presented, discussed and worked with during so called development week. Development week is an annual development and exchange forum that focuses on reflection and further development of teaching with all faculty and in addition with external stakeholders (there is a "stakeholder day" within the development week). These discussions were linked to the assignment to integrate the model and its competencies in already existing modules and into the design of new modules for the upcoming revision of the curriculum. This included the concretisation and contextualisation of the self and social

competencies as well as the selection and definition of the relevant professional and methodological competencies according to the concept of constructive alignment (Biggs, 1996). To support faculty doing so, further training on competency-based teaching were offered to all faculty members comprising of online courses and workshops (e.g. planning and design of competency-based teaching and competency-based assessment) in autumn 2024. As pointed out by Kazar and Eckes (2002) staff development and taking visible actions are key strategies. The model itself can be perceived as visible action as well as the other implementation activities described.

To summarize, all of the five strategies described were applied in the change process: during the two phases of the development process as well as in the implementation and have proven to be sucessful from our point of view. From a project team perspective, the development of a competency model was a necessary and worthwhile step to promote competency-based education and with the process described the awareness of the faculty has increased. Also changes in the module descriptions were made and the foundations for the curriculum revision were laid, so that the new curriculum is more (explicitly) competency-oriented compared to the old one. However, implementation is still going on and a systematic evaluation is missing. One next step will be the evaluation from a students' perspective in spring 2025 to investigate whether the development and integration of the model influences students' perceptions on competencies. We will furthermore explore to what extent they perceive their degree programme with its modules and the teaching taking place as competency-based and what their ideas are to promote competency-based education in the future.

4. Lessons learned and conclusion

Looking back at the development process, various lessons can be learned: The assignment with a mandate for the project team and the support of the management board throughout the process was an important success factor. This is in line with previous further studies (Kezar & Eckel. 2002; Dragoo & Barrows, 2016) stressing the importance of senior leadership support.

The joint development process was a central step and already represents an initial intervention for raising awareness of the topic and developing a common understanding of competencies within the organisation. A joint negotiation and production process is required for transformation (Dee & Leisyte, 2017) and is needed for organisational sensemaking (Kezar & Eckel, 2002). For this reason, we do not believe that adopting a ready-made model and/or a top-down model is expedient. However, it can be a necessary intermediate step and a first approach to the topic. The process described here would not have been possible in this form without the intermediate step we took using Heyse and Erpenbeck's competency explorer (2004).

A critical point in our process was the transition from the explore and collect phase to the decide and design phase. There was a threat of no longer seeing the wood for the trees and losing sight

of the goal to derive an actionable number of success-critical competencies for a competency model. The successful transition required the ability to leave things out and to make conscious decisions. In our view, the formation of a project team with a clear mandate to drive and orchestrate the project and to make those necessary decisions was key especially in an expert organisation. For acceptance of the process, the proposals and decisions made, it was moreover important that the various internal stakeholder groups felt well represented in the project team.

Regular and transparent information and the involvement of all stakeholders was central not only for organisational sensemaking, but also for the acceptance and subsequent use of the model and again must be supported by the management. Particularly in an expert organisation, it was important to keep in mind the process and when and to what extent participation and collaboration were useful and expedient and when this was not the case (e.g. fundamental discussions should be held at the beginning and not at the end of the process) and to communicate accordingly. The chosen approach with a comprehensive exploration and collection phase and targeted sounding has proven its worth here. Recurring information and discussion on different occasions, in different settings and with different stakeholder groups over the entire duration of the project was important to raise and keep awareness of the topic and provided visible action needed for successful change (Kezar & Eckel, 2002).

Furthermore, it was important for acceptance to keep in mind the future use of the model during development and to demonstrate and communicate the expected benefits. It has to be stressed that the aim is not developing a model, but to develop a model that is useful and integrated in teaching and learning now and in future.

And finally, the subsequent implementation requires at least as much effort and energy as the development and is never complete. There is a risk that a lot of energy and resources are invested in development, but then the project "runs out of steam" and the effort required for implementation is underestimated and no longer carried out to a sufficient extent. The assignment and commitment from the management board must not be limited to development but must include implementation with the necessary resources. It also needs the willingness of all those involved to continue working on the topic and to develop further.

References

Biggs, J. (1996). Enhancing teaching through constructive alignment. *High Educ, 32,* 347–364. https://doi.org/10.1007/BF00138871.

Dee, J., & Leisyte, L. (2017). Knowledge sharing and organizational change in higher education. *The Learning Organization, 24*(5), 355-365. https://doi.org/10.1108/TLO-04-2017-0034

Dragoo, A. & Barrows, R. (2016). Implementing Competency-Based Education: Challenges, Strategies, and a Decision-Making Framework. *The Journal of Continuing Higher Education, 64*(2), 73-83. https://doi.org/10.1080/07377363.2016.1172193

Ehlers, U.-D. (2020). *Future Skills. Lernen der Zukunft - Hochschule der Zukunft.* Springer. https://doi.org/10.1007/978-3-658-29297-3

Heyse, V., & Erpenbeck, J. (2004). *Kompetenztraining: 64 Informations- und Trainingsprogramme.* Schäffer-Poeschel Verlag.

Holmes, A.G.D., Tuin, M.P., & Turner, S.L. (2021). Competence and competency in higher education, simple terms yet with complex meanings: Theoretical and practical issues for university teachers and assessors implementing Competency-Based Education (CBE). *Educational Process: international journal, 10*(3): 39-52. https://dx.doi.org/10.22521/edupij.2021.103.3

Kezar, A., & Eckel, P. (2002). Examining the institutional transformation process: The importance of sensemaking, interrelated strategies, and balance. *Research in Higher Education, 43*(3), 295–328. https://dx.doi.org/10.1023/A:1014889001242

Sterel, S. (2018). *Ausbilden nach 4K. Ein Bildungsschritt in die Zukunft.* HEP

Wehr, S. (2011). Nicht nur belehren, sondern auch befähigen – zur Förderung des Kompetenzerwerbs an der Hochschule. In S. Wehr & T. Tribelhorn (Hrsg.), *Bolognagerechte Hochschullehre* (S. 9-12). Haupt.

Weinert, F. E. (2001). Concept of competence: A conceptual clarification. In D. S. Rychen & L. H. Salganik (Eds.), *Defining and selecting key competencies* (pp. 45–65). Hogrefe & Huber Publishers.

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Self-Stigma in Academic Help-Seeking: A Comparative Study of First-Generation and Continuing-Generation University Students

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Abstract

First-generation students (FGS) face unique challenges in their learning journey. Amongst, self-stigma around academic help-seeking is a significant psychological barrier. Students with high self-stigma view help-seeking as a sign of inadequacy, limiting them from accessing support when needed. This study examines differences in self-stigma in academic help-seeking between first-generation and continuing-generation students (CGS) in Hong Kong. Using an online questionnaire, this study collected data from 196 students (67.9% FGS). The results showed that compared to CGS, FGS reported significantly higher levels of self-stigma ($p = .019$, $d = 0.36$). The findings suggest that FGS may face more psychological challenges in their academic journey. Targeted interventions in reducing self-stigmas could encourage all students to utilize resources, and thus, provide equal opportunity for their academic success.

Keywords: *First-generation students; help-seeking; academic problems; self-stigma; equality; equity.*

1. Introduction

First-generation students (FGS) are the first in their families to attend university. Compared with continuing-generation students (CGS), FGS usually face more challenges, placing them in a significantly disadvantaged position across multiple domains. In the academic domain, FGS are often reported to have lower GPAs and degree completion rates (Marquez, 2019). These could be attributed to the limited access to essential academic resources, such as textbooks and technology (Patfield et al., 2022; Bamberger & Smith, 2023). Psychologically, FGS may also experience more stress and anxiety due to financial insecurity (Marquez, 2019). They may also have a greater sense of loneliness and isolation because of the difficulties in connecting with peers and teachers (Veldman et al., 2019; McCallen & Johnson, 2020). In general, FGS often lack knowledge and resources from their families in helping them navigate their higher

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education journey. Such a situation may cause heightened anxiety, isolation, and academic pressures, adversely affecting their performance and well-being (Smith & McLellan, 2023; White & Canning, 2023).

Academic help-seeking emerges as a crucial adaptive behaviour in response to the challenges in the learning journey. It enables students to access necessary resources and support when facing academic difficulties. However, students' tendency and decisions for academic help-seeking varies. Previous research showed that various factors, such as age, gender, educational background, socioeconomic status, and psychological factors, might affect students' decisions in academic help-seeking (Bornschlegl et al., 2020) and coping flexibility (Ng & Chen, 2023). Recently, Li and colleagues (2025) studied the academic help-seeking behavior of first-generation college students from rural China. Their findings highlighted that emotional barriers and concerns about the effectiveness of help significantly impact FGS's tendencies to seek help. Students are especially concerned about self-doubt (the lack of self-confidence) and peer judgment (others' opinion) (Li et al., 2025), viewing academic help-seeking as a sign of weakness or incompetence. These are closely related to the concept of self-stigma (the internalized negative beliefs).

The two contributors of self-stigma in academic help-seeking, namely, emotional barriers and perceived social pressures, might vary between FGS and CGS, as FGS may feel additional pressures to prove their academic ability in the higher education setting. As mentioned, FGS already felt isolated and faced difficulties accessing necessary resources throughout their academic journey. If FGS further associates academic help-seeking with weakness or incompetence, such self-stigma might further deter them from seeking academic support (Bornschlegl et al., 2021; Yu et al., 2019), creating a cycle of isolation particularly detrimental for them.

This research specifically aims at investigating the differences in self-stigma in academic help-seeking between FGS and CGS. The research proposes the research question of whether or not generational status will influence students' experiences of self-stigma when seeking academic help. The comparative approach would provide insights into how diverse students experience and cope with self-stigma. An understanding of the potential differences in self-stigma between FGS and CGS could help develop targeted interventions to address each group of students' unique psychological barriers, thus promoting academic success for all students. By examining these differences between FGS and CGS in the Hong Kong context, this research will not only contribute to developing culturally sensitive interventions that effectively address self-stigma and promote help-seeking behaviors but also shed light on other Asian educational contexts that share similar cultural values and academic pressures as Hong Kong.

2. Method

This research employed a quantitative approach using an online questionnaire to investigate the self-stigma of academic help-seeking among university students.

2.1. Participants

A total of 196 university students participated in the study through mass mail and/or campus-wide recruitment. Participants were informed of their rights and provided consent before participating in the study. They were free to withdraw at any time without penalty. The sample comprised both FGS (n = 133, 67.9%) and CGS (n = 63, 32.1%). About 60.7% were female (n = 119) and 39.3% were male (n = 77). They were aged from 18 – 24 (mean = 20.70, Sd = 1.28). They were invited to complete an online questionnaire in Traditional Chinese. A careful inspection revealed that there was no missing data. The questionnaire consists of the following measures:

Self-stigma of Academic Help-seeking: Participants indicated the extent to which individuals feel self-stigmatized when seeking academic help by a 10-item scale (Winograd & Rust, 2014). Sample item includes "Seeking help would make me feel less intelligent." The items are anchored on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), with higher scores generally indicating higher levels of stigma associated with seeking academic help. The scale was translated into Chinese and back-translated into English by two different bilingual persons to ensure the equivalence of the content and meaning (Brislin, 1986). The reliability in this research is satisfactory, with Cronbach's Alpha = .71.

Student Generation Status: Participants identified themselves as FGS or CGS by responding to the question "*Are you a "first-generation college student"? That is, if you are a first-generation college student in your family, your brothers and sisters may have received a college education, but your parents have not received higher education"* Responses were coded as 1 (*yes*) and 2 (*no*).

Demographic details: Age and gender were also collected.

2.2. Data Analysis Plan

To protect participants' confidentiality, analyses were conducted only on aggregated data. Descriptive statistics were first computed, followed by independent samples t-tests to examine the differences in self-stigma between first-generation students and continuing-generation university students. Levene's test was conducted to assess the equality of variances between groups of first-generation and continuing-generation students.

3. Results

3.1. Descriptive Analysis

Regarding self-stigma of academic help-seeking, FGS showed a higher mean score (M = 2.88, SD = .36) compared to CGS (M = 2.75, SD = .33). That is, FGS tend to stigmatize themselves when they seek help with their academic problems (see Figure 1).

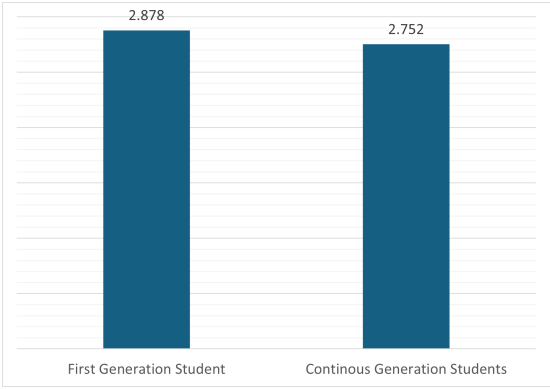


Figure 1. Mean ratings of Self-stigma of Academic Help-seeking.

3.2. Comparative Analysis

An independent samples t-test was conducted to examine differences in self-stigma of academic help-seeking between first-generation and continuing-generation university students. Levene's test indicated equal variances (F = .66, p = .418). The analysis revealed a significant difference between the groups (t(194) = 2.36, p = .019), with first-generation students reporting higher levels of self-stigma than continuing-generation students. The mean difference of .12 (95% CI [-.23, -.02]) represents a small to medium effect size, d = 0.36.

These findings suggest that generation status may influence their experience of self-stigma when seeking academic help, with first-generation university students potentially facing greater internal barriers to help-seeking behaviors.

Table 1. Comparison of the mean value of FGS and CGS's self-stigma.

Type of Student	Mean of Self-stigma
First Generation Students (FGS)	2.878
Continous Generation Students (CGS)	2.752

4. Discussion

The present study examined differences in academic help-seeking self-stigma between first-generation and continuing-generation university students in Hong Kong. Our findings revealed that FGS experience significantly higher levels of self-stigma when seeking academic help compared to their CGS peers, with a small to medium effect size. Our findings align with existing research that FGS faced more challenges in attaining higher education (Terenzini et al., 1996; Padgett, 2012) but further highlighted a psychological challenge.

Our findings highlighted that FGS faced a higher self-stigma level in academic help-seeking. Such a psychological barrier may deter their willingness to seek necessary academic help and negatively impact their academic performance (Richardson, Abraham, & Bond, 2012). Together with other documented challenges, such as academic preparation gaps and cultural adjustment difficulties (Gable, 2021), the decision not to seek academic help may trigger a downward cycle that hampers their academic performance and overall university experience (Bamberger & Smith, 2023).

The fact that FGS has a higher level of self-stigma than CGS could be attributed to several deep-rooted factors in FGS's unique background and experiences. Firstly, possibly because they were the first in their families to achieve a pioneering role in higher education, they may have internalized beliefs about their academic ability and independence (Patfield et al., 2021). Seeking help might harm their self-confidence. Besides, as FGS often navigate their life university life without parental guidance (which was based on direct college experience) (Atherton, 2014), seeking help might also make them feel vulnerable.

While the difference in self-stigma between FGS and CGS is significant, the small to medium effect size (d=0.36) suggests that other factors also shape students' tendencies toward academic help-seeking (Bornschlegl et al., 2020). Our findings not only suggest generation status as a crucial factor (Winograd & Rust, 2014) but also highlight that other factors may also play a role, thus highlighting that academic help-seeking behavior is a complex phenomenon.

The current research also brings some practical implications for higher education to create a more inclusive education environment. The higher education sector is serving an increasingly diverse student population, and our findings reveal that different students have different psychological needs. Targeted interventions that specifically address self-stigma among first-generation students would help normalize their help-seeking behavior. These may include social support, peer mentoring programs, and equipping frontline staff, such as faculties and counselors, with an awareness of FGS's heightened self-stigma, so that they can deliver academic support with more sensitive and inclusive approaches (Fong et al., 2023). These measures could help FGS to overcome their reluctance to seek help.

5. Conclusion

In conclusion, the current research suggested that FGS have a higher self-stigma in academic help-seeking, hinting that they might be more reluctant to seek academic help and less engaged in academic support, and hence, created a challenge that potentially hindered FGS's academic success. In general, our research highlighted that parents' education level could impact on the second generation's psychological characteristics.

There are several limitations that shed light on future research. Considering the sample, the current study collected samples only from a single institution, future research could collect more diverse samples to improve the generalizability. Besides, the current study only adopts a cross-sectional research design. Future research with a longitudinal design could further establish causal inferences about the relationship between generation status and self-stigmas and changes in students' academic journey (Langensee et al., 2024). Additionally, future research could also investigate the potential mediators, such as cultural values, family attitudes towards education, and previous academic experiences, to understand the mechanism underlying the differences in self-stigma (Choi et al., 2019). Future research and practical interventions to minimize self-stigma and encourage students to seek academic help could create a more supportive environment for students' success (Ng & Lam, 2022).

Creating inclusive and supportive environments that cater to varied individual preferences could enhance learning experiences and foster greater academic success (Richardson, Abraham, & Bond, 2012). This is especially important as the prevalence of educational technology has reduced the difficulty of differentiated learning (Huang, 2023; Lam et al., 2021), and that technology-enriched medium can enhance learning outcomes (Eom, 2023) and enrich learning experiences (Ng & Lam, 2022), even in the face of uncertainty (Lam & Ng, 2023; Fingrut & Ng, 2023). Adopting tailored pedagogical approaches with educational technology can be a solution to promote equitable outcomes in education.

References

Atherton, M. C. (2014). Academic preparedness of first-generation college students: Different perspectives. *Journal of College Student Development*, *55*(8), 824–829. https://doi.org/10.1353/csd.2014.0081

Bamberger, M. R., & Smith, T. J. (2023). First-generation college students: Goals and challenges of community college. *Journal of College Student Development*, *51*(3), 445–462. https://doi.org/10.1177/00915521231163903

Bornschlegl, M., Meldrum, K., & Caltabiano, N. J. (2020). Variables related to academic help-seeking behaviour in higher education: Findings from a multidisciplinary perspective. *Review of Education*, *8*(2), 486–522. https://doi.org/10.1002/rev3.3196

Bornschlegl, M., Townshend, K., & Caltabiano, N. J. (2021). Application of the theory of planned behavior to identify variables related to academic help seeking in higher education. *Frontiers in Education*, *6*, 738790. https://doi.org/10.3389/feduc.2021.738790

Brislin, R. W. (1986). The wording and translation of research instruments. In W. J. Lonner & J. W. Berry (Eds.), *Field methods in cross-cultural research* (pp. 137–164). Sage Publications, Inc.

Choi, N. Y., Kim, H. Y., & Gruber, E. (2019). Mexican American women college students' willingness to seek counseling: The role of religious cultural values, etiology beliefs, and stigma. *Journal of counseling psychology*, *66*(5), 577–587. https://doi.org/10.1037/cou0000366

Eom, S. (2023). The effects of the use of mobile devices on the E-learning process and perceived learning outcomes in university online education. *E-Learning and Digital Media*, *20*(1), 80–101. https://doi.org/10.1177/20427530221107775

Fong, C. J., Gonzales, C., Hill-Troglin Cox, C., & Shinn, H. B. (2023). Academic help-seeking and achievement of postsecondary students: A meta-analytic investigation. *Journal of Educational Psychology*, *115*(1), 1–21. https://doi.org/10.1037/edu0000725

Gable, R. (2021). *The hidden curriculum: First generation students at legacy universities*. Princeton University Press. https://doi.org/10.2307/j.ctv16f6d38

Huang, C.-K. (2023). Coaching for change: Preparing mathematics teachers for technology integration in differentiated classrooms. *Education and Information Technologies*, *28*(11), 13913–13941. https://doi.org/10.1007/s10639-023-11684-x

Fingrut, A., & Ng, H. K. Y. (2023). Studio-based architecture pedagogies in the new normal. *International Journal of Mobile Learning and Organisation*, *17*(1-2), 117-130. https://doi.org/10.1504/IJMLO.2023.128353

Lam, P., & Ng, H. K. Y. (2023). Teaching and learning with mobile technologies under Covid-19 pandemic: crisis or opportunity. *International Journal of Mobile Learning and Organisation*, *17*(1-2), 198-213. https://doi.org/10.1504/IJMLO.2023.128359

Lam, P., Ng, H. K. Y., Tse, A. H. H., Lu, I. M., & Wong, B. Y. W. (2021). eLearning technology and the advancement of practical constructivist pedagogies: Illustrations from classroom observations. *Education and Information Technologies*, *26*(1), 89–101. https://doi.org/10.1007/s10639-020-10245-w

Langensee, L., Rumetshofer, T., & Mårtensson, J. (2024). Interplay of socioeconomic status, cognition, and school performance in the ABCD sample. *NPJ Science of Learning*, *9*(1), 17. https://doi.org/10.1038/s41539-024-00233-x

Li, R., Che Hassan, N., & Saharuddin, N. (2025). Understanding academic help-seeking among first-generation college students: a phenomenological approach. *Humanities and Social Sciences Communication*, *12*, 56. https://doi.org/10.1057/s41599-024-04165-0

Marquez, C. G. (2019). A review on first-generation college students: Challenges they face in college when dealing with mental health issues. *UC Merced Undergraduate Research Journal*, *11*(2). https://doi.org/10.5070/M4112043709

McCallen, L. S., & Johnson, H. L. (2020). The role of institutional agents in promoting higher education success among first-generation college students at a public urban

university. *Journal of Diversity in Higher Education*, *13*(4), 320–332. https://doi.org/10.1037/dhe0000143

Ng, H. K. Y., & Chen, S. X. (2023). How does social complexity facilitate coping flexibility? The mediating role of dialectical thinking. *Anxiety, Stress, & Coping*. *36*(3), 291-303. https://doi.org/10.1080/10615806.2022.2117304

Ng, H. K. Y., & Lam, P. (2022). Advancing the understanding of the flipped classroom approach with students' perceptions of the learning environment: Variation between academic disciplines. *Journal of Learning Development in Higher Education*. *24*. https://doi.org/10.47408/jldhe.vi24.852

Padgett, R. D., Johnson, M. P., & Pascarella, E. T. (2012). First-generation undergraduate students and the impacts of the first year of college: Additional evidence. *Journal of College Student Development*, *53*(2), 243–266. https://doi.org/10.1353/csd.2012.0032

Patfield, S., Gore, J., & Fray, L. (2021). Reframing first-generation entry: how the familial habitus shapes aspirations for higher education among prospective first-generation students. *Higher Education Research & Development*, *40*(3), 599–612. https://doi.org/10.1080/07294360.2020.1773766

Patfield, S., Gore, J., & Weaver, N. (2022). On 'being first': The case for first-generation status in Australian higher education equity policy. *Australian Educational Researcher*, *49*, 23–41. https://doi.org/10.1007/s13384-020-00428-2

Richardson, M., Abraham, C., & Bond, R. (2012). Psychological correlates of university students' academic performance: A systematic review and meta-analysis. *Psychological Bulletin*, *138*(2), 353–387. https://doi.org/10.1037/a0026838

Smith, D., & McLellan, R. (2023). Mental health problems in first-generation university students: A scoping review. *Review of Education*, *11*(3), e3418. https://doi.org/10.1002/rev3.3418

Terenzini, P. T., Springer, L., Yaeger, P. M., Pascarella, E. T., & Nora, A. (1996). First-generation college students: Characteristics, experiences, and cognitive development. *Research in Higher Education*, *37*(1), 1–22. https://doi.org/10.1007/BF01680039

Veldman, J., Meeussen, L., & van Laar, C. (2019). A social identity perspective on the social-class achievement gap: Academic and social adjustment in the transition to university. *Group Processes & Intergroup Relations*, *22*(3), 403–418. https://doi.org/10.1177/1368430218813442

White, M., & Canning, E. A. (2023). Examining active help-seeking behavior in first-generation college students. *Social Psychology of Education: An International Journal*, *26*(5), 1369–1390. https://doi.org/10.1007/s11218-023-09794-y

Winograd, G., & Rust, J. (2014). Stigma, awareness of support services, and academic help-seeking among historically underrepresented first-year college students. *The Learning Assistance Review*, *19*(2), 19–43

Yu, B., Bodycott, P., & Mak, A. S. (2019). Language and interpersonal resource predictors of psychological and sociocultural adaptation: International students in Hong Kong. *Journal of Studies in International Education*, *23*(5), 572–588. https://doi.org/10.1177/1028315318825336

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TECSKILL: Development of a Green and Digital Competence Framework for Engineering PhD Students

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Abstract

The TECSKILL project (Erasmus+ KA220-HED) addresses the need to integrate sustainability and digital competences into the education of European Engineering PhD students. By adapting competences from the GreenComp and DigComp 2.2 frameworks, an integrated framework was developed, encompassing 12 sustainability and 21 digital competences. To monitor the learning progress, 137 knowledge indicators were defined across four proficiency levels, ensuring a structured assessment of skill acquisition.

The framework was implemented through four transnational training programs at universities in Spain, Italy, Portugal, and Sweden, providing PhD students with specialized lectures and hands-on workshops. A mid-term survey assessing student satisfaction confirmed the program's effectiveness in enhancing competences and fostering international collaboration. Future research activities will focus on evaluating competence acquisition over the whole project, assessing the impact of the trainings on students' research and professional development, and optimizing the developed competence framework based on the final outcomes.

Keywords: *Green competences, Digital competences, Engineering, PhD Students, Innovative teaching, competence assessment*

1. Introduction

The European Union is actively addressing the evolving challenges of digitalization and sustainability, prioritizing the adaptation and enhancement of its education systems to support

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this transition (Reisoğlu & Çebi, 2020). To achieve this, structured competence frameworks have been established, incorporating descriptors reflecting relevant knowledge, skills, and abilities (Sánchez-Tarazaga, 2023). These frameworks are a valuable tool for defining effective educational strategies as they enable the creation of training programs aligned with the real needs of society. Specifically, the GreenComp (Bianchi et al., 2022) and DigComp 2.2 (Vuorikari et al., 2022) competence frameworks, developed by the Joint Research Centre of the European Commission provide a reference framework to support the development of training programs aimed at strengthening sustainability and digital competences. On the one hand, GreenComp falls within the actions of the European Green Deal (European Commission, 2019), identifying competences that form a structured learning framework for environmental sustainability. The framework consists of four core competence areas: "embodying sustainability values", "embracing complexity in sustainability", "envisioning sustainable futures" and "acting for sustainability". Moreover, each area encompasses three interrelated competences. Conversely, DigComp 2.2, aligns with the objectives of the Digital Education Action Plan 2021-2027 (European Commission, 2020), identifying critical digital competences and providing a standardized framework to support the digital transformation of European citizens. This framework consists of 21 specific digital competences, grouped into 5 areas: "problem-solving", "information and data literacy", "communication and collaboration", "digital content creation" and "safety".

In recent years, numerous studies have been conducted on different competence frameworks and their application in higher education (Mezinska et al., 2024). Rózewski et al. (2021) have compared the digital competence framework DigComp 2.1 with a competence framework developed through international projects for engineering education. Zhao et al. (2021) have conducted a literature review of current research on digital competence in higher education, concluding that most frameworks and strategies are heavily influenced by European Union policies and information. Additionally, in their study, Valor et al. (2020) have identified seven key competences for sustainable consumption that should be included in higher education curricula. Other authors, such as Lambrechts et al. (2013), have evaluated the integration of sustainability competences in two undergraduate programs, highlighting the importance of conducting appropriate analyses to correctly include the relevant competences.

Engineering is a sector in which digital and sustainable competences play a major role. Higher education programmes, particularly at doctoral level, must ensure a solid foundation and comprehensive training in these areas to provide future professionals and researchers in the field with the necessary skills. While the development of educational curricula on bachelors' and masters' levels has been focusing on sustainability and digitalization for several years now, also according to ACM/IEEE/AAAI guidelines (Servin and Becker, 2023), no precedent can be found on the implementation of such competence frameworks in engineering doctoral programs. To fill this gap, the TECSKILL project (Erasmus + KA220-HED) aims to develop a

comprehensive competence framework tailored to engineering PhD students to support and enhance their education and meet the needs of digitization and sustainability in Europe.

The paper is structured as follows. Section 2 presents the methods adopted to develop the competence framework in the context of the TECSKILL project. Moreover, it introduces the survey used to assess the satisfaction and opinions of the PhD students currently attending the training programs. Section 3 features the competence framework resulting from the combination of significant green and digital frameworks, as well as the feedback obtained through the survey. These preliminary opinions, as the training programs are still ongoing, are relevant to assess whether project objectives have been clearly communicated, the organization was adequate, and the learning activities were appropriately defined and executed. Finally, concluding remarks and future activities are presented in Section 4.

2. Methodology

2.1. Framework development

The development of the green and digital competence framework for Engineering PhD students involved researchers and professors from four European universities: University of Gävle (Sweden), University of Évora (Portugal), University of Parma (Italy) and University of Extremadura (Spain). First, to get an overview of key sustainability and digitalization goals, the participants evaluated the competences described in GreenComp and DigComp 2.2 frameworks. Then, these competences were adapted for Engineering PhD students following a three-phase approach: *i)* redefining the competence, *ii)* maintaining the scope of action, and *iii)* defining a new objective to be achieved after the acquisition of the competence.

Moreover, knowledge indicators reflecting the key skills to be acquired were defined for each competence. To track the learning outcomes and progress of the PhD students throughout the project, four levels were identified for each knowledge indicator, namely “A – basic”, “B – intermediate”, “C – advanced” and “D – expert”. For each knowledge indicator, the levels corresponded to indicative sets of skills that the student should possess. Finally, a panel of external experts was set up to determine the suitability of the developed competence framework.

2.2. First training programs and students’ survey

In the context of TECSKILL, the developed competence framework was adopted to design four transnational training programs. Each mobility consisted of ten days of lectures and workshops, where professors and researchers presented relevant and timely topics to the class, consisting of international PhD students, with a maximum of five participants for each university. The students came from different areas of industrial engineering: mechanical, management, chemical, mechatronics. To address this multidisciplinary audience and provide the main green

and digital skills identified, the lectures covered topics related to the following macro-areas, among others: *i)* applications of simulation and artificial intelligence for the monitoring, predictive maintenance and control of industrial plants; *ii)* concepts of automation, data acquisition and IoT; *iii)* project management and intellectual property; *iv)* sustainability, LCA, green logistics, material science and packaging. Students' progress was periodically tracked with the knowledge indicators. This allowed to directly assess the efficacy of the competence framework in supporting learning in higher education

After the third training program held in Parma (Italy) in January 2025, the doctoral students underwent a mid-term satisfaction survey. The survey consisted of 23 questions, designed to assess on a scale from 1 (completely disagree) to 4 (completely agree) the results of the training programs in terms of organization, clarity of communication of the project and teaching objectives, relevance of the activities for the research career, and general satisfaction with the training programs. As the project is still ongoing, should potentially problematic aspects emerge, student feedback could be used to make appropriate adjustments.

3. Results

3.1. Green and digital competence framework

The 12 competences proposed by the GreenComp framework were maintained and adapted for PhD students (Figure 1). For instance, the green competence "Promoting nature" aims to help students recognise that human beings are part of nature, encouraging them to respect the environment and all its inhabitants and restore ecosystems.

Competence	Goal
Valuing sustainability	Critical evaluation in terms of sustainability of values and actions during the engineering PhD student's research career
Supporting fairness	Be able to understand and extract all the scientific knowledge that improves the sustainability of society and implement it in current and future projects
Promoting nature	Evaluate the impact on the ecosystem of the different actions taken during the PhD student's research career and make decisions that are sustainable
Systems thinking	Understand the relationship between sustainability and the main variables of research projects and the interrelation of environmental variables
Critical thinking	Adquires a critical perspective that improves the capacity of PhD students, increasing their understanding and assessing of sustainability concepts
Problem framing	Identification of sustainability issues/challenges in engineering research and ability to define strategies to mitigate and resolve these challenges
Futures literacy	Be able to analyse the limitations and risks of future sustainable research strategies in order to be able to anticipate and establish lines of action
Adaptability	Knows that actions carried out during the research career can generate unpredictable situations that affect the environment
Exploratory thinking	Understand different perspectives to successfully address sustainable engineering research and explore new research methods
Political agency	Be able to understand and analyze political strategies that promote sustainability within their research career
Collective action	Develop skills that enable PhD students to drive sustainability through joint action and implementation of innovative solutions
Individual initiative	Empower individuals to confidently and consciously take sustainable initiatives in their lives, becoming agents of change and inspiring others

Figure 1. Green competences for Engineering PhD students.

Competence	Goal
Searching and Filtering information	Develop and implement an efficient and customized search strategy, incorporating information filtering, to identify the scientific literature
Evaluating information	Improve the ability to discern the validity and usefulness of digital resources in relation to research objectives
Information Management	To manage the information through innovative solutions that optimize the handling of digital data in research projects
Interacting through Digital Technologies	Use and critically integrate digital technologies in the communication of engineering research projects
Sharing through Digital Technologies	Develop skills and capacities to share digital content effectively through advanced technology. Promote transparency of research results
Engaging Citizenship	Effectively apply digital technologies to strengthen community interaction, address social challenges through research
Collaborating Through Digital Technologies	Dominate the strategic selection of digital technologies for knowledge co-creation and collaboration within engineering research
Behaviour through technologies	To develop skills in understanding norms of behaviour in the use of technologies and interaction in digital environments
Managing Digital Identity	Achieve a wider dissemination of the achievements and knowledge gained in your doctoral thesis through social networks
Development of digital multimedia content	Effective use of digital tools to achieve efficient communication of information generated during doctoral student research
Digital Content Integration	To develop the ability to rework scientific digital content for the creation of new scientific
Copyright and Intellectual Property Licensing	Develop the knowledge necessary to understand and effectively apply copyright and intellectual property licenses in research projects
Programming	Develop programming skills for effective process automation, analysis of experimental data and creation of customized computational tools
Protecting Devices	Critical evaluation in terms of security and adoption of risk prevention, eradication and/or mitigation measures in digital research environments
Personal Data and Privacy	Effective protection of privacy and personal data and privacy within research projects against potential digital risks and threats
Protecting Health and Well-Being	Development technical abilities in identifying and evaluating problems in the use of digital technologies and implementing solutions
Protecting the Environment	Ability to analyze how digital technologies used in research projects affect the environmental impact and establish methods to mitigate it
Troubleshooting technical problems	Be able to solve technical problems at different stages of the research project: preparation, simulation, experimentation and results
Identification of technological needs	Be able to identify technological needs in a research project and evaluate and implement appropriate responses to promote results
Creative use of digital technology	Be able to use digital technologies to support research by improving processes and creating knowledge to understand and solve problems
Identifying gaps in digital skills	Be able to identify gaps in the development of digital skills useful in my research work in order to improve them

Figure 2. Digital competences for Engineering PhD students.

This competence was adapted to engineering PhD students to encourage them to assess the impact on the ecosystem of the various actions taken during their research career, and lead them to make sustainable and environmentally-conscious decisions. Regarding the digital skills, the 21 digital competences of DigComp 2.2 framework were maintained and adapted (Figure 2).

To specify the necessary knowledge and skills for each competence, a total of 137 knowledge indicators were established. 89 of these indicators were related to digital competences, and 48 to the green ones. Taking green competence "Valuing sustainability" as an example, this has the knowledge indicators: "Understand the concepts and values of sustainability in engineering research", "Know how to align the values and objectives of a project with sustainability values", "Evaluate the sustainability of engineering research projects", "Analyze and select the best strategy or course of action to improve research sustainability". Within each knowledge indicator, four levels of progress were defined, with A being the basic level, B the intermediate

level, C the advanced level and D the expert level. Figure 3 shows the levels of progress of the previously mentioned indicator. All competences and indicators were reviewed by external experts, obtaining positive feedback on most of them. When needed, the appropriate corrections were made according to the experts' suggestions.

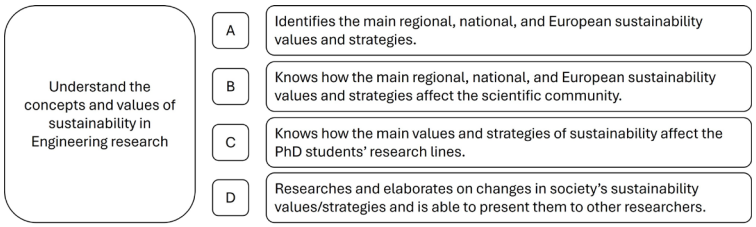


Figure 3. Levels of progress of a knowledge indicator of the "Valuing sustainability" competence.

3.2. Student satisfaction and opinions

The results of the students' survey, based on 15 answers, are shown in Figure 4. Overall, the feedback was very positive, a sign that the project was communicated effectively to the students. The training programs resulted effective in enhancing the students' green and digital skills, resulting relevant to the academic careers of the participants.

1.00	2.00	3.00	4.00

The objectives of the training programmes were clear and communicated effectively.	3.47
The activities of the training programmes were well-organized.	3.53
The project workshops and seminars were engaging and informative.	3.47
I found the content of the training sessions to be practical and applicable.	3.40
The training materials provided were comprehensive, helpful, and easily accessible.	3.40
The digital tools and platforms used during the project were easy to navigate.	3.47
Communication from the organizers was timely and clear.	3.73
Support was readily available whenever I encountered difficulties.	3.60
During the training programmes, the collaboration among participants was encouraged.	3.73
I gained valuable insights from interacting with other participants.	3.67
I appreciated the opportunity to visit different countries and explore their cultures.	4.00
I had the chance to bond and engage with other participants during extracurricular activities.	3.73
Thanks to the activities carried out during the training programmes, I can better evaluate sustainability issues in research.	3.27
I am now more aware of the environmental impacts of engineering research.	3.40
I now better understand how sustainability concepts can be integrated into practical solutions.	3.40
I am more skilled in using digital tools for data analysis and research.	3.27
I improved my ability to collaborate with others using digital technologies.	3.53
I gained a clearer understanding of my digital skill gaps and how to address them.	3.53
The activities carried out during the training programmes were relevant to my academic and professional goals.	3.13
The activities carried out during the training programmes encouraged me to reflect on the societal impact of my doctoral studies.	3.40
The training programmes I attended met my expectations.	3.20
Should other editions of TECSKILL Erasmus+ project be organised in the future, I would recommend other PhD students to attend.	3.80
I would participate in a similar project in the future if given the chance.	3.67

Figure 4. Results of the student satisfaction survey

Moreover, the programs were a valuable networking opportunity, and the participants recognized the value of collaborating with international peers. While all the evaluations were positive, rare cases (1 or 2 at most) of less positive evaluations were encountered, related to the relevance of the activities to the academic career, and the progress in green and digital skills. While such occurrences can be generally expected, this feedback will be considered during the design of the last training program in Gävle (Sweden).

4. Conclusions

This study describes the development process of a framework of green (12) and digital (21) competences adapted to the knowledge, skills and aptitudes that Engineering PhD students must acquire. Evidence from the literature shows how the definition of such competence frameworks is essential for the design of effective training and learning programs. 137 knowledge indicators were defined and will be used to monitor and track students' progress in developing the relevant skills and competences as learning activities unfold. To this end, for each knowledge indicator, a four-level progression was established to support the assessments.

International collaboration in the context of the TECSKILL project (Erasmus+ KA220-HED) has been fundamental in the analysis of existing competence frameworks developed by the European Commission and their adaptation for Engineering PhD students. The implementation of the developed framework during transnational training programs allowed for the international mobility of the participants. Based on the results of a satisfaction survey, this aspect was particularly appreciated by the students, as it gave them the possibility to collaborate, gain valuable insights from international colleagues, and even bond during extracurricular activities. Support and communication from the organizers were also highly appreciated by the participants. Overall, the PhD students were satisfied with having participated in the training programs and would suggest other students to take part in similar activities.

Future research related to the developed competence framework will focus on assessing the acquisition of green and digital competence during the whole project course. This evaluation will be possible after the end of the last training program in June 2025. The results of the first implementation of the developed competence framework will be essential in evaluating its effectiveness and in apporting eventual adjustments to the project goals and methods.

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References

Bianchi, G., Pisiotis, U., & Cabrera, M. (2022). GreenComp - The European sustainability competence framework. *Joint Research Centre*.

European Commission. (2019). The European Green Deal.

European Commission. (2020). Digital Education Action Plan 2021-2027.

Lambrechts, W., Mulà, I., Ceulemans, K., Molderez, I., & Gaeremynck, V. (2013). The integration of competences for sustainable development in higher education: an analysis of bachelor programs in management. *Journal of Cleaner Production*, 48, 65–73. https://doi.org/10.1016/j.jclepro.2011.12.034

Mezinska, S., Abolina, A., & Lubkina, V. (2024). Design-driven innovation in STEM disciplines in higher education: The role and impact of transversal competences. *Journal of Open Innovation: Technology, Market, and Complexity*, 10(4), 100429. https://doi.org/10.1016/j.joitmc.2024.100429

Pramila-Savukoski, S., Jarva, E., Kuivila, H.-M., Juntunen, J., Koskenranta, M., Kääriäinen, M., & Mikkonen, K. (2024). Generic competence among health sciences students in higher education – A cross-sectional study. *Nurse Education Today*, 133, 106036. https://doi.org/10.1016/j.nedt.2023.106036

Reisoğlu, İ., & Çebi, A. (2020). How can the digital competences of pre-service teachers be developed? Examining a case study through the lens of DigComp and DigCompEdu. *Computers & Education*, 156, 103940. https://doi.org/10.1016/j.compedu.2020.103940

Różewski, P., Kieruzel, M., Lipczyński, T., & Prys, M. (2021). Framework of Visual Literacy Competences for Engineering Education Discussed in the Scope of DigComp framework with Examples from Educational R&D Projects. *Procedia Computer Science*, 192, 4441–4447. https://doi.org/10.1016/j.procs.2021.09.221

Sánchez-Tarazaga, L. (2023). Los Marcos De Competencias Del Profesorado. Contribuciones desde una Perspectiva Local, Nacional y Supranacional. *Journal of Supranational Policies Of Education*, 17, 1–4.

Servin, C., & Becker, B. A. (2023). Towards Improving Green Technologies Education: The Role of the ACM/IEEE/AAAI Model Curricula. *2023 IEEE Green Technologies Conference (GreenTech)*, 270–274.https://doi.org/10.1109/greentech56823.2023.10173811

Valor, C., Antonetti, P., & Merino, A. (2020). The relationship between moral competences and sustainable consumption among higher education students. *Journal of Cleaner Production*, 248, 119161. https://doi.org/10.1016/j.jclepro.2019.119161

Vuorikari, R., Kluzer, S., & Punie, Y. (2022). DigComp 2.2 - The Digital Competence Framework for Citizens. *Joint Research Centre*.

Zhao, Y., Pinto Llorente, A. M., & Sánchez Gómez, M. C. (2021). Digital competence in higher education research: A systematic literature review. *Computers & Education*, 168, 104212. https://doi.org/10.1016/j.compedu.2021.104212

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How to enhance critical and reflexive practice in higher education. The case of the UPV Master's Degree in Development Cooperation

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Abstract

Incorporating critical and reflexive practice in higher education is a relevant element to contribute to the formation not only of future professionals but also of global citizenship, in a world that requires profound transformations oriented to social and environmental justice. Based on previous research and experiences developed from the MsC Degree in Development Cooperation at the Universitat Politècnica de València (UPV), the paper presents a coordinated framework to connect classroom learning and internships, integrating ethical, political, and emotional dimensions into student development and considering the evaluative and follow-up elements. Findings emphasize the importance of institutional support, coordinated teaching and tutor engagement. For university managers, this research suggests that embedding reflexive and critical elements into curriculum and internship design can foster transformative learning, align with global justice principles, and better prepare students for professional environment characterized by complexity, uncertainty and power relations.

Keywords: *critical practice; reflexive process; higher education; internships; competences; capabilities.*

1. Introduction

The current global landscape is marked by deepening inequalities, ecosocial crisis and shifting international relations (Chancel et al., 2021; UNDP, 2020). Within this complexity, diverse and often conflicting paradigms coexist in education, including education for global citizenship (EGC), which stems from development education in international cooperation (Boni et al., 2020). The Dublin Declaration 2022 (GENE, 2022) highlights the need for a reflexive and critical education that addresses historical legacies, global power dynamics, and curriculum decolonization. Pais and Costa (2017) identify two ideological currents in EGC: one rooted in

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critical democracy, emphasizing ethical values and active citizenship, and another aligned with market logic. This work aligns with the critical democracy approach, challenging university educators to address contradictions in practice.

This communication stems from years of experience by the teaching team of the Master's Degree in Development Cooperation (MUCD) at the Universitat Politècnica de València (UPV), guiding students' internships through a critical global citizenship lens (Boni et al., 2017; Calabuig et al., 2018; Delgado-Caro et al. 2023). These processes go beyond applying knowledge and skills, focusing instead on reflexive, critical, and attitudinal dimensions aligned with transformative cooperation. Studies have shown that critical and reflexive practice can be fostered under specific conditions and mechanisms. The challenge is to enhance these learnings further, emphasizing evaluation and monitoring throughout the degree, offering insights for the university community.

Focusing on critical and reflexive practice, this incorporates a change of focus in professional practice, since it raises the coexistence of different dimensions related to cultural, social, contextual, political and personal issues that inevitably come into play. Elements that, to be deployed in action "on the ground", must first be demonstrated and understood by the students

2. Critical and reflexive practice

Critical practice involves professionals considering the complex, political nature of development processes, including power relations and political influences. To better understand it, we differentiate between "critical vision" and "critical practice" (Boni et al., 2017). Critical vision rejects hegemonic development thinking, addressing injustices and inequalities, while critical practice requires active engagement, which doesn't happen automatically. Support during internships is essential to overcome the feeling of "impossibility of change." The "reflexive" component (Eyben, 2014) adds a personal and emotional dimension, urging individuals to recognize their contradictions, privileges and colonial past, aligning with restorative justice and acknowledging the partiality of their perspectives.

In this study, we align with a critical approach that emphasizes the political and complex nature of development, focusing on power relations (McCourt and Gulrajani, 2010; Eyben et al., 2015). Cooperation master's programs should enhance skills to navigate complex, power-laden contexts with openness, flexibility, and adaptability (Pearson, 2010). This is particularly relevant during internships, often in Global South contexts, where students learn to "understand, unveil and move in complex contexts embedded in power relations" (Calabuig et al., 2018, p. 1429).

In summary, critical and reflexive practice in development cooperation requires competencies such as political commitment, accountability, understanding power dynamics, navigating

complexity, generating alternatives for change and fostering social transformation. It also demands critical self-awareness, adaptability and constant reflection (Belda et al., 2012).

3. Context and case study

3.1. Characteristics of the MUCD

The MUCD is a 90 ECTS official degree, belonging to the branch of Social Sciences, which has been incorporating educational innovation in its teaching at UPV from 2011. It has a first year of classroom teaching of 60 ECTS, divided into five major subjects regarding development concepts, international cooperation system, research methodologies or project cycle management, and a second year of 30 ECTS for external internships and the Final Master's Thesis (as shows figure 1). The speciality of the master is Project and Processes Management.

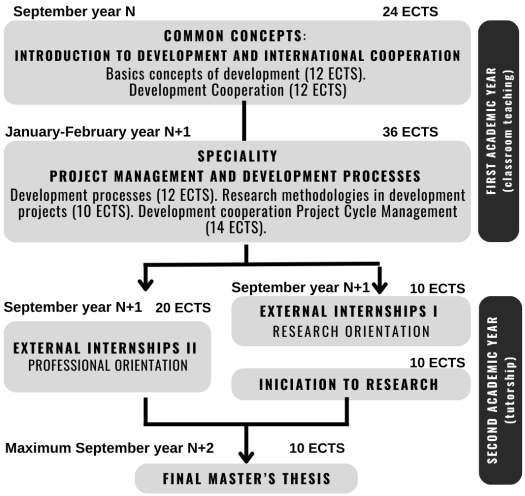


Figure 1. Structure of the MsC's degree in Development Cooperation by UPV. Own elaboration

The teaching actions aim to bring students as close as possible to their real practice, either with the presence of agents and entities in the classroom, working on new and current theories and approaches or carrying out visits in the different subjects. In fact, in the subject of Development Processes action learning (AL) is carried out, a methodology from the Action-Participatory Research family that is applied in neighbourhoods in the city of Valencia. In AL, students tackle complex problems and learn by exploring new opportunities, rather than applying the routines of pre-established systems (Pedler and Burgoyne, 2008). From the MCUD we recognise in this type of learning in real contexts also an ethical dimension (Calabuig et al., 2018) that connects in a very direct way with what is experienced in the subsequent practices or internships of the second year. For the MUCD, these external compulsory internships have a duration between

500 or 250 hours They aim for students to develop capabilities and skills for a possible future critical practice as development and cooperation professionals. Regarding the group, every academic course 23-25 new students begin the first year of presential teaching, as there are normally another 20-25 students that develop their external internships in Spain or internationally.

3.2. Motivation of the study

The MUCD has long aimed to foster meaningful learning in students both inside and outside the classroom. However, there is now a need to integrate and explicitly connect the compulsory second-year internships with the first-year coursework, an area that has been underdeveloped. The role of tutors (from both the UPV and host entities) is crucial in facilitating critical and reflexive practice. To address this, we propose exploring these issues from the start of each academic year, establishing an initial baseline and including the entire student cohort to avoid bias. Previous studies focused mainly on students assumed to have developed critical practice, missing the opportunity for a control group. While various actions have been implemented in the first and second years, they lack enough connection and tutor involvement.

4. Methodology

The research has been approached from a constructivist paradigm and with a mainly qualitative focus (Corbetta, 2007). The methodology used for the study has been divided into four stages, with different specific objectives, given that the process combines a more investigative dimension with an eminently practical one (improving the MUCD procedures not only to favour the acquisition of critical practice in students but also, in the future, to have more rigorous evaluations that allow us to confirm the usefulness of the approaches used). We will focus our discussion in stages I, II and III. With regard to ethical issues, all participants have signed the informed consent to participate in the study and their data have been treated with strict anonymity. On the other hand, the study has been funded by the Institute of Education Sciences of the UPV, through a Project for Educational Innovation from 2023 to 2025.

The methodology designed and applied consisted of the following phases:

STAGE I. DIAGNOSIS, to review the mechanisms already put in place by the MCAD about the approach to critical and reflexive practice (definition, dimensions, implementation) in both academic years. The techniques were mainly documentary review and one focus group meeting with teaching staff, master's degree students and pre-doctoral students researching development issues and learning processes in higher education. Six teachers and four students actively participated in this stage and the next, discussing and debating the mechanisms put in place.

STAGE II. DESIGN OF IMPROVEMENT ACTIONS, with the purpose of defining coordinated procedures to incorporate the postulates and dimensions of critical and reflexive practice, both in first-year teaching and in second-year external internships. Also to define procedures for the assessment of critical and reflexive practice during both years (see figure 2).

STAGE III: IMPLEMENTATION OF MECHANISMS AND ASSESSMENT, to identify the degree of student reflexivity with respect to the dimensions of critical and reflexive practice. Between the mechanism included (see figure 2), there has been possible to apply the personal reflexivity exercise and the individual external internship report.

5. Results

The main results of a year and a half study's progress are exposed below. Some results have been considered as outcomes because bring us a valuable information to improve the new and old mechanism to promote the critical and reflexive practice in the MUCD.

5.1. Outputs of the process

5.1.1. Regarding master's procedurals

With regard to the procedures available in the Master's degree, the work carried out has made it possible to better connect the different subjects of the first year with each other and with regard to the second year of internships. Figure 2 shows the dashboard or roadmap that has been designed specifically to coordinate subjects, incorporating techniques and evaluation mechanisms in both the first and second years, some of which are currently being developed:

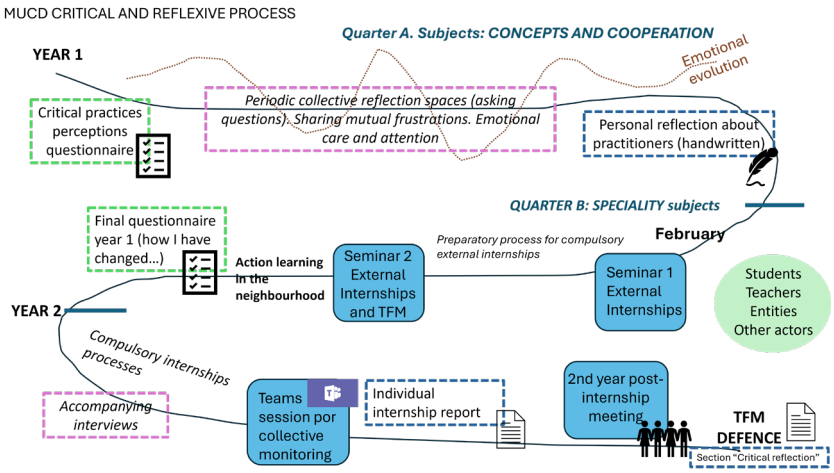


Figure 2. Original dashboard created to improve the coordination inside the MUCD. Own elaboration

On the other hand, essential documents have been reviewed and modified, such as the explanatory dossier of external internships and the personal reflection exercise that students carry out in the first year. This exercise includes specific questions related to what they consider they should be like as practitioners in the future if they wish to promote transformative cooperation; what attitudes and skills they value as essential; or how they consider they should face the contradictions, complexities and power relations in their professional practice.

5.1.2. Regarding new mechanism to evaluate perceptions and learnings

A questionnaire has been elaborated and will be distributed in spring 2025 to the host organisations, mainly Development NGOs. The questionnaire gathers the items and variables expected to be identified in a critical and reflexive practice and allows us to have the vision of the host entities of internships (this questionnaire incorporates elements that are being included in a second questionnaire, aimed specifically to students, to be distributed on June 2025). Among the questions, one refers to what abilities the entities consider as essential that a future professional in development cooperation develops, such as: engaging in social change, knowing how to live with and value differences, navigating complexity or recognising and managing power relations. Another question refers to the degree of importance that the institution gives to certain attitudes of students in internships, such as commitment, solidarity, critical reflection, non-conformism, resilience or the willingness to take a stand for justice.

5.2. Outcomes of the process

5.2.1. Regarding teachers' labour

There has been a strong involvement of a large part of the teaching staff of the MUCD and the collaborating doctoral students, although greater coordination is needed in this respect. The existence of an educational innovation team in the MUCD has undoubtedly favoured the first stage of the study and will do so in the third. The great challenge is how to incorporate teachers who are less involved in such as this research, or who do not necessarily subscribe to the approach of critical and reflexive practice, even though their work as internship tutors.

5.2.2. Regarding learnings in students

A total of 25 first-year students of course 2024-2025 and 23 students who have completed their external internships in 2023-2024 and 2024-2025 will receive the new questionnaire on Juny 2025. Regarding the other mechanisms, 22 and 23 first-year students have made freely a handwritten individual reflection on December 2023 and 2024, respectively. On the other hand, the individual internship report has been applied, which contains specific sections that question them about key moments in the process, so that they can reflect critically and compare their experiences with their previous fears, expectations, as well as with the learnings int the MUCD first year. The evidence of the application of both mechanisms are currently being analysed in

depth. On the one hand, 21 students who did their internships in 2023-2024 and another 3 ones in the current academic year 2024-2025 express in their reports items that reinforce the evidence obtained from previous research. Firstly, the ethical-reflexive questioning, the immersion in a different socio-cultural environment and the accompaniment of processes and communities are the most valued aspects by the students after having completed their external internships. Secondly, the process is valued as enriching and has allowed them to learn in a real way what it means to work in cooperation; however, the teachers' overload and the limitation that this entails for even greater accompaniment is evident. Thirdly, the skills linked to personal development, such as the social circle, take on an important dimension, being a determining factor when it comes to assessing the experience and providing resources and support to students in the different changes that the internship experience may entail. Finally, the attitudes expressed by the students in their handwritten individual reflection show elements of critical and reflexive practice and have been, among others: empathy, deconstruction, humility, active listening, kindness, accompanying, building trust, respect and understanding of other cultures; however, attitudes such as recognising the complexity of development processes or accepting uncertainty (although they do mention resilience) are not so present at the start of the MUCD.

6. Conclusions

The study carried out, although it has not yet been completed, provides valuable evidence to question the approaches adopted by the master's degree, the mechanisms developed and the coordination between subjects. Firstly, the contents worked on in the classroom, the meeting spaces and the accompaniment given to the students are key for the development of critical and reflexive practice; students demonstrate the development of agency, the consideration of power issues and the implementation of reflexivity, according to Boni et al. (2017). On the one hand, the study makes us question the conceptual working assumptions, reflecting on education for critical global citizenship and whether we are consistent with a truly transformative, decolonial approach that challenges a system that is basically driven by the logic of the market (Peris and Costa, 2017) as we previously reflected in Delgado-Caro et al. (2024). Secondly, it allows us to identify the critical points of the process and to what extent it’s possible to achieve a coherent roadmap for the interconnection between first- and second-year subjects, well dimensioned in terms of time and not excessively burdensome for students, teaching staff and the external entities involved. Thirdly, the study highlights the importance of continuing to focus on critical and reflexive practice, but developing more and better qualitative and quantitative evaluation mechanisms to reinforce the rigorousness of the evidence and to allow new learning to emerge from these processes. In this sense, the research aims to inform higher education managers to reflect about this alternative way to conceive more reflexive internships at different degrees. Finally, and from an ethical perspective, the study has allowed us to reflect self-critically on the role of university teaching staff and their commitment to educational processes as Boni et al.

(2020) propose, especially highlighting the often forgotten final phase of returning research processes to the people who have been active subjects in them; we are referring in particular to our students, to whom we owe it to them to accompany their learning process.

References

Belda, S., Boni, A., Peris, J., & Terol, L. (2012). Rethinking capacity development for critical development practice. inquiry into a postgraduate programme. *Journal of International Development*, *24*(5), 571–584. doi:10.1002/jid.2850

Boni, A., Calabuig, C., & Pellicer, V. (2017). Transforming the System from Within: Experiences of a Development Cooperation Master. In M. Walker & M. Wilson-Strydom (Eds.), *Socially Just Pedagogies, Capabilities and Quality in Higher Education* (pp. 201 – 220). Palgrave Macmillan.

Boni, A., Belda, S., & Calabuig, C. (2020). *Educación para la ciudadanía global crítica*. Editorial Síntesis.

Calabuig Tormo, C., Fernández-Baldor Martínez, A., & Belda Miquel, S. (2018). El trabajo en equipo desde la mirada de los cuidados y la participación: reflexiones de su aplicación en el Máster en Cooperación al Desarrollo por la UPV. In *IN-RED 2018. IV Congreso Nacional de Innovación Educativa y Docencia en Red*. Editorial Universitat Politécnica de València. pp.1428-1442. doi:10.4995/INRED2018.2018.8727

Chancel, L. (2021). *Informe sobre la desigualdad global 2022*. World Inequality Lab.

Corbetta, P. (2007). *Metodologías y Técnicas de Investigación Social*. McGraw Hill.

Delgado-Caro, C., Calabuig-Tormo, C., & Maicas-Pérez, M. (2023). Fostering a Reparative International Development Cooperation System: Transformative Learning in a Master's Degree in Development Cooperation. In Walker, M., Boni, A.,Velasco, D. (Eds), *Reparative Futures and Transformative Learning Spaces* (pp. 111-136). Palgrave Macmillan.

Eyben, R. (2014). *International Aid and the Making of a Better World. Reflexive practice.* Routledge.

Eyben R., Guijt, I., Roche, C., & Shutt, C. (Eds.) (2015). *The Politics of Evidence and Results in International Development: Playing the game to change the rules?*. Practical Action Publishing.

GENE (2022). Declaración Europea sobre Educación Global hacia 2050. Declaración de Dublín. Un marco estratégico europeo para mejorar e incrementar la Educación Global en Europa hacia el año 2050. https://www.gene.eu/ge2050-congress

McCourt, W., & Gulrajani, N. (2010). The future of development management: Introduction to the Special Issue. *Public Administration and Development*, 30, 81-90. doi:10.1002/pad.568

Pedler, M., & Burgoyne, J. (2008). Action learning. In H. Bardbury (Ed.), *The SAGE Handbook of Action Research. Participative Inquiry and Practice* (pp. 179-187). SAGE Publications.

UNDP (2020). *Human Development Report 2020. The next frontier: human development and the anthropocene.* United Nations Development Programme. Retrieved from: https://hdr.undp.org/content/human-development-report-2020

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Multivariate Analysis of Academic Competencies in Civil Engineering Programs in Colombia

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Abstract

This research aims to evaluate the academic efficiency of civil engineering programs in Colombia, using Data Envelopment Analysis (DEA) and the results of standardised tests at high schools and Universities and identifying significant differences in universities' academic performance through clustering (k-means) and Principal Component Analysis (PCA). As a result, disparities in educational quality were identified, suggesting that some universities face difficulties in preparing students. The conclusions revealed a need to implement strategies to improve education quality and strengthen civil engineers' training in Colombia.

Keywords: *Academic efficiency; educational quality; civil engineering; data envelopment analysis.*

1. Introduction

Adequate planning and structuring of the urban environment are fundamental to the development of a population because they become key tools for achieving a sustainable transformation (Barroso Del Toro et al., 2022). In addition, they help formulate medium—and long-term objectives in a way that fosters a collective and rational vision of the resources to achieve them.

In contrast, in countries with low urban development, a shortage of trained civil engineers and insufficient resources can make growing and maintaining adequate infrastructure complex (Theophilus, 2023). According to the Organisation for Economic Co-operation and Development (OECD) report "OECD Employment Outlook 2021", some developing countries still face challenges due to a lack of engineers and limited resources. As mentioned, civil engineering has been one of the most important agents for urban development today. The functionality of construction depends on this discipline since it offers society improvement and

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advances in the environment, promoting progress in societies that are disadvantaged by others. The participation of civil engineering allows advances in infrastructure to occupy a relatively important place in society, and that can be used in a maximum way to improve the well-being of citizens (Polmear, 2022).

In this order of ideas, it can be said that engineering plays a fundamental role in the economic development of countries. Engineers apply science and technology to improve the development of society, thus increasing people's quality of life. Important entities related to the promotion and management of the discipline recognise engineering as a creative process, the maintenance or operation of systems, equipment, products and processes that respond to specific needs.

Therefore, evaluating academic efficiency in civil engineering programs in Colombia allows for guaranteeing educational quality in terms of training and developing competent professionals in this field. However, despite this need, the existing evaluations and controls in this situation have not been addressed comprehensively so far, so students' evolution throughout their university careers has been complicated. All this is because there are no adequate tools to measure and improve the quality of education.

2. Literature review

Various authors solve this problem from different approaches:

Their work (Zuluaga-Ortiz et al., 2022) carried out an efficiency analysis of higher education in Colombia, focusing on academic engineering programs. They used the data envelopment analysis (DEA) methodology with data from the Saber 11 Tests and Saber Pro Tests. The results indicated that industrial engineering showed greater efficiency than other programs and that non-accredited institutions had higher efficiency than accredited universities.

On the other hand, a study by (Visbal-Cadavid et al., 2017) efficiency study of Colombian public universities in 2012, conducted using the methodology of Data Envelopment Analysis (DEA) and the models CCR, BCC and SBM under output orientation. The results showed Tolima, Caldas and UNAD to be the best-performing universities, with Universidad del Pacífico as the worst performer. The malmquist index was applied to analyse the change in productivity from 2011 to 2012. The Universidad de La Guajira greatly improved technical efficiency between 2011 and 2012.

The authors (Puertas & Marti, 2019) also developed a sustainability indicator for higher education, evaluating academic and socioeconomic variables in a Data Envelopment Analysis model.

Consequently, Delahoz-Dominguez et al. (2020) developed an analysis of the competencies of the Saber Pro tests in Colombia based on the variable of Accreditation in the quality of Industrial

Engineering programs. The results show that accredited universities perform superiorly in each competency evaluated.

Considering previous research, it is necessary to conduct a study that seeks to estimate the academic efficiency of civil engineering programs in Colombia through data envelopment analysis (DEA), using the results of the SABER 11 tests and the SABER PRO tests as a database. The main objective of this research is to provide a comprehensive evaluation of existing university programs, identifying strengths and weaknesses in student training. Likewise, it will provide information to these entities for continuous improvement to identify factors that influence academic performance and implement specific strategies to optimise training quality.

3. Theoretical framework

This section presents the key tools for research.

3.1. Cluster analysis: k-means

The k-means algorithm (Clayman et al., 2020) or also called Cluster Analysis, is an experimental data analysis technique to solve classification problems. Arrange items into groups so that the similarity between members of the same profile is more compact than the association between members of different profiles. This allows you to discover structures in the data that are not very obvious but could be helpful to once they have been found.

3.2. Principal Component Analysis (PCA)

Principal Component Analysis is a statistical technique used to analyse large data sets containing many dimensions per observation, creating variables that function as linear combinations of the original variables. These new variables are weighted combinations of the original variables and are ordered according to their importance in explaining the variability of the data.

3.3. Academic competencies

The SABER 11 test is a Colombian secondary-level assessment designed to provide educational institutions with information on the development of basic skills that students must develop during their schooling. On the other hand, SABER PRO is an assessment for undergraduate students. Both evaluations are carried out by the Colombian Institute of Educational Evaluation (ICFES) and are designed to evaluate the quality of any public or private educational institution.

4. Methodology

This research proposes a methodology based on three stages: experimental data analysis, efficiency analysis and predictive data analysis (see Figure 1). In this first stage, a cluster analysis model is implemented using the K-means algorithm to help facilitate data clustering. In turn, the second stage is intended to carry out an exploratory analysis of data through principal component analysis (PCA) that allows reducing the dimensionality of the data and, finally, it is intended to diagnose the results delivered by the empirical methodology of the research.

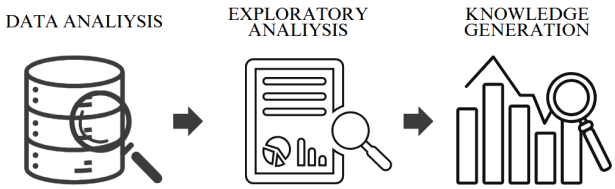


Figure 1: Research approach

5. Population analysis

The representative factors were identified through a rational analysis with a database containing 53,342 observations, each representing a student. This contemplation comes from applying state evaluations to 86 universities in Colombia for university students. However, in this research, the civil engineering program was considered. Only the parameters of universities and departments were established to reduce the number of observations, with 86 observations to be analyzed. Likewise, the data used in Table 1 reports the study's names, general average and standard deviation. The suffix for high school-level test variables and college-level assessments is S11 and SPRO, respectively. The indicators obtained corresponded to the results of the academic competencies presented above.

Table 1: Statistical summary of study variables.

VARIABLE	FULL NAME	$\bar{x}$	σ
MATH.HS	MATH - HIGH SCHOOL	58,40	6,17
CR. HS	CRITICAL READING - HIGH SCHOOL	55,43	4,14
SC. HS	CITIZENSHIPS SKILLS - HIGH SCHOOL	54,97	4,2
ENG.HS	ENGLISH - HIGH SCHOOL	55,88	7,05
NS. HS	SCIENCE - HIGH SCHOOL	56,11	4,86
CS.PRO	CITIZENSHIPS SKILLS – UNIVERSITY	101,83	17,93
WC.PRO	COMUNICACIÓN ESCRITA - UNIVERSITY	99,54	16,99
ENG.PRO	INGLÉS - UNIVERSITY	111,67	18,93
CR.PRO	LECTURA CRITICA - UNIVERSITY	107,78	18,05
QR.PRO	RAZONAMIENTO CUANTITATIVO - UNIVERSITY	116,95	22,15

6. Analysis by university

In the cluster analysis, the k-means algorithm was applied to improve the interpretation of the universities studied. Using a two-dimensional projection, the generated groups were represented in four clusters, each with specific dimensions.

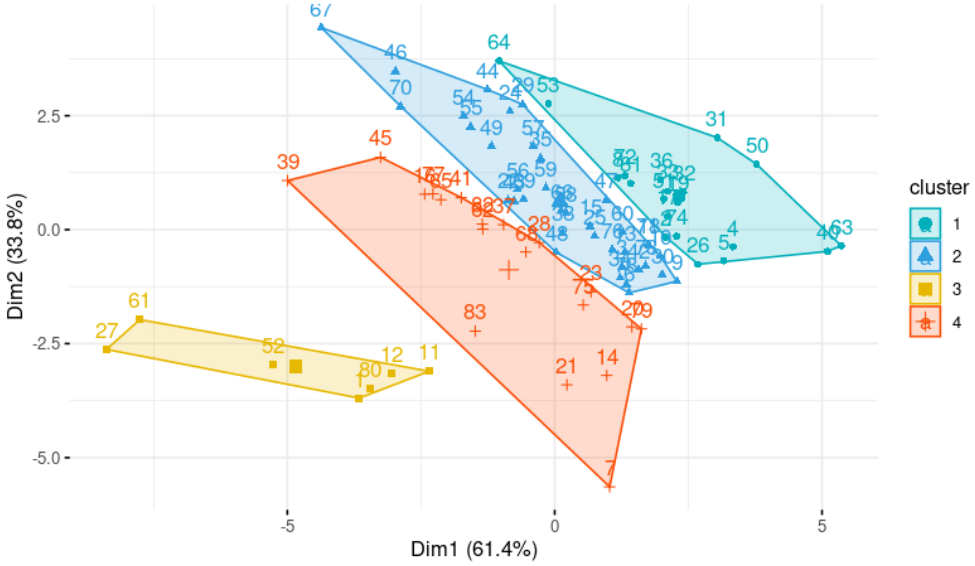


Figure 1. Cluster plot

The k-means method identified four different clusters. Figure 2 shows each cluster occupying a different region of the space and reflecting particular performance patterns based on Saber 11 and Saber Pro outputs.

Cluster 3 (High Performers): Located in the upper-right quadrant, this group includes universities that demonstrate strong outcomes across both Saber 11 and Saber Pro tests. Universities in this cluster present the highest overall academic efficiency, suggesting robust educational processes that effectively build on students' prior knowledge. These universities are closest to the direction of growth for Saber Pro competencies, which are aligned with the top-right direction of the first principal component (Dim1) and the second (Dim2), indicating advanced development in university-level skills such as critical reading, quantitative reasoning, English, and writing.

Cluster 1 (Low Performers): Positioned in the bottom-left quadrant, this cluster contains universities with the lowest performance across all assessed competencies. Their location—opposite to the vectors representing the growth of both Saber 11 and Saber Pro competencies—suggests significant challenges in incoming student preparation and institutional academic

development. Therefore, these institutions require support in curriculum design, pedagogical practices, and student support services.

Cluster 2 (Moderate Saber Pro Focus): Situated in the upper-center region of the plot, this group of universities shows a balanced but slightly stronger performance in Saber Pro competencies compared to Saber 11. Despite moderately prepared student cohorts, these institutions may be achieving learning gains during university education.

Cluster 4 (High Saber 11 Input, Low Saber Pro Output): Found in the lower-right region of the plot, this cluster represents universities with well-prepared incoming students (strong Saber 11 scores), but with less-than-expected development in Saber Pro competencies. This suggests a potential underperformance in value-added educational processes, where initial student potential is not fully realized during the university stage.

These clusters provide a meaningful segmentation of the civil engineering programs analyzed. While clusters 3 and 1 represent extremes in performance, clusters 2 and 4 reveal nuanced inefficiencies or mismatches between input and output competencies. This typology supports targeted policy interventions: strengthening pedagogical strategies in Cluster 4, leveraging best practices from Cluster 3, and designing support mechanisms for Cluster 1.

7. PCA Analysis by University

The graphical representation generated through principal component analysis (PCA) offers insight into the relationship between universities and the SABER 11 and SABER PRO competencies in the context of the Civil Engineering educational program. In this graph, the different universities' observations are dispersed and far from the competence variables.

The variability observed insinuates that most educational institutions that teach the Civil Engineering program show a limited level of mastery in the competencies evaluated in the SABER 11 and SABER PRO exams. Universities are far from proficiency metrics, suggesting an essential difference between the skills and knowledge students should acquire according to the standards established by these assessments and what they achieve during their academic training.

This graphical representation also suggests possible disparities in the quality of education offered by different universities in Civil Engineering. Distant observations of the variables may indicate deficiencies in the preparation and teaching of the competencies assessed, which in turn may have implications for students' training and competitiveness in the labor field.

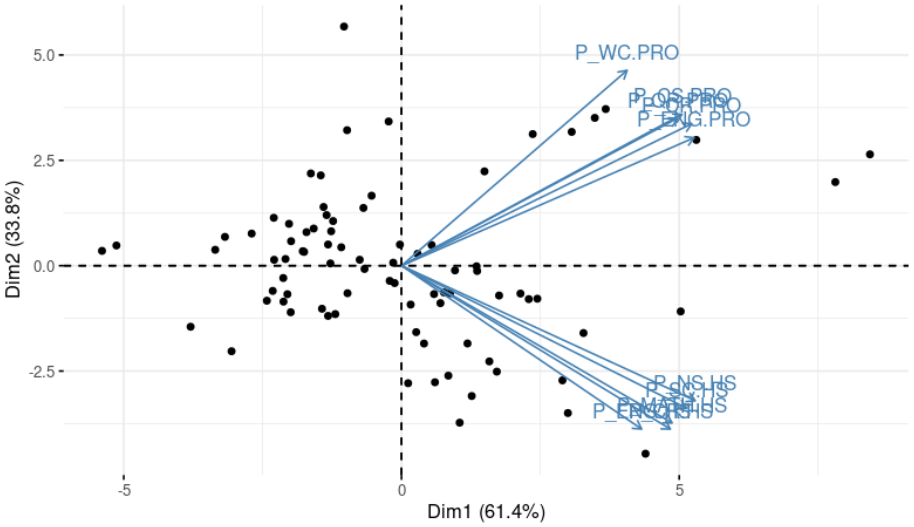


Figure 2. Two dimensions PCA-BIPLOT

8. Conclusions

Clustering analysis carried out in universities has been an important tool for discovering clusters similar to the Saber 11 and Saber Pro exams. This provides a unique opportunity to identify competencies requiring specific improvement in each set of departments and those you perform outstandingly. Such results are of fundamental importance for creating strategies for improvement in the educational system at the departmental level, providing a solid basis for informed decision-making in the educational field.

The information generated by the analysis of university clustering is relevant to understanding the performance and efficiency of the evaluated universities, which simplifies decision-making in the search for increasing the quality of education in the country.

Finally, the principal component analysis has provided the possibility of placing universities in four different quadrants according to their scores on academic tests. Quadrants one and three exhibit more modest averages, while quadrants two and four reveal a higher correlation in their achievements. These findings are invaluable for identifying patterns and trends in university performance and, consequently, implementing strategies that aim at improvement in specific areas.

References

Barroso Del Toro, A., Vivas Crisol, L., & Tort-Martorell, X. (2022). The Sustainability Narrative: A Multi Study Using Event Studies to Analyse the American Energy Companies

Shareholder's Reaction to Sustainability News. International Journal of Environmental Research and Public Health, 19(23), Article 23. https://doi.org/10.3390/ijerph192315489

Clayman, C. L., Srinivasan, S. M., & Sangwan, R. S. (2020). K-means Clustering and Principal Components Analysis of Microarray Data of L1000 Landmark Genes. Procedia Computer Science, 168, 97-104. https://doi.org/10.1016/j.procs.2020.02.265

Delahoz-Dominguez, E. J., Guillen-Ibarra, S., & Fontalvo-Herrera, T. (2020). Análisis de la acreditación de calidad en programas de ingeniería industrial y los resultados en las pruebas nacionales estandarizadas, en Colombia. Formación Universitaria, 13(1), 127-134.

Polmear, M. (2022). Macroethical development in civil engineering education. 2151-2155. https://doi.org/10.5821/conference-9788412322262.1234

Puertas, R., & Marti, L. (2019). Sustainability in Universities: DEA-GreenMetric. Sustainability, 11(14), Article 14. https://doi.org/10.3390/su11143766

Theophilus, A. A. (2023). Literature Review for Civil Engineering Practice and Technology Innovation in Civil Engineering and Educational Sustainability. ASEAN Journal of Science and Engineering Education, 3(2), Article 2. https://doi.org/10.17509/ajsee.v3i2.49738

Visbal-Cadavid, D., Martínez-Gómez, M., & Guijarro, F. (2017). Assessing the efficiency of public universities through DEA. A case study. Sustainability, 9(8), 1416.

Zuluaga-Ortiz, R., DelaHoz-Dominguez, E., & Camelo-Guarín, A. (2022). Academic efficiency of engineering university degrees and its driving factors. A PLS-DEA approach. Journal of International Studies, 15(2), 107-121. https://doi.org/10.14254/2071-8330.2022/15-2/8

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Cognitive Semantics and Emotional Lexicon in L2 Spanish. Analysis of Derived and Parasynthetic Verbs

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Abstract

The study examines how Spanish native speakers (L1) and Italian learners of Spanish as a second language (L2) perceive the emotional intensity and morphological transparency of derived and parasynthetic emotional verbs. Based on cognitive semantics, we analyse whether verb structure influences comprehension and acquisition. Forty participants (20 L1 Spanish speakers, 20 L2 learners) completed two tasks: (1) rating the emotional intensity of verbs and (2) identifying their morphological bases. Regression analyses confirm a correlation between perceived transparency and semantic understanding, both for L1 and L2 speakers. These findings highlight the challenges of acquiring a morphologically complex emotional lexicon and underscore the role of cognitive transparency in L2 learning. The study has pedagogical implications, recommending an instructional approach that introduces transparent verbs first, followed by less transparent ones at advanced levels.

Keywords: *Cognitive Semantics; Morphological Transparency; Mental Lexicon; Second Language Acquisition.*

1. Introduction

Understanding the lexicon of emotions, particularly through the use of morphologically complex verbs, presents challenges for second language (L2) learners. Cognitive semantics argues that cultural and linguistic frameworks shape our interpretation and understanding of emotions, often leading to differences in how emotional meanings are perceived across languages (Wierzbicka, 1996; Goddard & Wierzbicka, 2014). Furthermore, as indicated in the literature (Ekman, 2007; Pavlenko, 2014), while certain basic emotions are similarly recognised across cultures and languages, the way they are lexically and structurally encoded differs, meaning that each language may favour specific morphosyntactic patterns, resulting in varying degrees of structural equivalence between them (Pérez García, 2019).

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In this regard, studying emotions from a cognitive perspective provides a solid foundation for understanding how emotions are structured and expressed in the lexicon of different languages, particularly in the context of verbs (Muñoz Medrano, 2019). Spanish is rich in emotional expressions, making it a key element for social interaction (Soriano, 2016).

Emotional verbs, in particular, carry a significant semantic load, as they not only convey an action or state but also reflect the speaker's feelings and experiences. In this context, the perception and use of these verbs can vary significantly between native speakers (L1) and L2 learners, affecting their proficiency and fluency in the language (Dirven, Frank & Pütz, 2003). According to cognitive semantics theory, emotional meanings in Spanish, as in any language, are structured through conceptual metaphors, which can either facilitate or hinder the acquisition of these terms depending on the learner's familiarity with such structures (Lakoff & Johnson, 1986; García Jiménez, 2023).

Moreover, the literature (Blanco Canales & Pérez García, 2024; Muñetón-Ayala & Vásquez Arango, 2024; Pavlenko, 2008a, 2008b; Pérez García, 2019) suggests that the morphological structure and grammatical category of emotion-related words can influence how L2 learners process them. The emotional lexicon in Spanish exhibits morphological patterns that, while transparent for native speakers, tend to be complex for L2 Spanish learners (Ibarretxe-Antuñano, 2013). For this reason, the verbs selected in the present study are all morphologically complex, either derived (word formation through affixation) or parasynthetic (formation that involves the simultaneous addition of a verbalizing suffix and a prefix to a base, resulting in the ternary morphological structure [prefix-base-verbalizing suffix] and implying the non-existence of the intermediate forms [prefix-base] and [base-verbalizing suffix] (Sotelo & Pujol Payet, 2015)). L2 learners face specific difficulties when dealing with parasynthetic or derived structures, as their morphological components can affect the clarity with which emotional meanings are perceived (Del Barrio de la Rosa, 2022). Parasynthetic verbs, which are morphologically more complex than derived verbs, may, however, offer greater semantic transparency, that is, their meaning is more accessible due to their compositional structure (Trombetta, Albano de Vázquez & Gianmatteo, 2000, Sotelo & Pujol Payet, 2015).

This research explores whether the Spanish emotional lexicon is perceived differently between Spanish native speakers and Italian learners of Spanish as an L2, focusing on derived and parasynthetic verbs such as *entristecer* ('to sadden') and *alegrar* ('to cheer up'). Specifically, the study investigates how subjects perceive the emotional intensity and transparency of these terms. Given the strong similarities between Spanish and Italian, the perception of these verbs could be influenced by factors such as morphological transparency and structural familiarity. The main hypothesis posits that L2 learners who perceive greater transparency in the emotional verbs presented to them also demonstrate a better understanding of their meanings (Geeraerts, 2010; Ibarretxe-Antuñano, 2013).

The conceptualization of emotional verbs, especially in the context of an L2, is influenced by cognitive semantics. Verbs may carry emotional and cultural nuances that differ between Spanish and other languages. It is essential to analyse how native speakers conceptualize these verbs compared to learners (Gómez Vicente, 2019) to gain a better understanding of how meanings are internalized and integrated into the mental lexicon.

2. Methodology

2.1. Participants

The study involved 51 participants, divided into three groups: 18 Spanish native speakers, 16 Italian learners of Spanish with C range[1] proficiency level and 17 with B range[2] proficiency level. Participants with learning or language disorders were excluded. Participants were all university students from Malaga, Padua and Verona Universities, aged 19 to 34, both native and non-native speakers of Spanish. The study compares data from the native group and the L2 groups to analyse how and to what extent perceptions of transparency and intensity differ between L1 and L2 Spanish speakers.

2.2. Materials

For the creation of the experimental materials, 52 emotional verbs from the Spanish lexicon were initially selected, evenly divided between parasynthetic and derived verbs. To ensure a valid comparison between the two verb types in the subsequent analysis, the selected verbs were controlled for both verb and base frequency, ensuring that the difference did not exceed one standard deviation. From this initial list, 36 verbs were selected and distributed across two tasks.

2.2.1. Semantic reflection task

The first task administered to participants was a semantic reflection task, consisting of 20 verbs divided into four groups, each containing five verbs. Within each group, the verbs were evenly distributed according to the following criteria: (I) each group alternated between parasynthetic and derived verbs; (II) each group included both positively connoted verbs (e.g., *desear* 'to desire') and negatively connoted verbs (e.g., *desamorar* 'to stop loving'); (III) each group contained pairs of parasynthetic and derived verbs whose logarithmic frequencies did not differ by more than two points (see Table 1).

[1] It included both C1 and C2 proficiency level speakers

[2] It included both B1 and B2 proficiency level speakers

Table 1. Example of Semantic reflection task selected items

Verbs	Verb logarithmic frequency	Verb type	Base	PoS	Base logarithmic frequency	F.v/F.b.
decepcionar	9,983	D	decepción	noun	9,770	1,237
entristecer	8,119	P	triste	adj	9,967	0,158
deleitar	7,444	D	deleite	noun	8,555	0,329
encandilar	8,181	P	candil	noun	7,216	2,625
asustar	10,369	P	susto	noun	9,640	2,075

For this task, participants were asked to rate the emotional intensity conveyed by each verb using a five-point Likert scale scoring from "not at all intense" to "very much intense". Additionally, they were instructed that the same intensity rating could not be assigned to more than one verb within the same group.

2.2.2. Morphological decomposition task

The second task was a morphological decomposition task, consisting of 16 verbs. The selected verbs were evenly distributed by verb type (eight derived and eight parasynthetic verbs) and frequency ranges. (See Table 2)

Table 2. Example of Morphological decomposition task selected items

Verbs	Verb logarithmic frequency	Verb type	Base	PoS	Base logarithmic frequency	F.v/F.b.	Frequency range
atediar	1,945	P	tedio	noun	7,556	0,00314	low
emocionar	10,347	D	emoción	noun	11,251	0,40510	high
encariñar	6,632	P	cariño	noun	10,864	0,01450	mid
empatizar	6,733	D	empatía	noun	9,035	0,09993	low
enorgullecer	8,448	P	orgullo	noun	10,562	0,12069	high

Unlike the previous task, this one did not maintain an alternation between positive and negative meanings, as the primary goal was to analyse how verb frequency, base frequency, and their frequency ratio (F.v./F.b.) influence perceived transparency. Indeed, as outlined by Todaro (2017), the ratio between a verb's frequency and that of its base can be considered an indicator of the derivative transparency.

However, the alternation between derived and parasynthetic verbs was maintained in this task, as a secondary objective was to determine whether the morphological structure of the verb, along with frequency effects, influences perceived transparency.

In this second task, participants were asked to identify the base word from which each verb was derived. Subsequently, they rated the ease with which they identified the base word on a five-point Likert scale, where 1 correspond to "very difficult" and 5 to "very easy".

2.3. Data Collection

Data were collected through an online questionnaire in which participants evaluated the emotional transparency and perceived intensity of several derived (D) and parasynthetic (P) verbs in European Spanish.

3. Results

Data analysis was conducted using R (R Studio). Mixed linear regression was used to analyse perceived transparency (PT), while multinomial logistic regression was run to assess the accuracy of participants' responses. Furthermore, Mixed linear regression was run to explore correlations between verb and base frequency and the semantic perception provided in the first task by native and L2 speakers.

3.1. Morphological Decomposition Task

3.1.1. Transparency

To analyse PT, we transformed the Likert-scale values in an ordinal, numerical variable. The predictive variable considered to select the model for the analysis were verb frequency (FV), base frequency (FB), the ratio between the derivative's frequency and the one of its base (Fv/Fb), the type of verb (TYPE) and the proficiency level of participants[3]. Through the stepwise method we selected a model of linear regression that includes only the main effects; random effects were calculated both for participants and tokens.

From the analysis, it results that FB has a positive effect on PT (estimate= 0.4402, p= 0.035), as expected by the evidence presents in previous literature. Furthermore, the analysis revealed proficiency level to have a significant effect too (level C estimate= 0.35, p= 0.020 – level B estimate= -0,51, p= 0.001): as expected, a lower proficiency influences negatively PT, while a

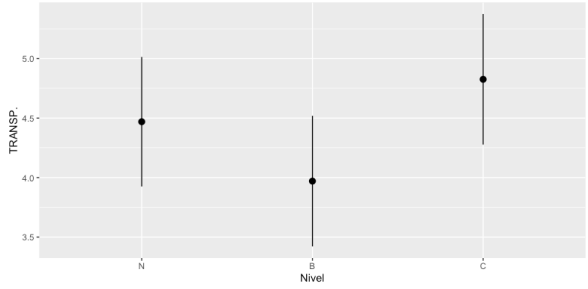


Figure 1. Mean PT values for proficiency levels

[3] We coded them as follows: N for native Spanish speakers, C for Italian learners of Spanish with C range proficiency level, B for Italian learners of Spanish with B range proficiency level.

higher level influences it positively. However, the most surprising results stands in that for C level speakers PT was even higher than those rated by native speakers (See Figure 1).

3.1.2. Accuracy

To consider an answer accurate, participants needed to write exactly the base form listed on Real Academia Española dictionary; we did not accept inflectional variations. Similarly to PT analysis, through the stepwise method we selected a model of logistic regression that, besides the main effects, includes second order interactions; random effects were calculated both for participants and tokens.

The analysis confirmed what the previous data on PT showed, that is, FB has a facilitative effect (p= 0.008), with more accurate responses for verbs with higher FB values. In addition, it was also confirmed the effect related to proficiency levels (level C p= 0.012 – level B p= 0.144): we observed less accurate responses for speakers with B range proficiency level, while more accurate ones for those belonging to C range proficiency level (see Figure 2).

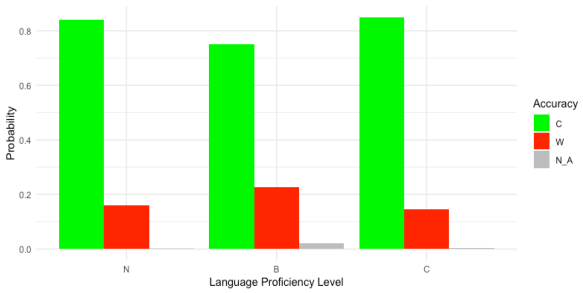


Figure 2. Response accuracy based on proficiency levels

However, the interaction between proficiency levels and FV (p= 0.010) seems to indicate that, when a verb is highly frequent, this seems to influence negatively response accuracy, especially for L2 speakers. High FV values seem also to have a negative effect on accuracy when correlated with verb typology (p= 0.024): parasynthetic verbs receive less accurate responses when they are very frequent, while otherwise they were decoded more accurately. Thus, FV seems to have a negative effect on decoding. Finally, data seems to confirm Todaro's (2017) proposal on Fv/Fb (p= 0.018): to a high value of Fv/Fb corresponds less accurate answers, even across all proficiency levels. Even if it was not significant, it is still worth commenting that the negative effect of Fv/Fb seems to affect less L2 speakers.

3.2. Semantic reflection task

To analyse the semantic intensity rated by participants, we transformed the Likert-scale values in an ordinal, numerical variable. The predictive variable considered to select the model for the analysis were verb frequency (FV), base frequency (FB), the ratio between the

derivative's frequency and the one of its base (Fv/Fb), the type of verb (TYPE), the proficiency level of participants and the semantic value of each verb (positive or negative, e.g. *decepcionar*, 'to disappoint': negative, *deleitar,* 'to delight'*:* positive). Through the stepwise method we selected a model of linear regression that includes only the main effects; random effects were calculated both for participants and tokens. During the selection, we excluded from the model the semantic value, Fv/Fb and TYPE variables, as they did not contributed significantly to the analysis.

Contrary from what was observed in the previous analysis, even if not significant, high FB values correlated to a lower intensity of the verb (estimate= -0.053, p= 0.54), while high FV values correlate higher intensity rates (estimate= 0.156, p= 0.028) (see Figure 3).

No significant effect was found for proficiency levels; however, it is worth to comment that it seems that L2 speakers tend to perceive verbs slightly more intensely than native speakers.

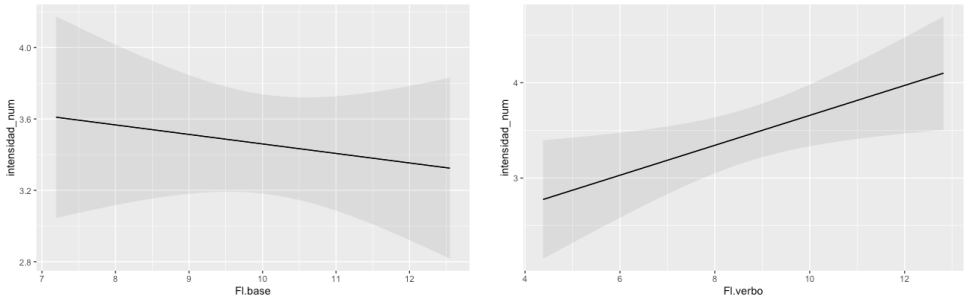


Figure 3. Semantic intensity related to FB and FV

4. Conclusions

The present study aimed to explore the relationship between morphological transparency and semantic understanding in L2 learners on Spanish emotional verbs. In line with our hypothesis, learners with the higher proficiency level (C) demonstrated higher accuracy in identifying base forms and rated them as more transparent (PT), especially when the base frequency (FB) was high. Interestingly, C-level learners even outperformed native speakers in perceived transparency and accuracy, suggesting that morphological awareness may be heightened in advanced L2 learners due to formal instruction. Accuracy data further confirmed the positive role of FB, but revealed a negative effect of verb frequency (FV). Although semantic ratings did not show a significant effect of proficiency, the trend of L2 learners attributing higher intensity to verbs aligns with the idea that whole form frequency may enhance semantic salience. These findings highlight the intricate relationship between morphological awareness and lexical comprehension in L2 acquisition and suggest that targeted instruction on morphological structure may serve as a valuable tool for enhancing learners' semantic processing of complex verbs.

References

Del Barrio De la Rosa, F. (2022). Verbos parasintéticos en español y sus equivalentes en italiano: simetrías, correspondencias e implicaciones teóricas. In: *Artifara 22.1 Monográfico: Estudios sobre el Lèxico del español,* 219-235.

Blanco Canales, A., Pérez García, E. (2024). Transfer of Affective Connotations in the Basic Lexicon of Spanish Learners of L2 English. In: *Revista de Lingüística y Lenguas Aplicadas*, 19, 16-32.

Dirven, R., Frank, R., Pütz, M. (2003). *Cognitive Models in Language and Thought: Ideology, Metaphors and Meanings*. De Gruyter Mouton.

Ekman, P. (2007). *Emotions revealed: recognizing faces and feelings to improve communications and emotional life*. Times Books - Henry Holt and Company.

García Jiménez, S. (2023). Verbos de percepción sensorial: un estudio contrastivo español-italiano desde la lingüística cognitiva. In: *Revista De La Sociedad Española De Italianistas*, 16, 39–54.

Geeraerts, D. (2010). *Theories of lexical semantics*. Oxford University Press, 182-258.

Goddard, C., & Wierzbicka, A. (2014). *Words and meanings: Lexical semantics across domains, languages, and cultures*. Oxford University Press, New York.

Gómez Vicente, L. (2019). La expresión de las emociones en la enseñanza del español LE/L2. In: I. Ibarretxe Antuñano, T. Cadierno López y A. Castañeda Castro (Coords*.), Lingüística cognitiva y español LE/L2* (pp. 340-370). Routledge.

Ibarretxe-Antuñano, I. (2013). The relationship between conceptual metaphor and culture. In*: Intercultural Pragmatics*, 10(2), 315-339.

Lakoff, G. & Johnson, M (1986). *Metáforas de la vida cotidiana*. Cátedra.

Muñetón-Ayala, M. A., Vásquez Arango, C. F. (2024). Análisis psicolingüístico de las palabras emocionales y las categorías gramaticales en las narrativas en los tiempos de Covid-19. In: *Revista Virtual Universidad Católica del Norte*, 72, 128-159.

Muñoz Medrano, M. C. (2019). La expresión de emociones a través de la metáfora: análisis contrastivo español-italiano. In*: ELUA: Estudios De Lingüístic*a. Universidad De Alicante, (33), 141–156.

Pavlenko, A. (2008)a. Emotion and emotion-laden words in the bilingual lexicon. In: *Bilingualism: Language and Cognition*, 11, 147-164.

Pavlenko, A. (2008)b. Structural and conceptual equivalence in the acquisition and use of emotion words in a second language. In: *The mental Lexicon*, 3, 91-120.

Pavlenko, A. (2014). Emotional worlds: Emotion categorization, affective processing, and ascription of significance. In: *The Bilingual Mind: And What It Tells Us about Language and Thought*. Cambridge University Press, 245-298.

Pérez García, E. (2019). *La conceptualización de la emoción en el lenguaje*. Grupo Leide. https://grupoleide.com/la-conceptualizacion-de-la-emocion-en-el-lenguaje/

Sotelo G.B., Pujol Payet I. (2015). Semantic approaches to the study of denominal parasynthetic verbs in Spanish. In: *Morphology*, 25, 439-472.

Todaro, G. (2017). *Nomi (e aggettivi) che diventano verbi tramite prefissazione: quel che resta della parasintesi*. Università degli Studi Roma Tre.

Trombetta, A., Albano de Vázquez, H., Gianmatteo, G.M. (2000). Léxico Mental e Inferencia Morfosemántica. In: *Lenguas Modernas,* 26-27, 245-269.

Wierzbicka, A. (1996). *Semantics: Primes and universals*. Oxford University Press.

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The Impact of Peer-review of Teaching on Students' Performance

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Abstract

Amidst the increasing focus on teaching quality, Peer Review Teaching (PRT) is acknowledged for improving pedagogy and student performance. However to date, a comprehensive framework linking PRT effectiveness with student outcomes is lacking in the literature. The study addresses this oversight and conducts a literature review to develop six propositions and a conceptual framework. This identifies the key elements of effective PRT and assesses its impact on student performance. The study contributes to evaluation and assessment in higher education and extends the understanding of PRT's role in educational success. Practically, it provides actionable strategies for educators and policymakers. The research underscores the criticality of resource utilization, technological integration, and embracing diversity in PRT for enhancing various student performance dimensions.

Keywords: *Academic; Evaluation; Feedback; Peer-review of Teaching; Performance; Student*

1. Introduction

With the growing focus on the significance of university teaching, peer-review of teaching is regarded as a method to enhance teaching quality by promoting the exchange of effective practices among faculty members (Hinrichs et al., 2022). Nonetheless, this improvement in teaching quality can only be realized if programs are executed with care and consider major apprehensions regarding the peer-review of teaching. This process may require a considerable shift in staff attitudes, as they must recognize the benefits of peer-review for it to effectively contribute to the enhancement of teaching quality. According to Lomas and Nicholls (2005), UK universities have increasingly adopted the practice of peer-review of teaching, though its utilization is not as widespread as it is in countries such as Australia and the USA. However, Johnston et al. (2020) noted that recently, peer-review of teaching (PRT) has emerged as a key method for enhancing teaching quality in higher education. However, calls for further research are significant (Tennant & Ross-Hellauer, 2020). Despite significant international research on

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PRT outcomes (e.g., Lomas & Nicholls, 2005), findings are not extensively documented within Australian universities (Burrows et al., 2011). In Australia's tertiary education sector, PRT initiatives have predominantly been informal and small-scale, with limited publication of their results (Harris et al., 2008). Thus, this literature review aims to deepen our understanding of the elements within PRT that contribute to the development of teaching, specifically in the context of Australian higher education. The study synthesizes prior literature to create a conceptual framework to address the following research questions: (1) What are the elements that enhance the effectiveness of PRT? (2) What aspects of student performance/learning outcome does an effective PRT affect? The study highlights six propositions; while propositions 1,2, and 3 are focused on addressing research question 1, propositions 4,5, and 6 address research question 2.

2. Literature Review

2.1. Elements that enhance the effectiveness of PRT

The peer-review process for teaching programs has demonstrated positive outcomes at various levels, yet its effectiveness is contingent on diverse resources, encompassing both human and non-human elements. Positioned as an established system nurturing a culture of collaboration, reflection, and excellence through feedback and academic discussion (Hinrichs et al., 2022), PRT relies significantly on human resources. At the program level, significant factors such as framework, program design, basis of participation, observation, feedback, and reflective practice are central to determining program engagement and achieving successful outcomes. Individual-level factors such as prior experience and participants' perceived development requirements also play a role in the effectiveness of a PRT program. However, Woodman & Parappilly (2015) found that even early-career academics without previous experience of peer review can benefit from the process and accelerate changes to their teaching approaches. Faculty members who embrace accountability, establish high standards, and pursue continuous improvement play a pivotal role in cultivating a culture of excellence, ultimately contributing to the success of PRT programs (Hinrichs et al., 2022). Diverse non-human resources have also been identified as key factors influencing the success of PRT programs. These resources encompass program development processes, review instruments, and program evaluation strategies. The literature regarding the influence of human and non-human resources leads to the development of Proposition 1. This proposition posits that the success of PRT programs is significantly influenced by the utilization of both human and non-human resources. This proposition underscores the importance of various elements such as faculty expertise, administrative support, technological tools, and educational materials in shaping the effectiveness of PRT. It suggests that a harmonious integration of these resources is crucial for the optimal functioning and impact of PRT programs within educational institutions.

Proposition 1*: Human and non-human resources influence the effectiveness of a PRT program.*

Another element that influences the effectiveness of PRT is the integration of technology. Integration of technology into the PRT process can substantially improve teaching adaptability, which in turn positively impacts student performance. The term 'technology' in this context refers to digital tools and platforms that assist in collecting, analyzing, and disseminating feedback throughout the PRT process. The adoption of technology-enhanced classroom observation systems, which are becoming widely accessible and economically feasible, exemplifies this integration (Rodgers et al., 2019). Moreover, the role of digital platforms extends further to facilitate collaborative and continuous processes of reflection and improvement among educators (Fallon et al., 2015). Additionally, the use of visual data outputs, when combined with feedback, has been predominantly employed to track student behavioral trends (Noell et al., 2002) and specific teaching actions, such as the delivery of praise statements. The potential of these outputs, however, extends to portraying larger instructional practices. For instance, outputs that illustrate the use of modelling or other complex teaching strategies offer a rich source of information for further enhancing teaching methods (Rodgers et al., 2019). Thus, the literature suggesting the importance of integration of technology in PRT, leads to the development of Proposition 2. This proposition focuses on the transformative role of technology in the Peer-Review of Teaching process. It argues that the integration of digital tools and platforms in PRT not only enhances the adaptability of teaching methods but also positively impacts student performance. This proposition highlights how technology can facilitate more dynamic and responsive teaching approaches, thereby aligning educational practices with contemporary learning needs.

Proposition 2: *Integration of Technology in PRT Enhances Teaching Adaptability and the effectiveness of PRT*

Prior studies have debated on whether it is better to have PRT conducted by individuals from the same discipline, or whether different disciplines may add more value. The importance of diversity in educational settings is well-documented in academic literature (Quinlan, 1995). This diversity, facilitated by comprehensive peer-review feedback, enables educators to tailor their teaching methods to be more inclusive and reflective of the student population. De Lange & Wittek (2018) observe that a dominant teaching approach within a single discipline could overshadow more unique teaching styles and restrict the variety of methods used, a concern also raised by Quinlan (1995). Therefore, introducing a variety of perspectives from different disciplines into the Peer-Review of Teaching is essential to circumvent this limitation and promote a broader array of teaching methodologies. This leads to the development of Proposition 3. In this proposition, the emphasis is placed on the value of incorporating inclusive and diverse perspectives in PRT. It asserts that a PRT process enriched with varied cultural, academic, and pedagogical viewpoints contributes to the creation of a holistic learning environment. This proposition advocates for the recognition and integration of diverse insights and experiences, enhancing the quality and relevance of the educational experience for students.

Proposition 3: *Inclusive and Diverse Perspectives in PRT enhance the effectiveness of PRT and contribute to a Holistic Learning Environment*

2.2. Aspects of student performance influenced by effective PRT

The notion that peer-review of teaching serves as a developmental tool is strengthened by findings suggesting that it benefits not only the individual being reviewed, but also the reviewer. Assessing the quality of academic teaching is crucial for improving teaching and learning outcomes and achieving strategic goals related to enhancing education (Baik & Blasioli, 2018). At the individual level, faculty members experience numerous benefits, such as the development of reflective practices, stronger collegiate relationships, and enhanced teaching effectiveness (Bowen, 2009). From an institutional perspective, PRT initiatives can foster a transition in teaching methodologies from a teacher-centric to a student-centric focus (Baik & Blasioli, 2018), lead to improved student learning outcomes and place a greater emphasis on teaching quality (Bell & Thomson, 2018). At the organizational level, discipline-specific factors play a crucial role in fostering teaching development. Various scholars suggest that the observer/reviewer should either belong to the same discipline, be a senior academic leader, or an educational developer (Bell, 2001). This leads to the development of Proposition 4. This proposition explores the impact of PRT programs on student performance, both at individual and institutional levels. It posits that PRT, when effectively implemented, can lead to significant improvements in student learning outcomes, academic achievement, and overall educational quality. This proposition underscores the far-reaching benefits of PRT in fostering academic excellence and institutional success.

Proposition 4*: PRT programs have a positive impact on students' performance at the individual level and institutional level.*

Defining what constitutes good teaching is challenging, as it can manifest in various ways. The specific context of the environment and the objectives of a class largely influence the different forms good teaching can take. For example, the range of teaching behaviors displayed in a lecture is likely to differ from those in a tutorial, workshop, laboratory, or online setting. While collaboration with peers plays a crucial role in refining one's teaching abilities, the primary focus should always be on the student, their experiences, and their learning outcomes. Additionally, for university educators, Glassick's (2000) sixth standard of scholarship involves engaging in reflective critique of one's own work. The key elements of this standard are the critical evaluation of teaching practices based on a wide range of evidence, and, crucially, using this evaluation to improve the quality of future teaching. This leads to the development of Proposition 5. This proposition delves into the relationship between effective PRT programs and deep learning outcomes. It suggests that well-structured and thoughtfully executed PRT processes can significantly enhance students' deep learning capabilities, leading to a more profound understanding of subject matter and critical thinking skills. This proposition highlights

the role of PRT in cultivating an educational environment conducive to in-depth learning and intellectual growth.

Proposition 5*: Effective PRT programs have a positive impact on deep learning outcomes.*

The literature suggests that an effective PRT process enhances teaching quality (Raj et al. 2017), which in turn influences students' involvement and commitment to their learning journey, characterized by increased attentiveness, active participation in discussions, and deeper engagement with course material. Moreover, the role of student engagement is not limited to arousing interest; it extends to deepening students' commitment to their education. Axelson and Flick (2010) emphasize that when students find their classes engaging and relevant to their interests and aspirations, their motivation and dedication to studies are significantly enhanced. This heightened engagement benefits academic performance and fosters a positive, enduring attitude toward learning. Insightful PRT feedback enhances teaching quality in several ways. It creates a more diversified, inclusive, and collaborative learning environment and fosters a culture of ongoing feedback and reflective practice. This continuous refinement of teaching methods ensures that they evolve in response to constructive critiques, aligning closely with the needs and expectations of students. The benefits of effective PRT on student engagement and participation, as evidenced in the existing literature, lead to the development of Proposition 6. This proposition focuses on the role of PRT programs in enhancing student engagement and active participation in the learning process. It posits that through the refinement of teaching methods and strategies guided by PRT, educators can create more engaging and interactive classroom environments. This proposition emphasizes that enhanced student engagement, fostered by PRT, is key to fostering a dynamic and effective learning experience.

Proposition 6: *PRT Programs Enhance Student Engagement and Participation in the Learning Process*

3. Findings

Through synthesizing evidence from existing literature, this study has developed six propositions. Using the propositions, the study has designed a conceptual framework that provides a comprehensive understanding of what leads to effective PRT, and what outcomes an effective PRT has in regard to student performance and learning outcomes.

In response to the first research question, the study finds that human and non-human resources, technology integration, and inclusive and diverse perspectives contribute to enhancing the effectiveness of PRT. Based on this, as illustrated in Figure 1, the study has developed the following three propositions:

Proposition 1*: Human and non-human resources influence the effectiveness of a peer-review of teaching program.*

Proposition 2: *Integration of Technology in PRT Enhances Teaching Adaptability and the effectiveness of PRT*

Proposition 3: *Inclusive and Diverse Perspectives in PRT enhance the effectiveness of PRT and contribute to a Holistic Learning Environment*

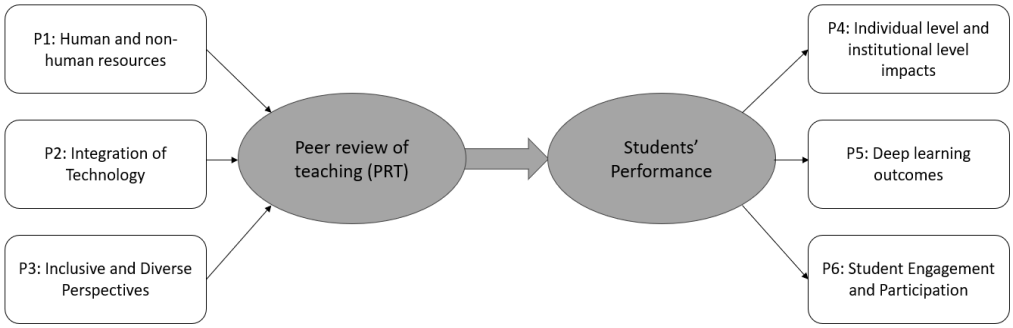


Figure 1. Conceptual framework. Source: Authors

In response to the second research question, the study finds that an effective PRT positively influences several aspects of student performance, including positive impacts on individual level and institutional level performance, deep learning outcomes, and student engagement and participation. Based on this, as illustrated in Figure 1, the study has developed the following three propositions:

Proposition 4*: PRT programs have a positive impact on students' performance at the individual level and institutional level.*

Proposition 5*: Effective PRT programs have a positive impact on deep learning outcomes.*

Proposition 6: *PRT Programs Enhance Student Engagement and Participation in the Learning Process*

4. Discussion

The study findings provide a nuanced understanding of the elements contributing to the effectiveness of Peer-Review of Teaching programs and their subsequent impact on student performance, offering valuable insights for both academics and policymakers in the higher education sector. The findings have several important implications for both academic practices and policy formulation within the higher education sector. The elucidation of six key propositions sheds light on vital aspects of Peer-review of Teaching, thereby providing a roadmap for enhancing the quality of education and student outcomes. For academics, the implications are multifaceted. The study underscores the importance of utilizing both human

and non-human resources effectively (Proposition 1), emphasizing that a well-coordinated interplay of faculty expertise, administrative support, and technological tools is crucial for the successful implementation of PRT programs. Furthermore, the integration of technology in PRT (Proposition 2) is identified as a key factor in not only enhancing the adaptability of teaching methods but also in elevating the overall effectiveness of PRT. This suggests a shift towards more digitally enabled peer-review processes, leveraging technology for more efficient and innovative teaching practices. Additionally, the study highlights the significant role of inclusive and diverse perspectives in PRT (Proposition 3). Policymakers in the HE sector, on the other hand, are urged to take actionable steps in light of these findings. The study advocates for policies that ensure adequate allocation and support for resources critical to PRT programs, aligning with the need for a comprehensive approach to resource utilization in peer-review practices. Moreover, the integration of technology in teaching and peer-review processes is seen as a priority, calling for policy frameworks that facilitate and support the use of digital platforms and tools in educational settings. Additionally, the promotion of diversity and inclusivity in educational policies is emphasized, highlighting the need for initiatives that foster diverse perspectives in teaching methodologies and PRT processes. The broader impact of these propositions on student performance is also evident. The latter propositions (4, 5, and 6) collectively illustrate the positive influence of effective PRT on enhancing student performance at both the individual and institutional levels, deepening learning outcomes, and boosting student engagement and participation. This comprehensive impact necessitates a concerted effort from both educators and policymakers to recognize and endorse PRT programs that are not only methodologically sound but also profoundly beneficial in improving student learning experiences.

5. Conclusion

In essence, the implications of this study offer a strategic direction for elevating the standard of higher education. By focusing on key factors that enhance the effectiveness of PRT and understanding their impact on student learning, both educators and educational policymakers can collaboratively work towards enriching teaching practices and fostering an environment conducive to student success. The adoption of these insights promises to lead to more effective, inclusive, and responsive educational practices, ultimately benefiting the broader educational landscape. The generalizability of the findings, which may vary across different educational contexts, disciplines, and cultures poses a limitation of this study. The study contributes to evaluation and assessment in higher education with implications for both theory and practice.

References

Axelson, R. D., & Flick, A. (2010). Defining student engagement. Change: *The Magazine of Higher Learning*, 43(1), 38-43.

Baik, C., & Blasioli, J. (2018). *Fostering teaching excellence at the University of Melbourne: The Melbourne peer review of teaching program*. Retrieved from https://melbourne-cshe.unimelb.edu.au/pd/teaching-learning-and-assessment/melbourne-peer-review-of-teaching-program, accessed December 17, 2023.

Bell, M. (2001). Supported reflective practice: A programme of peer observation and feedback for academic teaching development. *International Journal for Academic Development*, 6(1), 29-39.

Bell, M., & Thomson, K. (2018). Supporting peer observation of teaching: Collegiality, conversations, and autonomy. *Innovations in Education and Teaching International*, 55(3), 276-284.

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal*, 9(2), 27-40.

Burrows, T., Findlay, N., Killen, C., Dempsey, S. E., Hunter, S., Chiarelli, P., & Snodgrass, S. (2011). Using nominal group technique to develop a consensus-derived model for peer review of teaching across a multi-school faculty. *Journal of University Teaching & Learning Practice*, 8(2), 1-9.

Chester, A. (2012). Peer partnerships in teaching: Evaluation of a voluntary model of professional development in tertiary education. *Journal of the Scholarship of Teaching & Learning*, 12(2), 94-108.

de Lange, T., & Wittek, L. (2018). Creating shared spaces: Developing teaching through peer supervision groups. *Mind, Culture, and Activity*, 25(4), 324–339. https://doi.org/10.1080/10749039.2018.1544645

Fallon, L. M., Collier-Meek, M. A., Maggin, D. M., Sanetti, L. M. H., & Johnson, A. H. (2015). Is performance feedback for educators an evidence-based practice? A systematic review and evaluation based on single-case research. *Exceptional Children*, 81, 227–246.

Glassick, C. (2000). Boyer's expanded definitions of scholarship, the standards for assessing scholarship, and the elusiveness of the scholarship of teaching. *Academic Medicine*, 75(9), 877-880.

Harris, K. L., Farrell, K., Bell, M., Devlin, M., & James, R. (2008). Peer review of teaching in Australian higher education: *A handbook to support institutions in developing and embedding effective policies and practices*. Australian Learning and Teaching Council.

Hinrichs, L., Judd, D., Hernandez, M., & Rapport, M. J. (2022). Peer review of teaching to promote a culture of excellence: A scoping review. *Journal of Physical Therapy Education*, 36(4), 293-302. https://doi.org/10.1097/JTE.0000000000000242.

Johnston, A. L., Baik, C., & Chester, A. (2020). Peer review of teaching in Australian higher education: A systematic review. *Higher Education Research & Development*, 41(2), 390-404.

Lomas, L., & Nicholls, G. (2005). Enhancing teaching quality through peer review of teaching. *Quality in Higher Education*, 11(2), 137-149.

Noell, G. H., Duhon, G. J., Gatti, S. L., & Connell, J. E. (2002). Consultation, follow-up, and implementation of behavior management interventions in general education. *School Psychology Review*, 31, 217–234.

Quinlan, K. M. (1995). Faculty perspectives on peer review. *Thought & Action*, 11(2), 5-22.

Raj, S. J., Massey, S. R., & Jose, S. (2017). Peer review and reflective teaching practices: An effective mechanism for quality enhancement in Higher Education. *International SERIES on Information Systems and Management in Creative eMedia* (CreMedia), (2017/1), 193-240.

Rodgers, W. J., Kennedy, M. J., VanUitert, V. J., & Myers, A. M. (2019). Delivering performance feedback to teachers using technology-based observation and coaching tools. *Intervention in School and Clinic*, 55(2), 103-112.

Tennant, J. P., & Ross-Hellauer, T. (2020). The limitations to our understanding of peer review. *Research Integrity and Peer Review*, 5(6). https://doi.org/10.1186/s41073-020-00092-1.

Woodman, R.J., & Parappilly, M. (2015). The effectiveness of peer review of teaching when performed between early-career academics. *Journal of University Teaching and Learning Practice*, 12(1).

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Neuroanalytic and Summative Evaluation of Undergraduate Candidates: Criteria Based on Transversal Competencies

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Abstract

This study explores critical thinking as a key transversal competency, focusing on its neurocognitive processes through Electroencephalography (EEG) analysis during a critical thinking test. Conducted with 18 undergraduate students at Tecnologico de Monterrey, the research employed the Watson-Glaser Critical Thinking Appraisal II, a standardized test. EEG data were recorded using a 16-channel system, with signals pre-processed to extract Event-Related Potentials (ERPs). Results identified two main ERP components: N200 and P275, associated with Error-Related Negativity and Positivity, respectively. However, no statistically significant differences were found between correct and incorrect responses. The findings, while inconclusive regarding neural differences in response accuracy, highlight different ERP components when students response correctly or incorrectly. This research advances in neuroeducation, offering insights into the neurophysiological foundations of critical thinking and providing a basis for improving evaluation and development of transversal competencies in educational contexts.

Keywords: *Transversal competencies; Critical thinking; Electroencephalogram (EEG); Event-Related Potentials (ERPs); Neuroeducation; innovative education, higher education.*

1. Introduction

The continuous evolution of knowledge has reshaped education, emphasizing skills that enable individuals to adapt to complex environments. Transversal competencies, such as critical thinking, communication, and ethical awareness, transcend disciplines and are essential for modern education (Alsina et al., 2011; Salcines et al., 2018; Yániz & Villardón, 2006; Vincent-Lancrin et al., 2019; Pellegrino & Hilton, 2012).

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Critical thinking, defined by Glaser (1941) and expanded by Watson and Glaser (1994, 2010), involves evaluating evidence to form logical conclusions and solve open-ended problems (Thagard, 2011; Dwyer et al., 2014; Halpern, 2014). While its role in education is well established, its cognitive neuroscience aspects remain underexplored (Butler et al., 2017).

This study addresses this gap by combining the Watson-Glaser II Critical Thinking Appraisal with EEG technology to investigate the neural basis of critical thinking. Previous attempts, such as Shaddock (1981), relied on outdated EEG systems and did not assess real-time task performance, such as the precise tracking of neural activity during complex reasoning tasks proposed by Kappenman & Luck (2016). This research advances the field by directly capturing EEG data during critical thinking, providing novel insights into its neurophysiological mechanisms.

2. Materials and Methods

2.1. Participants

The study involved 18 final-semester Biomedical Engineering students aged between 20–23, 10 males and 8 females with an A-B socio-economic from Tecnologico de Monterrey. Inclusion criteria included written informed consent, while exclusion criteria involved withdrawal or incomplete procedures. Ethical compliance followed the Declaration of Helsinki.

2.2. Materials and Equipment

The critical thinking test, developed by Assessment Day Ltd., featured five sections: 1) Arguments, 2) Assumptions, 3) Deductions, 4) Interpreting Information, and 5) Inferences. Instructions and example questions preceded each section, with responses recorded via keyboard. Breaks between sections minimizing fatigue, ensuring reliability.

EEG signals were recorded using the g.USBamp system (g.tec Medical Engineering), a 16-channel FDA-certified amplifier with Type II security and biocompatible conductivity gel. Impedance was kept below 5 kΩ, and signals were digitized at 256 Hz for analysis.

2.3. Experimental Procedure

The experiment consisted of a 73-minute session organized in six stages. First, participants were informed for 10 minutes about the research aims and the consent form. Second, electrodes were collocated in accordance with the International 10/20 System and the EEG system was calibrated (10min). Third, participants at rest were registered for 3min. Finally, the critical thinking test was applied for 50 minutes.

2.4. EEG Paradigm

Participants completed five subtests, each containing 3–7 questions per problem. Problems were displayed at the top of the screen, followed by questions and multiple-choice answers. Participants responded via keyboard, with a 1-second interstimulus interval (ISI) and a 5-minute break after each subtest. The design of the critical thinking task is shown in Figure 1.

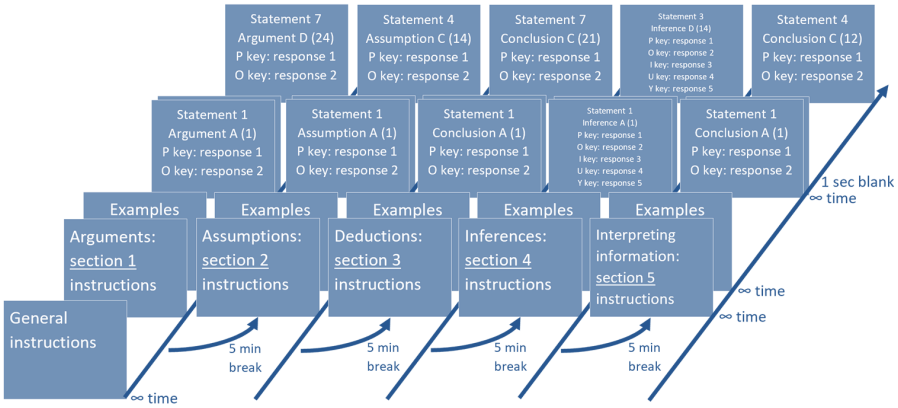


Figure 1. Design of the critical thinking task. The first and the last questions of each section are shown. Parentheses indicate the number of questions within a section, e.g., section 4 had 14 questions.

2.5. Signal Analysis

2.5.1. EEG Pre-processing

EEG data were pre-processed using MATLAB and EEGLAB toolbox (v2021.0). Signals were channel-locked, baseline-removed, and noise-cleaned using CleanLine (Mitra & Bokil, 2007). Clean_rawdata (Kothe & Makeig, 2013) removed significant amplitude artifacts. A high-pass Butterworth filter at 1 Hz, and independent component analysis (WICA plugin) were applied to identify and remove sources such as cardiac, muscular, and ocular activity.

2.5.2. Event-Related Potentials (ERPs)

Epochs were extracted in line with correct and incorrect responses (-300 to 1000 ms), and question presentations (-300 to 2000 ms). Then, ERPs were plotted for the three study cases.

2.6. Statistical Analysis

2.6.1. Event-related Responses: Correct and Incorrect

Correct vs. incorrect responses were analysed using paired t-tests and one-way ANOVA, supplemented by nonparametric permutation testing (10,000 iterations) to address parametric assumptions. Condition labels were shuffled while preserving data structure to create empirical

null distributions. After pFDR correction (Storey, 2002), neither parametric nor permutation tests revealed significant differences.

2.6.2. Event-related Questions

One-way ANOVA was applied to compare the five sections of the critical thinking test. The results showed no significant differences, consistent with prior research on averaging limitations (Van Vliet et al., 2016; Lee et al., 2016).

3. Results

3.1. Scores critical thinking task

The mean and standard deviation of scores in each critical thinking task section from all participants are shown in Table 1. As the standard deviation is small, most of the participants were consistent in their answers.

3.2. Event-related Responses: Correct and Incorrect

A negative component with 200 ms latency (N200) after the responses of participants is shown in Figure 2. A positive component with 275ms latency (P275) was also present. P275 had the highest peak mean amplitude in frontal pole channels and the longest latency to return to baseline. Sample-wise t-tests with pFDR correction did not find a statistically significant difference between correct and incorrect components on the mean amplitudes at timepoints near their peaks. All other timepoints' t-tests from this comparison were also not statistically significant after pFDR correction.

Analysis based on event-related responses (correct and incorrect) across the five sessions showed the same components and similar distribution across channels. Sample-wise, one-way ANOVAs with pFDR correction did not find a statistically significant difference between section-specific.

Table 1: Mean ($\overline{x}$) and standard deviation (SD) of proportion scores in each critical thinking task section from all participants.

	Sample (n=18)
Scores in section 1: $\overline{x} \pm$ SD	0.6250 ± 0.1178
Scores in section 2: $\overline{x} \pm$ SD	0.6008 ± 0.1096
Scores in section 3: $\overline{x} \pm$ SD	0.7255 ± 0.1061
Scores in section 4: $\overline{x} \pm$ SD	0.4127 ± 0.1134
Scores in section 5: $\overline{x} \pm$ SD	0.6852 ± 0.0836

3.3. Event-related questions

Results showed in Figure 3 several local minima (hereafter denoted with N) and maxima (hereafter denoted with P) in these ERPs. About 12 components could be identified (N100, P125, N150, P155, N175, P225, N280, P280, N325, P375, N425, and P1050). ERPs from question presentations were also divided by section. Sample-wise, one-way ANOVAs with pFDR correction did not find a statistically significant difference between section-specific, question presentation ERPs on the mean amplitudes at timepoints near the peaks of all previous components. All other timepoints' one-way ANOVAs from this comparison were also not statistically significant after pFDR correction.

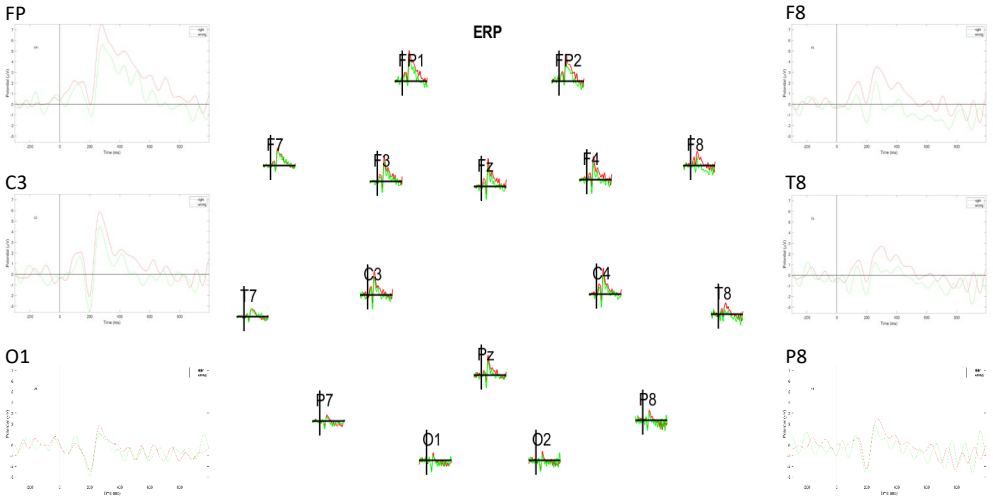


Figure 2: ERPs from all right and wrong responses of the critical thinking task. Red = right, green = wrong. X-axis: vertical line = 0ms, label intervals = 200ms, limits = -300 to 1000ms. Y-axis: horizontal line = 0μV, label intervals = 1μV, limits = -3.5 to 7.5μV.

4. Discussion

This study investigated the neural underpinnings of critical thinking as a transversal competency in undergraduate students by analysing their event-related responses (both correct and incorrect ones) and event-related questions. Two primary ERP components, N200 and P275, were identified, corresponding to Error-Related Negativity (ERN) and Positivity (PE), respectively, as described in the literature (Dietrich, 2004; Hughes & Zaki, 2015; Falkenstein et al., 1991). However, the analysis revealed no statistically significant differences between correct and incorrect responses, suggesting that mental resources employed in both processes are very similar, at least being analysed by ERP techniques.

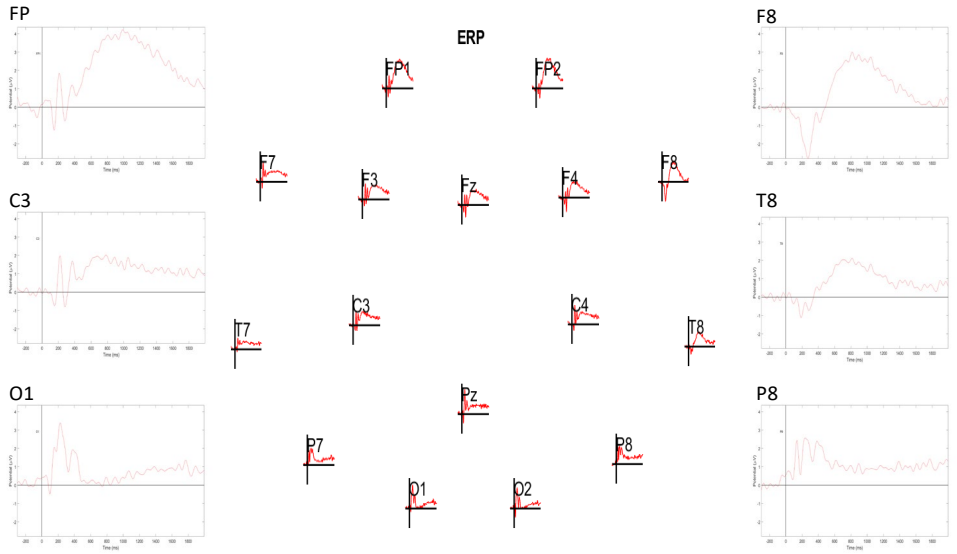


Figure 3: ERPs from all question presentations in the critical thinking task. X-axis: vertical line = 0ms, label intervals = 200ms, limits = -300 to 2000ms. Y-axis: horizontal line = 0μV, label intervals = 1μV, limits = -2.75 to 4.25μV.

The presence of twelve identifiable components during question presentations, including N100, P125, and P275, highlights the complexity of cognitive processing during critical thinking tasks (Luck, 2014). Nonetheless, the absence of statistically significant differences between subtests or conditions underscores the need for further studies to elucidate the relationship between neural activity and critical thinking performance. The high variability in cognitive engagement across tasks and the relatively small sample size likely contributed to this limitation (Cohen, 1992). It is recommended to perform an Inter-Trial-Coherence analysis for differentiating between components and peaks. Possibly, some of the twelve appearing components are only peaks, and they could be only fortuity events, rather than cognitive processes.

The findings of this study align with prior work suggesting that critical thinking is a multifaceted cognitive process, engaging diverse neural networks without clear differentiation by task accuracy (Goel et al., 2017; Thagard, 2011; Holroyd et al., 2008). The results extend this understanding by demonstrating the feasibility of using real-time EEG to investigate critical thinking. However, the findings emphasize the importance of refining methodological approaches, including larger samples and more targeted task designs, to capture the nuanced neural mechanisms underlying this skill. A further study with more focus on the evaluation of the critical thinking test is suggested. For example, reaction time to read and answer the questions could be a dependent variable to reorganize epochs and visualize different components, or different ERP properties. The study's findings have several implications for

education and future research, i.e. If neural engagement in correct and incorrect critical thinking processes is indeed similar, educators might focus on metacognitive training to help students better monitor and adjust their reasoning strategies, rather than solely emphasizing accuracy. And for assessment methods, incorporating neurophysiological measures (e.g., EEG) alongside traditional assessments could provide a more holistic understanding of students' critical thinking development.

5. Conclusion

This research contributes to the development of neuroeducation by identifying neurophysiological markers of critical thinking. Although the study did not find conclusive evidence of differences in neural activity between correct and incorrect responses, the identified ERP components provide a foundation for future research.

Future studies should address the limitations noted here by employing more robust statistical analyses, increasing sample size, and exploring longitudinal designs to understand how critical thinking develops over time (Button et al., 2013). Additionally, integrating multimodal approaches, such as functional MRI and behavioral data, could offer richer insights into the cognitive and neural dimensions of transversal competencies (Wertheim & Ragni, 2020; Van Vliet et al., 2016).

Finally, the integration of neuroscientific findings into educational frameworks holds promise for enhancing the evaluation and development of critical thinking, equipping students to navigate the demands of a complex, rapidly evolving world (Alsina et al., 2011; Sarathy, 2018).

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References

Alsina, P., Boix i Tomàs, R., Burset Burillo, S., García Asensio, M., Mauri, T., & Pujolà, J. T. (2011). *Evaluación por competencias en la universidad: las competencias transversales*.

Association for the Study of Higher Education. (1988). Cognitive processes in critical thinking. *ASHE-ERIC Higher Education Report*, *17*(2), 25–49. https://doi.org/https://doi.org/10.1002/aehe.3640170207

Blanchette, I., Caparos, S., & Trémolière, B. (2018). Emotion and reasoning. In *The Routledge international handbook of thinking and reasoning.* (pp. 57–70). Routledge/Taylor & Francis Group.

Butler, H. A., Pentoney, C., & Bong, M. P. (2017). Predicting real-world outcomes: Critical thinking ability is a better predictor of life decisions than intelligence. Thinking Skills and Creativity, 25, 38-46. https://doi.org/10.1016/j.tsc.2017.06.005

Button, K. S., Ioannidis, J. P. A., Mokrysz, C., Nosek, B. A., Flint, J., Robinson, E. S. J., & Munafò, M. R. (2013). Power failure: why small sample size undermines the reliability of neuroscience. *Nature Reviews Neuroscience*, 14(5), 365–376. https://doi.org/10.1038/nrn3475

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155–159. https://doi.org/10.1037/0033-2909.112.1.155

Dwyer, C. P., Hogan, M. J., & Stewart, I. (2014). An integrated critical thinking framework for the 21st century. Thinking Skills and Creativity, 12, 43-52. https://doi.org/10.1016/j.tsc.2013.12.004

Dietrich, A. (2004). The cognitive neuroscience of creativity. *Psychonomic Bulletin & Review*, *11*(6), 1011–1026. https://doi.org/10.3758/BF03196731

Falkenstein, M., Hohnsbein, J., Hoormann, J., & Blanke, L. (1991). Effects of errors in choice reaction tasks on the ERP under focused and divided attention. *Electroencephalography and Clinical Neurophysiology, 78*(6), 447–455. https://doi.org/10.1016/0013-4694(91)90062-9

Fellows, L. K. (2004). The Cognitive Neuroscience of Human Decision Making: A Review and Conceptual Framework. *Behavioral and Cognitive Neuroscience Reviews*, *3*(3), 159–172. https://doi.org/10.1177/1534582304273251

Goel, V., Navarrete, G., Noveck, I. A., & Prado, J. (2017). Editorial: The Reasoning Brain: The Interplay between Cognitive Neuroscience and Theories of Reasoning . In *Frontiers in Human Neuroscience* (Vol. 10, p. 673).

Halpern, D. F. (2014). Thought and knowledge: An introduction to critical thinking (5th ed.). Psychology Press.

Holroyd, C. B., & Coles, M. G. H. (2008). The neural basis of human error processing: Reinforcement learning, dopamine, and the error-related negativity. *Psychological Review, 109*(4), 679–709. https://doi.org/10.1037/0033-295X.109.4.679

Hughes, B. L., & Zaki, J. (2015). The neuroscience of motivated cognition. *Trends in Cognitive Sciences*, *19*(2), 62–64. https://doi.org/10.1016/j.tics.2014.12.006

Kappenman, E. S., & Luck, S. J. (Eds.). (2016). The Oxford handbook of event-related potential components. Oxford University Press.

Lee, W. L., Tan, T., Falkmer, T., & Leung, Y. H. (2016). Single-trial event-related potential extraction through one-unit ICA-with-reference. *Journal of Neural Engineering*, *13*(6), 066010. https://doi.org/10.1088/1741-2560/13/6/066010

Luck, S. J. (2014). *An introduction to the event-related potential technique*. MIT Press.

Rey, B. (2000). ¿Existen las competencias transversales? *Educar*, *26*, 9–17.

Pellegrino, J. W., & Hilton, M. L. (Eds.). (2012). Education for life and work: Developing transferable knowledge and skills in the 21st century. National Academies Press. https://doi.org/10.17226/13398

Salcines, I., González-Fernández, N., Ramírez-García, A., & Martínez-Mínguez, L. (2018). Validación de la escala de autopercepción de competencias transversales y profesionales de

estudiantes de educación superior. *Profesorado. Revista de Currñiculum y Formación Del Profesorado*, *22*(3), 31–51.

Sarathy, V. (2018). Real World Problem-Solving . In *Frontiers in Human Neuroscience* (Vol. 12, p. 261).

Sawyer, K. (2011). The Cognitive Neuroscience of Creativity: A Critical Review. *Creativity Research Journal*, *23*(2), 137–154. https://doi.org/10.1080/10400419.2011.571191

Seitz, R. J., & Angel, H.-F. (2020). Belief formation – A driving force for brain evolution. *Brain and Cognition*, *140*, 105548. https://doi.org/https://doi.org/10.1016/j.bandc.2020.105548

Shaddock, R. (1981). *Critical Thinking, Open Mindedness, and EEG Coherence in Students Practicing TM*. https://doi.org/10.13140/2.1.4040.8966

Storey, J. D. (2002). A Direct Approach to False Discovery Rates. *Journal of the Royal Statistical Society. Series B (Statistical Methodology)*, *64*(3), 479–498.

Thagard, P. (2011). Critical Thinking and Informal Logic: Neuropsychological Perspectives. *Informal Logic*, *31*(3).

Van Vliet, M., Chumerin, N., De Deyne, S., Wiersema, J. R., Fias, W., Storms, G., & Van Hulle, M. M. (2016). Single-trial ERP component analysis using a spatiotemporal LCMV beamformer. *IEEE Transactions on Biomedical Engineering*, *63*(1), 55–66. https://doi.org/10.1109/TBME.2015.2468588

Vincent-Lancrin, S., González-Sancho, C., Bouckaert, M., de Luca, F., Fernández-Barrerra, M., Jacotin, G., Urgel, J., & Vidal, Q. (2019). Fostering students' creativity and critical thinking: What it means in school. OECD Publishing. https://doi.org/10.1787/62212c37-en

Wertheim, J., & Ragni, M. (2020). The Neurocognitive Correlates of Human Reasoning: A Meta-analysis of Conditional and Syllogistic Inferences. *Journal of Cognitive Neuroscience*, *32*(6), 1061–1078. https://doi.org/10.1162/jocn_a_01531

Yániz, C., & Villardón, L. (2006). Planificar desde competencias para promover el aprendizaje. El reto de la Sociedad del conocimiento para el profesorado universitario. *Cuadernos Monográficos Del ICE*, *12*.

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The Student's Environmental Footprint: A pilot experience of research-based learning in higher education

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Abstract

A pilot project has been designed and implemented in a Master's degree course in engineering, using Research-based learning methodology and grounded in the Life Cycle Assessment framework. The aim was to develop sustainability skills by applying a scientific-technical methodology to the daily habits of the students in order to determine their environmental footprint and subsequently propose measures to reduce their environmental impact.

Experience has shown that student engagement has been high. While analysing their individual impact, students also understand how life cycle assessment provides valuable information to assess a product or process. Finally, they see how aggregate changes in individual behaviour can have a significant collective impact.

Keywords: *Life Cycle Assessment; sustainability; green skills; research-based learning; environmental footprint; SDGs.*

1. Introduction

The concept of sustainability is becoming increasingly important in universities around the world; the importance of different international agreements such as the United Nations Agenda 2030 or the Paris Agreement (United Nations Climate Change Conference) both signed in 2015, have highlighted the need for a change in the economic and social system in all regions of the world.

University, as a place of learning, reflection and acquisition of professional competences for students, is an exceptional framework for sustainability to be incorporated as a fundamental competence, related to the set of basic and specific technical skills of each university degree.

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The set of skills linked to sustainability, biodiversity, climate change, circular economy and renewable energy, among other topics, are now grouped together under the term green skills (European Commission, 2023).

However, university students, who are also citizens and members of the urban or rural communities in which they live, often lack the skills to translate classroom learning into real-life situations (García-Aranda et al, 2020).

There are a variety of teaching methodologies that allow learning to be connected with real contexts (Hernández de Menéndez, 2019), among them, Research-based learning has been chosen in this experience, which is based on the scientific method in teaching (Obwegeser & Papadopoulos, 2017). In this case study, it has been applied to analyse the environmental impact of each student's consumption habits, as a model of practical learning and identification of improvements in real situations.

2. Context or Framework

This experience has been implemented in the context of engineering studies, specifically within the Master's Degree in Chemical Engineering at the Universidad Politécnica de Madrid (UPM). Master's studies imply that students have already completed an undergraduate degree—four academic years under the Spanish university system—so their age and prior education should have provided them with a higher level of professional and personal competencies.

However, the professors who have developed this project have observed in previous courses that the students' knowledge in the field of sustainability is mainly theoretical. When practical applications are introduced in the course, students often face significant challenges in applying these concepts to real-world cases.

Specifically, one of the competencies that students are expected to achieve, as stated in the syllabus is: *"To adapt to structural changes in society driven by economic, energy-related, or natural factors, in order to address emerging challenges and provide technological solutions with a strong commitment to sustainability."*

To address this identified gap and meet the established learning objectives, this pilot project has been designed and implemented using a Research-based learning methodology. It is grounded in the framework of Life Cycle Assessment (LCA), which constitutes one of the core content areas of the course. This first experience has been tested with a small group, to be extended to more groups in the next course.

The main goal is to familiarise students with the scientific-technical methodology of LCA through the use of an impact assessment tool developed by the European Life Cycle Assessment Platform (EPLCA, https://eplca.jrc.ec.europa.eu/).

3. Objectives

The main objective of the project is for students to learn about environmental impact through a personal research experience focusing on their habits, and how our individual impact influences our collective impact. It focuses on the following secondary objectives:

- Calculate the environmental impact associated with the students' consumption habits and compare their environmental impact with the average impact of their classmates and an average EU citizen.
- Analyze the main contributors to individual environmental impact for specific environmental factors, such as climate change or water resource consumption.
- Identify and evaluate measures that can be implemented to reduce both individual and collective environmental impact among students and develop a best practice guide for our daily habits to reduce environmental impact, ensuring that it is easily "transferable" to other groups within society.

4. Methodology

In the educational context, the methodology used in the project has been Research-based Learning, which is focused on teaching students through practical research experiences, each student's research is part of the learning, data or models are provided, complex questions are asked and students are researchers (Dekker & Walsarie, 2016).

The working methodology used in the project can be summarised in the next 4 stages.

4.1. Familiarization with Life Cycle Impact Assessment and Impact Categories

The first step involves introducing students to the key concepts related to the LCA methodology and the life cycle impact assessment method to be used, which is the Environmental Footprint (EF) method**,** in accordance with EU Commission Recommendation 2021/2279**.** This method includes 16 environmental impact categories and has been developed by the EPLCA. It is also the method used in the Consumer Footprint Calculator (CFC) (Sala et al., 2022; Genta et al., 2022), a tool developed by EPLCA and applied within the framework of this project.

4.2. Calculating the environmental impact associated with students' consumption patterns

Students use the CFC tool to determine the environmental impact associated with their consumption habits and their relation to planetary boundaries (Fig. 1). This stage is carried out in two phases:

- Introduction to the tool: A session led by the professors in which the tool is explained, and students are provided with a questionnaire containing the type of information they need to

gather about their consumption habits in the five considered areas: food, mobility, household goods, housing, and appliances.

- Calculation of individual environmental impact associated with consumption habits: After a week in which students gather data related to their consumption habits, they input it into the tool to calculate their environmental impact. Once the environmental impact is calculated (e.g., carbon footprint or water footprint), the tool allows for comparisons with the average environmental impact of a European citizen and with the trajectory of achieving the Sustainable Development Goals (SDGs) set out in the 2030 Agenda. For instance, assessing the environmental impact associated with the consumption of products and services is crucial for achieving SDG 12 (Responsible Consumption and Production). In addition, students compare their results with those of their classmates and identify the main contributions to the selected impacts. That is, they analyze which aspects of their daily life or which products/services/habits are responsible for their collective impact.

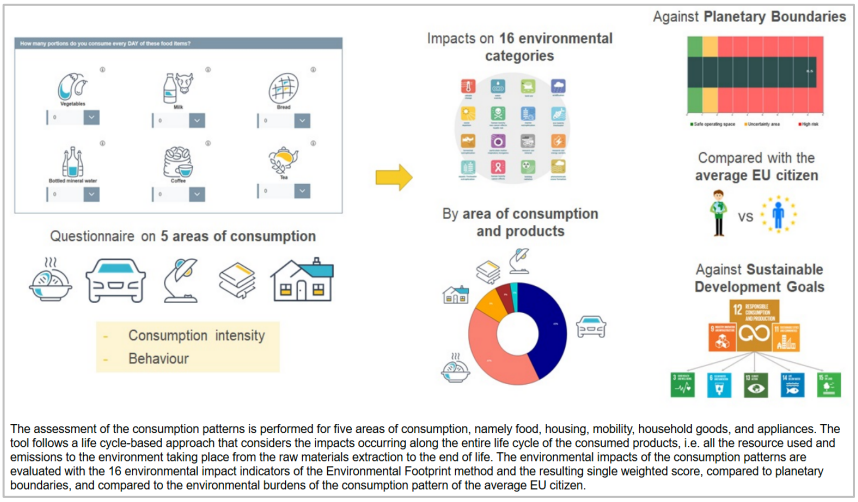


Figure 1. Schematic of the EPLCA CFC tool. Source: EPLCA (2024).

4.3. Research phase on measures that can reduce environmental impacts

Once the individual impact is determined, students conduct research, guided by professors, on specific measures they can easily incorporate into their daily consumption habits to reduce their impact.

4.4. Proposed actions to reduce the impact based on the goals set at different levels

Once a significant set of measures to reduce environmental impact has been identified, each student is required to propose a small number of measures aimed at reducing their environmental impact. But what level of reduction is needed? In the project conducted, students

are asked to reduce their impact on climate change by 65%, in line with European, national, and local greenhouse gas emission reduction targets, with the goal of bringing this impact below the "high-risk" threshold when compared to the planetary boundaries model.

5. Results

The project has been carried out in the "Industrial Ecology" course of the Master's Degree in Chemical Engineering (first year) with 19 students. The environmental impact generated by each student's consumption habits, weighted across the 16 impact categories of the EF method, is shown in Figure 2. This figure allows for the analysis of results in relative terms and provides insight into each student's position compared to the class average. The same information is presented in Figures 3 and 4, but specifically for the impact categories of climate change and water use.

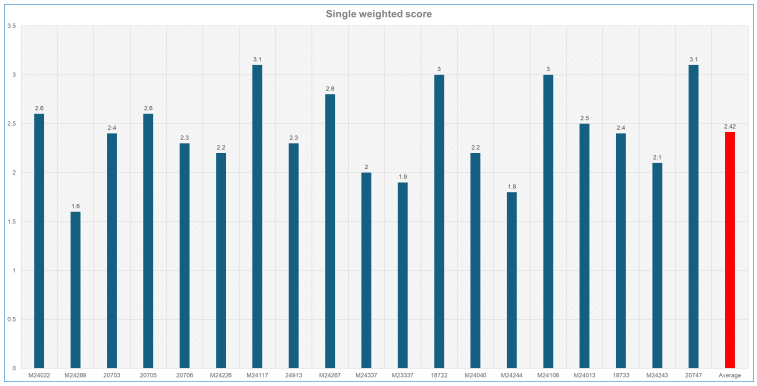


Figure 2. Environmental impact of each student and the average value obtained for the group as a whole (in red), expressed in terms of the weighted assessment. Source: By the authors (2025).

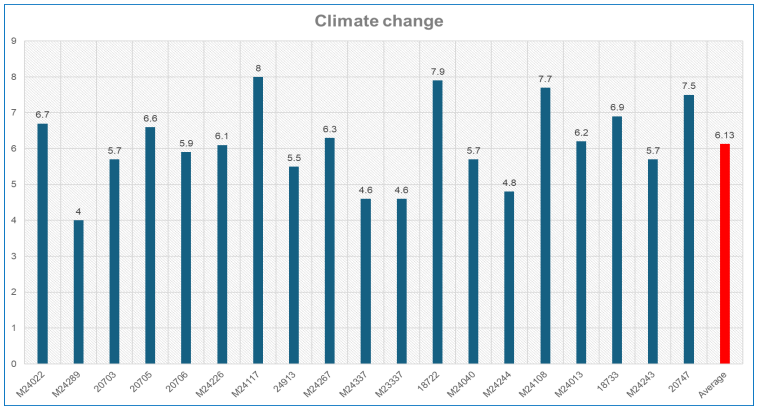


Figure 3. Environmental impact of each student in climate change and the average value obtained for the group as a whole (in red), normalized values (dimensionless). Source: By the authors (2025).

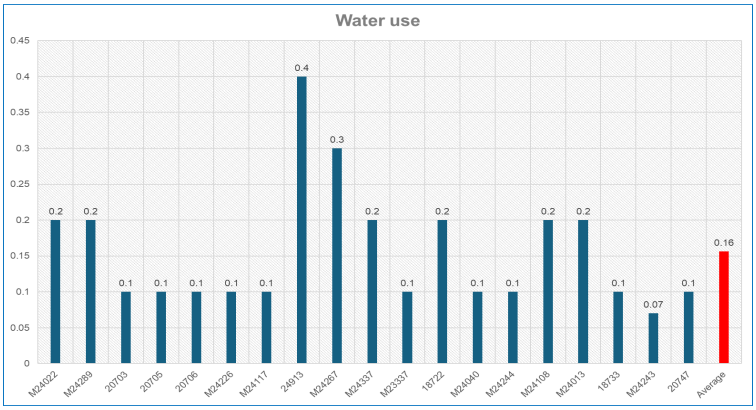


Figure 4. Environmental impact of each student in water use and the average value obtained for the group as a whole (in red), normalized values according to the tool (dimensionless). Source: By the authors (2025).

After estimating their impact by category, each student is asked to analyze and reflect on their results. For this purpose, they must assess their situation in relation to planetary boundaries, the results by consumption area, and a comparison with the impact of an average European citizen. An example of these results, for one of the participating students and for the climate change impact category, is shown in Figure 5.

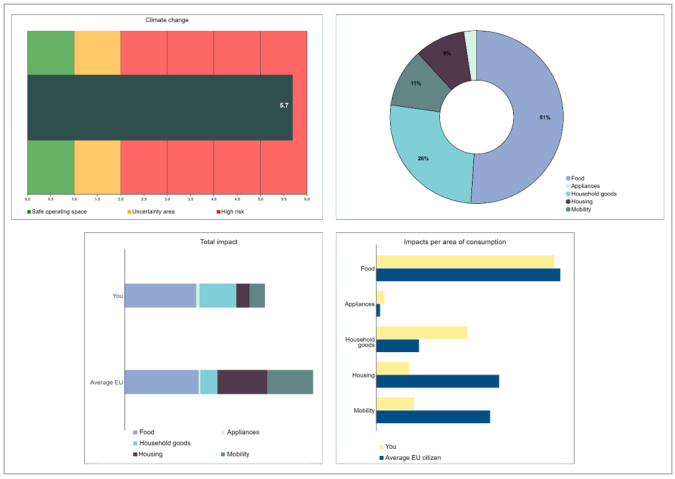


Figure 5. Analysis of the situation in relation to planetary boundaries (top-left), results by consumption area (top-right), and comparison with the total impact of an average European citizen (bottom-left) and by consumption area (bottom-right) for the climate change category and a specific student. Source: Consumer Footprint Calculator (2024).

Students find (and are often surprised) that their greatest contributions to climate change impact come from food consumption, followed by mobility/transportation and household goods. Compared to the average European citizen, the contribution of housing is lower due to Spain's specific climate conditions (Madrid).

After this initial analysis, each student proposes a set of measures to implement in their daily lives to reduce their impact and achieve the proposed goal. In this way, each student must attempt to reduce their impact by aligning it with planetary boundaries, keeping it below the "high-risk" threshold.

The measures proposed by the students focus on changing dietary habits (reducing meat, dairy, and cocoa consumption, etc.), improving or reducing mobility habits by using public transport, increasing product reuse, and prioritizing "servitization" over product/device ownership.

To conclude the research activity, students respond to a survey assessing their satisfaction with the activity based on three questions (Figure 6), with the following average results:

- **Q1:** Rate the overall usefulness of the activity (0 = useless within the course framework, 10 = very interesting within the course framework) → **8.2/10**
- **Q2:** Evaluate whether the activity helps in understanding the methodology and applications of LCA (0 = not helpful at all; 10 = significantly facilitates understanding and comprehension of the methodology) → **7.6/10**
- **Q3:** Assess whether the practical activity should be carried out in future courses (0 = should definitely be eliminated, 10 = would be very useful to repeat) → **8.3/10**

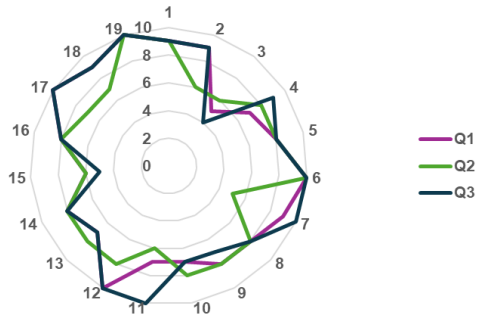


Figure 5. Satisfaction survey results from the nineteen students. Source: By the authors (2025).

6. Conclusions

The proposed project provides an answer to two current challenges in university education. First, the shift in the model of subject learning, making the student the protagonist of the process and advancing toward active learning. On the other hand, it incorporates skills into the academic curriculum that will allow university graduates to adapt to a changing job market, where the

sustainability of activities is crucial, and within this, the reduction of environmental impacts caused by industrial activities throughout the entire production and consumption process.

This research-based learning model allows students to seek solutions and improvement actions, with the positive impact results being measured on their own habits. In this way, learning becomes more personal and deeper, making students aware of their environmental impact so that they can apply it in their future professional activity.

The project evaluation shows a high level of satisfaction. Students state that it helps them understand the subject's core topics, as well as the origin and nature of the environmental impacts caused by their consumption habits, enabling them to become aware of the magnitude of the impact and how they can act to minimize these impacts.

References

Dekker, H., & Walsarie, S. (2016). *Re-inventing research-based teaching and learning*. Centre for Education and Learning, Leiden-Delft-Erasmus Universities.

European Commission. (2023). *Vocational education and training and the green transition: A compendium of inspiring practices*. Directorate-General for Employment, Social Affairs and Inclusion. Directorate B — Jobs and Skills, Unit B.3 — Vocational Education and Training, CEDEFOP.

García-Aranda, C., Molina-García, A., Morillo Balsera, M. D. C., Martínez-Cuevas, S., Rodríguez Hurtado, M. E., Pérez Rodríguez, J., Rodriguez-Chueca, J. J., Torroja Fungairiño, Y., Rodríguez Hernández, M., González Miquel, M., Díaz Moreno, I., González Gómez, E. J., Fuente García-Soto, M. D. M. de la, Giannakis, S., Castillo González, I. del, Martínez Núñez, M., Blasco Contreras, F., & Izquierdo García, P. C. (2020). *Creativity and innovation skills in university STEM education: The CHET project approach.* In *6th International Conference on Higher Education Advances (HEAd'20)* (pp. 679–687). Valencia, Spain. https://doi.org/10.4995/HEAd20.2020.11127

Genta, C., Sanyé-Mengual, E., Sala, S., & Lombardi, P. (2022). The consumption footprint as a possible indicator for environmental impact evaluation at the city level: The case study of Turin (Italy). *Sustainable Cities and Society, 79*, 103679. https://doi.org/10.1016/j.scs.2022.103679

Hernández-de-Menéndez, M., Vallejo Guevara, A., Tudón Martínez, J. C., Hernández Alcántara, D., & Morales-Menendez, R. (2019). Active learning in engineering education: A review of fundamentals, best practices, and experiences. *International Journal on Interactive Design and Manufacturing, 13*(3), 909–922. https://doi.org/10.1007/s12008-019-00557-8

Obwegeser, N., & Papadopoulos, P. M. (2017). Integrating research and teaching in the IS classroom: Benefits for teachers and students. *Journal of Information Systems Education, 27*(4), 249–258.

Sala, S., De Laurentiis, V., Barbero Vignola, G., Marelli, L., & Sanyé Mengual, E. (2022). *The Consumer Footprint Calculator* (EUR 31089 EN). Publications Office of the European Union. https://doi.org/10.2760/597000

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DOI: https://doi.org/10.4995/HEAd25.2025.20199

The Role of Peer-learning techniques in enhancing and scaling Project-based Learning

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Abstract
In the domain of business education, conventional pedagogical approaches can prove inadequate in equipping students with the skills needed to tackle practical challenges. The speed of change means that education must keep pace with the job market and innovative educational frameworks are necessary to bridge the emerging gap. This original research reports on and analyses designs for an innovative 'virtuous learning cycle' in an MBA Extended Work Project (EWP) at a UK University. Gathering evidence from a mixed-method approach, this paper demonstrates the capacity to improve student engagement, enrich comprehension, and cultivate the very meta-skills in demand in today's workplace – notably those surrounding collaborative competencies. In evaluating the design, it champions the transformative potential of building this cycle through a purposeful amalgamation of project-based and peer-to-peer learning approaches.

Keywords: *Project-based learning, Peer-learning, MBA, Meta Skills.*

1. Introduction

Business education generally and MBA programmes, must remain current, developing the skills and competencies demanded by the changing professional workplace. Over many years now, several authors have warned that graduates lack the requisite job skills; that they are not 'job-ready' (Garcia-Alvarez et al., 2022; Bhatti et al., 2022). In the area of Business Administration this means a shift of focus from traditional, technical, business knowledge in favour of meta-skills, those high-end human abilities to think, create, problem solve and collaborate. These pressures are considerable and have consequently also meant an evolution of educational techniques which de-emphasise didactic approaches and promote experiential learning experiences (Goulart et al., 2021; Barber, 2018).

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The work outlined in this paper has been conducted amid these pressures. It describes and evaluates the extent to which integrating project-based learning with peer learning could transform the development of these meta-skills and competencies in MBA students preparing themselves for the workplace. Interestingly from a case study standpoint, this is a part of the programme which reported consistent overall student satisfaction meaning failure was not a driver of change. The catalyst was a form of horizon scanning supported by primary data collected by way of interviews with a range of business employers connected to the programme.

Reflecting the challenge, the MBA team set themselves, the research outlined here seeks to examine whether the integration of project-based and peer learning methodologies might improve the educational environment and perhaps cultivate students' meta-abilities to address difficult, transdisciplinary situations. It investigates if this strategy might enhance the scalability of project work for universities and corporations by facilitating more student involvement. The research assesses the prospective efficacy of this integrated approach in equipping students for professional settings that need flexibility, teamwork, and imaginative problem-solving abilities.

The central question of this study is to ask, to what extent does incorporating project-based learning and peer-to-peer interactions establish a beneficial learning cycle and prepare students for today's business environment? Consequently, this paper is organised by adopting theoretical and empirical approaches. Conceptually, it considers briefly the current understanding of Project-Based learning and Peer-learning before applying this understanding to a proposed learning design to be implemented in practice, evaluating the evidence generated through surveying students and businesses involved.

2. Literature review

Given the context and historic successes and potential of the MBA EWP, this section reviews the existing body of knowledge surrounding Project-based Learning and Peer Learning to identify conceptual crossovers supportive of the ambitions of the project. Project-based Learning is a pedagogical approach that involves students in the development of knowledge through the completion of significant projects and the creation of tangible goods (Brundiers & Wiek, 2013; Krajcik & Shin, 2014). Project-based learning is a teaching method in which students learn by actively engaging in real-world projects comprising real business and economic challenges resolved through a theory to practice style of learning. This approach aims to help students develop deep content knowledge as well as critical thinking, problem-solving, collaboration, creativity, and communication skills.

The latest research has surfaced benefits in improving student self-confidence (Safitri et al., 2024) and indeed developing these meta-cognitive skills (Wang et al., 2024). This experiential learning method not only improves practical skills but also enables the application of academic

ideas in real-world contexts. It reflects workplace requirements, fostering time management and flexibility while enhancing motivation via concrete relevance.

This creation process necessitates collaborative efforts among learners to find solutions to challenges during knowledge integration, application, and construction. Instructors and community members, typically as facilitators, offer assistance and evaluation to enhance learners' educational experiences.

The approach that conceptually converges with PBL here is Peer Learning, a natural approach as old as humanity itself but which can be defined as "the acquisition of knowledge and skill through active helping and supporting among status equals or matched companions. It involves people from similar social groupings who are not professional teachers helping each other to learn and learning themselves by so doing" (Topping, 2007). This approach promotes learners to exchange views, provide comments, and assist one another's growth. Students acquire many views in collaborative settings, enhancing their capacity to express ideas while solidifying their comprehension via instruction. This approach cultivates leadership abilities and self-sufficiency by using collective knowledge. It appears to positively influence students' feelings of social isolation, enabling them to more effectively confront challenges within a secure and non-threatening educational environment (Christiansen & Bell, 2010).

Contemporary peer learning has progressed beyond the antiquated approach of using high-achieving students as surrogate educators. It currently emphasizes matching learners of comparable ability to foster reciprocal cognitive challenges. This method acknowledges that peer connections are fundamentally distinct from conventional teacher-student relationships. Encouraging "learning by teaching" benefits both participants, with the facilitator acting as a relevant role model. This transition optimizes cognitive benefits for all participants and cultivates a more interactive, cooperative educational atmosphere (Carvalo & Carlos, 2020).

The peer learning concept is a solution to mitigate challenges at universities and institutions, where the availability of preceptors and the quality of mentorship remain insufficient; furthermore, supervisors are not consistently present during clinical practice (Zhang & Bayley, 2019).

3. Methodology

Having briefly reviewed these two selected concepts; this study adopts an exploratory mixed method approach based on quantitative and qualitative analyses. The research refers to a project-based learning activity, developed by a London University as part of its MBA programme, to assess the influence of the virtuous learning cycle on educational results. In the module, students are assigned to a real business case that a partner company has developed in collaboration with the teaching team and working in direct collaboration with the business partner, they must

develop and present solutions to solve the issue. The students receive training at the beginning of the project and continuous support in the developing of the solution both by the university and the business partners. The digital tools utilized have been Moodle and Microsoft Teams.

The learning design, aligned to the learning outcome of the EWP module, includes two main data collecting strategies; a survey addressed to students enrolled in the MBA EWP program and semi-structured interviews with representatives from collaborating firms. This dual approach enables an extensive examination of viewpoints from both students and business domains.

The questionnaire aimed to assess students' opinions of the effectiveness of the project-based learning experience in fostering pragmatic abilities relevant to modern job requirements. The semi-structured interviews had two objectives: to analyze the effectiveness of project-based teaching methods and to evaluate the feasibility and possible advantages of integrating peer-learning strategies into the educational framework. Four semi structured interview were answered in January 2025 and 57 students fully answered the survey, relative to the 23/24 A/Y.

Semi-structured interviews are a widely used qualitative research method that combines predetermined open-ended questions with the flexibility to explore topics in greater depth (Lochmiller, 2021. Naeem et al., 2023). This approach allows researchers to guide the conversation while giving participants freedom to express their views and experiences (Qu & Dumay, 2011).

The data collected were transcribed and analysed using Leximancer software. Leximancer is an advanced text analytics software that employs machine learning techniques to conduct automated content analysis of qualitative data. It uses co-occurrence information to perform semantic and relational analyses of text corpora, identifying key concepts, themes, and their interrelationships (Biroscak et al., 2017).

Leximancer's thematic analysis capability is particularly noteworthy. The software automatically extracts main themes from the text and visually represents them in concept maps, providing researchers with a comprehensive overview of the data. These concept maps display themes as coloured circles, with the size and colour intensity indicating the theme's relative importance. Within these themes, Leximancer identifies, and groups related concepts, represented as smaller dots connected by lines to show their relationships (Gkevrou & Dimitrios, 2022).

4. Findings

The survey results indicated a degree of consensus on the programme's efficacy across essential parameters. Participants consistently reported that experiential learning activities markedly increased their acquisition of practical, industry-relevant abilities, indicating a heightened

capacity to tackle real-world professional issues. Respondents emphasized faculty members' expertise in integrating theoretical frameworks with practical applications, especially acknowledging instructors' ability to interpret academic ideas within real-world commercial situations.

Participants saw quantifiable enhancements in problem-solving agility and collaborative cooperation skills, explicitly linking these advancements to the program's experiential approach. Respondents noted that the incorporation of peer-learning dynamics enhanced their adaptation to intricate professional settings, while confirming the program's efficacy in simulating genuine workplace requirements via its practice-oriented framework with an outstanding 100% satisfaction in knowledge development. The results confirm the programme's relevance to current business challenges, demonstrating its effectiveness in developing career-ready graduates via experiential and collaborative teaching methods. The total student satisfaction percentage for the EWP module for the 23/24 academic year was recorded at 93.7%.

The semi-structured interview methodology included seven main questions on the project experience, the student contributions to corporate goals, the participants' skills development, and the program's educational method. The interview also sought recommendations for project enhancements and assessed Peer-learning potential. This systematic methodology examined the program's industrial effect and the viability and potential benefits of peer-learning methodologies in education. The method was ideal for collecting rich, detailed qualitative data on participants' thoughts, feelings, and experiences (Kallio et al., 2016) and allowing for the exploration of emergent themes and unexpected responses through follow-up questions (Carruthers, 1990). This strategy was essential for getting detailed project perspectives from corporate representatives. The examination of comments about students' competencies used in the project indicated mostly favourable replies from host businesses (fig. 1).

Three key topics emerged from the analysis: The first is the Student-Focused Methodology; the host businesses exhibited recognition of the project's academic foundations and recognized their involvement in partnering with the university to enhance students' competencies. The second is Diversity as a Resource; the varied student population of the university was emphasized as a notable asset. One interviewee remarked: "When a diverse group of individuals from various regions of the world convene, they collaborate in groups, each contributing their own insights, (..) and they present particular ideas and solutions". Finally the Skill Development; the host organizations recognized students' current talents but noted that more training was essential for the efficient application of these competencies in a professional setting.

After this debate, the interview examined the prospective integration of Peer-learning with the conventional project-based approach (fig. 2).

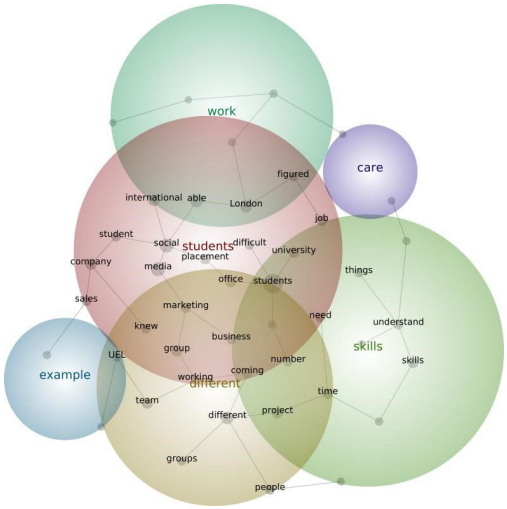


Figure 1. Thematic analysis: students owning skills. Source: our elaboration.

The suggestion for peer-to-peer learning garnered fervent support. Host businesses envisioned this as learning via exemplification, with theme analysis suggesting it as a feasible and advisable improvement to the program. One commenter emphasized: "Indeed, the mentorship is exceptional." I would advocate including peer-to-peer learning for students from such background, since it enhances their learning speed more effectively than traditional instruction.

This response indicates that integrating Peer-learning may substantially improve the efficacy of the Project-based learning method, possibly expediting skill acquisition and information dissemination among students. One interviewee remarked: “The mentorship is fantastic. I think I would recommend having a student from there (the University) to build (the new student knowledge) because that will accelerate the way they learn, and peer-to-peer learning is faster than having somebody coming and teaching.”

The interview data also demonstrated a clear benefit of incorporating peer learning into project work: increased scalability. Respondents said that this method might allow for more student participation without increasing the burden on industry and university resources. Furthermore, respondents felt that peer-learning might possibly improve the learning experience for learners. Participants may benefit from varied viewpoints and collaborative problem-solving by drawing on their peers' expertise and experiences, improving their skill development and project results.

5. Conclusion

This paper lends weight to the significance of incorporating project-based learning and peer-to-peer interactions to establish a beneficial learning cycle and prepare students for today’s business environment. Initial data suggest that the integration of project-based and peer-to-peer

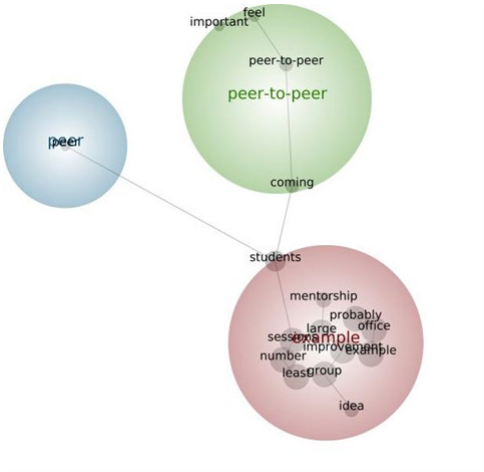


Figure 2. Thematic analysis: Peer-learning. Source: our elaboration

learning markedly could improve student engagement and satisfaction as well as develop the sought-after meta-skills. Peer learning could enhance project-based learning by promoting cooperation among participants. Especially in an MBA programme, where diverse backgrounds and experiences intersect, systematic peer-to-peer interactions has the potential to enhance the learning experience, allowing students to access fresh perspective on business challenges.

The MBA EWP case illustrates that this strategy has the potential to enhance educational outcomes and equip students with the meta-skills they need in professional life. Moreover, the scalability of the project-work learning integrated with the peer-learning is particularly valuable for expanding educational initiatives while maintaining efficiency.

References

Barber, S. (2018). A truly 'transformative' MBA: executive education for the fourth industrial revolution. Journal of Pedagogic Development, 8(2), 44-55.

Bhatti, M. A., Alyahya, M., Alshiha, A. A., Qureshi, M. G., Juhari, A. S., & Aldossary, M. (2022). Exploring business graduates' employability skills and teaching/learning techniques. *Innovations in Education and Teaching International, 60*(2), 207-217. https://doi.org/10.1080/14703297.2022.2049851

Biroscak, B. J., Scott, J. E., Lindenberger, J. H., & Bryant, C. A. (2017). Leximancer software as a research tool for social marketers. *Social Marketing Quarterly, 23*(3), 223-231.

Boss, S. (2013). *PBL for 21st century success: Teaching critical thinking, collaboration, communication, and creativity*. Buck Institute for Education.

Brundiers, K., & Wiek, A. (2013). Do we teach what we preach? An international comparison of problem-and project-based learning courses in sustainability. *Sustainability, 5*(4), 1725-1746. https://doi.org/10.3390/su5041725

Carruthers, J. (1990). A rationale for the use of semi-structured interviews. *Journal of Educational Administration, 28*(1). https://doi.org/10.1108/09578239010006046

Carvalho, A. R., & Santos, C. (2021). Developing peer mentors' collaborative and metacognitive skills with a technology-enhanced peer learning program. *Computers and Education Open*, 3, 100070. https://doi.org/10.1016/j.caeo.2021.100070

Christiansen, A., & Bell, A. (2010). Peer learning partnerships: Exploring the experience of pre-registration nursing students. *Journal of Clinical Nursing, 19*(5-6), 803-810.

García-Álvarez, J., Vázquez-Rodríguez, A., Quiroga-Carrillo, A., & Priegue Caamaño, D. (2022). Transversal competencies for employability in university graduates: A systematic review from the employers' perspective. *Education Sciences*, 12(3), 204. https://doi.org/10.3390/educsci12030204

Gkevrou, M., & Stamovlasis, D. (2022). Illustration of a software-aided content analysis methodology applied to educational research. *Education Sciences, 12*(5), 328. https://doi.org/10.3390/educsci12050328

Goulart, V. G., Liboni, L. B., & Cezarino, L. O. (2021). Balancing skills in the digital transformation era: The future of jobs and the role of higher education. *Industry and Higher Education*, 36(2), 118-127. https://doi.org/10.1177/09504222211029796

Kallio, H., Pietilä, A.-M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: Developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing, 72*(12), 2954-2965. https://doi.org/10.1111/jan.13031

Krajcik, J., & Shin, N. (2023). Student conceptions, conceptual change, and learning progressions. In *Handbook of research on science education* (pp. 121-157). Routledge.

Lochmiller, C. R. (2021). Conducting thematic analysis with qualitative data. *The Qualitative Report, 26*(6), 2029-2044. https://doi.org/10.46743/2160-3715/2021.5008

Naeem, M., Ozuem, W., Howell, K., & Ranfagni, S. (2023). A step-by-step process of thematic analysis to develop a conceptual model in qualitative research. *International Journal of Qualitative Methods, 22*. https://doi.org/10.1177/16094069231205789

Pengyue, G., Saab, N., Post, L. S., & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. *International Journal of Educational Research, 102*, 101586. https://doi.org/10.1016/j.ijer.2020.101586

Qu, S. Q., & Dumay, J. (2011). The qualitative research interview. *Qualitative Research in Accounting & Management, 8*(3), 238-264.https://doi.org/10.1108/11766091111162070

Safitri, R., Wahyuri, A.S. and Ockta, Y., 2024. The Impacts of the Project-Based Learning and Problem-Based Learning Models with Self-Confidence on Students' Learning Outcomes. *Indonesian Research Journal in Education*| IRJE|, 8(1), pp.269-283.

Snoke, R. L. (2004). *Generic attributes of Australian information systems graduates: An empirical study* (Doctoral dissertation, Queensland University of Technology).

Topping, K. J. (2005). Trends in peer learning. *Educational Psychology, 25*(6), 631-645.

Wang, C.Y., Gao, B.L. and Chen, S.J., 2024. The effects of metacognitive scaffolding of project-based learning environments on students' metacognitive ability and computational thinking. *Education and Information Technologies*, *29*(5), pp.5485-5508.

Zhang, Z., & Bayley, J. G. (2019). Peer learning for university students' learning enrichment: Perspectives of undergraduate students. *Journal of Peer Learning, 12*(5), 61-74.

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Service-Learning in Finance: Enhancing Financial Advisory Education through Community-Oriented Learning in Higher Education

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Abstract

This study examines the implementation of service-learning methodology in finance courses at the Public University of Navarre. The research focuses on a challenge where students create educational videos on financial literacy for a non-specialized audience, integrating knowledge from four specialized courses. The aim was to enhance students' understanding of financial concepts while developing crucial skills. Results show high average grades in the challenge and positive student feedback, indicating the effectiveness of this approach in deepening subject knowledge and connecting academic content to real-world applications. The study concludes that service-learning in finance education significantly contributes to students' skill development, particularly in teamwork, information management, and creativity, while simultaneously addressing community needs for financial literacy.

Keywords: *Service-learning; Finance education; Financial literacy*

1. Introduction

Service-learning is an educational approach that combines teaching and learning with community service. It is based on the idea that students acquire knowledge and skills more effectively when they have the opportunity to apply what they are learning in real-world contexts while contributing to the well-being of the society (Bringle & Hatcher, 1995).

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The aim of this paper is twofold: first, to provide other instructors with a practical guide on how to implement this methodology in a finance course, and second, to present the outcomes in terms of student satisfaction and academic performance.

The underlying ideas of this methodology trace back to educational philosophers who emphasize the importance of learning through experience, reflection, and interaction with the environment (Dewey, 1933 and 1938), principles that have been incorporated into the practice of service learning. However, the term "service-learning" was first coined in 1967 by Robert Sigmon and William Ramsey at the Southern Regional Education Board (Giles & Eyler, 1994). At the end of this decade, service learning as a concept in American higher education began, initially linked to internship programs that combined academic credit with community service projects, and later, in the 1980s and 1990s, gained prominence by distinguishing itself from general community service through its integration of service with academic study (Kenny & Gallagher, 2002).

There are many recent examples of the application of this methodology in university business education studies. For instance, in the U.S., Moran (2024) proposes a project for accounting students that involves analyzing the financial statements of nonprofit organizations. Another, proposal in Spain is that of García-Álvarez and Teijeiro-Álvarez (2018), who explain the implementation of a service-learning project in the course "Economic Analysis of Organizations" in the dual degree program in Business Administration and Law at the Universidade da Coruña. The project involved creating reports addressing issues faced by a specific company, whose employees were characterized by a certain degree of disability.

Marco-Gardoqui et al. (2020) provides a systematic review of the benefits of service-learning methodology in business schools, highlighting its positive impact on students' personal, social, academic, and civic development. Additional advantages are increased learning and practical experience for students, civic engagement, and the reciprocal relationship between the campus and the community, institutional satisfaction, and civic literacy, increased social responsibility and civic leadership among students, a deeper understanding of course content, and the improvement of community life through awareness and problem-solving skills (Chow et al., 2024; Marco-Gardoqui et al., 2020; Salam et al., 2019; Yorio & Ye, 2012). This is in line with the philosophical roots of service learning, which emphasize the importance of connecting academic learning with community service to foster civic engagement and social responsibility (Harkavy & Hartley, 2010). However, the integration of service learning into higher education faces challenges such as insufficient educator capacity, funding, and varying educator attitudes towards its implementation (Álvarez-Vanegas, 2024).

In this paper, we present the application of service-learning methodology in four elective finance courses of the Bachelor's degree in Business Administration and Management (BA&M), the degree in Economics (E), and the double degree in Business Administration and Economics

(BA&E) at the Public University of Navarre (UPNA). Additionally, we will show the main results of its application regarding the qualifications obtained and the responses from past student surveys about their experience with this methodology. This implementation is part of a project of educational innovation in the Financial Economics area, supported by the Public University of Navarre, which involved the application of service-learning in the courses of the Financial Advisory Specialization (FAS).

2. Applying service-learning in finance

2.1. Context

The FAS provides final-year students with specialized knowledge in finance, building on the multidisciplinary business foundation they have acquired in previous years. This specialization focuses on financial advisory, a key field in the globalized environment, which offers opportunities both in the corporate sector and for independent entrepreneurship. To complete the specialization, students must enroll in four courses: *Derivatives Financial Assets*, *Banking and Insurance Operations*, *International Finance*, and *Entrepreneur and Taxation*. These courses cover everything from the management of various specialized financial products such as those traded in fixed and variable income markets, derivatives, currencies, and other banking and insurance products, to the impact of taxation on individuals. The specialization aims to train specialists in the comprehensive analysis of the financial and fiscal landscape for individuals and businesses in a globalized environment.

The specialization is structured around the completion of a *challenge*, as can be seen from Figure 1. Through the execution of the *challenge*, students will integrate the knowledge gained in the four courses, providing a holistic view of the roles and functions of a financial advisor. Additionally, the project will help them develop transversal skills, such as teamwork, autonomy, proactivity, creativity, and communication, which are highly valued by companies.

2.2. The *challenge*

As previously mentioned, the specialization is structured around a challenge, which follows the Service-Learning methodology. However, it is important to emphasize that not all students participating in the challenge belong to the specialization. In other words, there may be students who are taking only one of the four subjects, in which case they would complete the challenge solely for the subject they are enrolled in. This allows us to distinguish later in the analysis between students with a greater (FAS students) or lesser (non-FAS students) preference for financial topics.

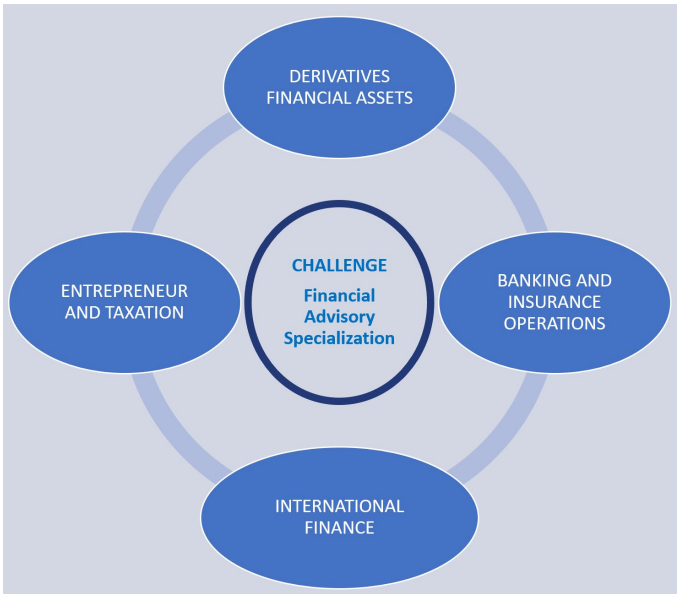


Figure 1. Financial Advisory Specialization and Challenge.

Specifically, the challenge involves creating an informational video on financial education, similar to the informative videos that can be found from the Bank of Spain, aimed at a non-specialized audience. To do this, the financial and fiscal knowledge acquired in the four courses will be used as a foundation. To complete this challenge, students will work in teams of 3 or 4 people. First, students will have a regular class period during which they will acquire the necessary knowledge to later tackle the challenge. In the second phase, students will have work to do outside the classroom to address the challenge. Finally, the students must present the video they have created and answer the questions from the instructor about the material presented.

This challenge aligns with the service-learning methodology by integrating academic learning with meaningful service to the community. The task of creating an educational video on financial literacy for the general public allows students to apply the knowledge they've gained in their courses to a real-world project that addresses a social need—improving financial understanding. The challenge incorporates active learning, as students use their theoretical knowledge in a practical setting; community service, as the video aims to benefit the wider public; collaboration, through team-based work; and reflection, with students being evaluated on both their work and their understanding of the material.

The evaluation of the challenge will be non-recoverable and will account for 20% of the grade in each of the subjects involved in the program. In table 1 we present the rubric used to evaluate the challenge.

Table 1. Rubric for Challenge Assessment

Understanding and Relevance of the Content (2 points)
The video addresses relevant topics related to the course content. A deep understanding of the content covered in the video is demonstrated. The video promotes the integration of aspects related to the SDGs, presenting elements associated with what is known as green finance and/or green taxation.
Educational Value (2 points)
The video provides useful information that the target audience can apply in their daily lives. Concrete and applicable examples related to everyday personal finance situations are provided. The language used is appropriate for the general public and avoids complex financial jargon.
Creativity and Originality (2 points)
The video uses visual elements, graphics, or examples that enhance understanding of the topic. The approach of the video demonstrates an innovative perspective on financial education.
Technical Quality of the Video (2 points)
The audio quality is clear, with no interference that hinders the understanding of the message. The video quality is adequate, and the visual elements are sharp and well-presented. The information is presented in a structured and easy-to-follow manner. The video duration is appropriate to cover the content thoroughly and effectively.
Oral Interaction (2 points)
The responses are clear, coherent, and demonstrate a strong grasp of the concepts presented in the video. The group provides additional examples or practical applications of the concepts discussed in the video. There is active participation from all group members during the question-and-answer session.

3. Results

3.1. Qualifications

The survey conducted with students about their experience with the challenge, which we will discuss in more detail later, indicates that on average, students dedicated approximately 5 hours of out-of-class work per week to complete the challenge. This dedication has resulted in an average grade of the challenge across the four subjects of 7.6, as shown in Table 2.

We observe differences in the grades across the four subjects, as well as between students who belong to the specialization and those who do not. As expected, in three of the four subjects, the results for the group of students more focused on financial topics (FAS students) are significantly higher than those of the group less focused (non-FAS students). Overall, these grades are considerably higher than the grades students typically achieve through traditional exams.

Table 2. Average grade of the challenge by subject

Subject	Number of Students	All students	FAS students	Non-FAS students	Difference of mean test
Banking and Insurance Operations	43	7.6	8.7	6.8	5.21***
Derivatives Financial Assets	40	8.1	9.0	7.4	3.80***
International Finance	38	7.7	8.5	7.0	3.77***
Entrepreneur and Taxation	23	7.7	7.8	7.4	1.48
All	**63**	**7.6**	**8.5**	**7.2**	4.36***

3.2. Students' survey

To gather the opinions of the 63 students involved in the challenge, they were surveyed about their experience with the implementation of the service-learning methodology after completing the challenge. The aggregated results are presented in Table 3, with a response rate of 65%, using the following scale: 1. Not at all, 2. A little, 3. To a great extent, 4. Quite a bit.

Table 3. Survey on Students on their Experience with the Service-learning Methodology

Survey Questions: To what extent has the service learning (challenge) methodology…					
	Not at all	**A little**	**To a great extent**	**Quite a bit**	**Average**
… been helpful in improving your teamwork skills?	0.0%	28.6%	57.1%	14.3%	2.9
… been helpful in improving your information management skills?	2.4%	35.7%	40.5%	21.4%	2.8
… been helpful in improving your oral communication skills?	0.0%	45.2%	42.9%	11.9%	2.7
… been helpful in improving your innovation and creativity skills?	2.4%	28.6%	47.6%	21.4%	2.9
… surpassed traditional teaching as a learning method?	2.4%	31.0%	47.6%	19.0%	2.8
… helped you deepen your knowledge of the subject?	4.8%	35.7%	28.6%	31.0%	2.9
Would you recommend the service-learning methodology in university studies?					
Yes			**No**		
71%			29%		

Overall, more than 60% of students express optimistic results. In conclusion, we can say that the service-learning methodology has significantly contributed to enhancing skills such as teamwork, information management, oral communication, and innovation and creativity. Many students believe that this methodology substantially outperforms more traditional approaches and has helped them deepen their knowledge of the subjects. Additionally, it was found that 71% of the students would recommend this methodology for university studies.

They were also asked about the strengths and weaknesses of this methodology. The main advantage of the service-learning methodology, according to students, is the promotion of

teamwork and the ability to connect academic content with real-life situations, fostering a more dynamic, practical, and self-directed learning experience. While the main disadvantage is the significant amount of time and effort required for video creation and editing, which often detracts from focusing on the content and in-depth understanding of the subject matter.

4. Conclusions

In conclusion, the implementation of service-learning methodology in finance courses at the Public University of Navarre has demonstrated significant benefits for students' learning experiences and skill development. The challenge of creating educational videos on financial literacy not only enhanced students' understanding of complex financial concepts but also fostered crucial skills such as teamwork, information management, oral communication, and creativity. The high average grades achieved in the challenge, coupled with positive student feedback, indicate the effectiveness of this approach in deepening subject knowledge and connecting academic content to real-world applications. While students acknowledged the time-intensive nature of the project as a potential drawback, the majority would recommend this methodology for university studies, highlighting its superiority over traditional teaching methods. This successful integration of service-learning in finance education aligns with broader research findings on the positive impacts of such methodologies in business schools, including enhanced personal, social, academic, and civic development. Moving forward, this approach shows promise in preparing finance students for the complexities of their future professional roles while simultaneously contributing to society financial literacy.

References

Álvarez-Vanegas, A., Ramani, S., & Volante, L. (2024). Service-Learning as a niche innovation in higher education for sustainability. *Frontiers in Education*. https://doi.org/10.3389/feduc.2024.1291669.

Bringle, R. G., & Hatcher, J. A. (1995). *A service learning tutorial: Video and instruction guide*. Indiana University-Purdue University Indianapolis.

Chow, Y. T. H., Lam, Y. C. A., Lau, M. M., Yuen, S. S. M., & Chin, I. O. K. (2024). Service learning in business education: Expectations and reality. *The Asian Conference on Education & International Development 2024 Official Conference Proceedings*, 573–586. https://doi.org/10.22492/issn.2189-101X.2024.46.

Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process*. D.C. Heath and Company.

Dewey, J. (1938). *Experience and education*. Macmillan.

García-Álvarez, M. T., Teijeiro-Álvarez, M. (2018). Diseño y puesta en marcha de un proyecto de Aprendizaje y Servicio en Análisis Económico de las Organizaciones. En E. de la Torre Fernández (ed.) (2018). Contextos universitarios transformadores: retos e ideas innovadoras.

II Xornadas de Innovación Docente. Cufie. Universidade da Coruña (pág. 169-182). DOI http://hdl.handle.net/2183/20732.

Giles, D. E., Jr., & Eyler, J. (1994). The theoretical roots of service-learning in John Dewey: Toward a theory of service-learning. *Michigan Journal of Community Service Learning, 1*(1), 7-26.

Harkavy, I., & Hartley, M. (2010). Pursuing Franklin's Dream: Philosophical and Historical Roots of Service-Learning. *American Journal of Community Psychology*, 46, 418-427. https://doi.org/10.1007/s10464-010-9341-x.

Kenny, M.E., Gallagher, L.A. (2002). Service-Learning: A History of Systems. In: Kenny, M.E., Simon, L.A.K., Kiley-Brabeck, K., Lerner, R.M. (eds) Learning to Serve. Outreach Scholarship, vol 7. Springer, Boston, MA. https://doi.org/10.1007/978-1-4615-0885-4_2

Marco-Gardoqui, M., Eizaguirre, A., & García-Feijoo, M. (2020). The impact of service-learning methodology on business schools' students worldwide: A systematic literature review. *PLOS ONE, 15*(12), e0244389. https://doi.org/10.1371/journal.pone.0244389.

Moran, W. (2024). Integrating academic service learning into higher education business curriculum. *Journal of Management and Business Education*, *7*(1), 116–136. https://doi.org/10.35564/jmbe.2024.0007.

Salam, M., Awang Iskandar, D. N., Ibrahim, D. H. A., & Farooq, M. S. (2019). Service learning in higher education: a systematic literature review. *Asia Pacific Education Review, 20*(4), 573–593. https://doi.org/10.1007/s12564-019-09580-6.

Yorio, P. L., & Ye, F. (2012). A meta-analysis on the effects of service-learning on the social, personal, and cognitive outcomes of learning. *Academy of Management Learning & Education, 11*(1), 9–27. https://doi.org/10.5465/amle.2010.0072.

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Project-Based Learning versus traditional methods in empirical subjects in Finance and Economics

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Abstract

This research compares Project-Based Learning (PBL) with Traditional Practices (TP) in empirical Finance and Economics courses at the Faculty of Economics and Business Studies, Universidad Complutense de Madrid. The experience specifically focused on two subjects: Empirical Analysis of Financial Markets and Econometrics, with 66 and 64 students enrolled, respectively. PBL emphasizes real-world tasks and the development of skills such as analytical reasoning, communication, collaboration, and autonomy. The study examines both student and lecturer perceptions regarding learning outcomes, academic performance, and associated challenges. The findings indicate that PBL boosts engagement, teamwork, and practical competencies but it also increases instructor workload, faces student resistance, and highlights possible gaps in foundational knowledge. Successful PBL implementation requires careful planning to maximize benefits and address challenges.

Keywords: *Project-based learning; Active learning; Students projects; Students engagement; Learning motivation; Empirical task.*

1. Introduction

This work examines the effectiveness of Project-Based Learning (PBL) versus Traditional Practices (TP) in empirical subjects. It assesses students' perceptions of learning, skills, and competencies while evaluating the advantages of PBL over traditional methods from both lecturers' perspectives and student academic outcomes.

The learning experience has been implemented in two subjects on quantitative methods (statistics and econometrics) with an empirical focus, one in the Degree in Finance, Banking and Insurance, FBI (Empirical Analysis of Financial Markets, EAFM) and the other (Econometrics) taught jointly in the Degree in Business Administration and Management (ADE) and the Double Degree in Law and Business Administration and Management (D-ADE),

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in the Faculty of Economics and Business Studies at Universidad Complutense de Madrid. Both are empirical subjects insofar as they consist not only of the presentation of quantitative methods for economic and financial analysis but also of the development of applications of these methods in the analysis of real-world data. Both focus on their usefulness in using data to test purely theoretical models and hypotheses. They require collecting economic and financial information from various sources to perform quantitative analysis to test economic theories, estimate relationships between variables, and forecast economic trends, thus improving decision-making based on concrete evidence rather than abstract theory.

These subjects require significant student effort and maturity to understand theoretical concepts and quantitative tools for real-world applications. The empirical projects help students see how quantitative methods are used in data analysis. The main difference between traditional and problem-based learning (PBL) projects is that PBL projects are student-designed based on their interests and focus on results. This method addresses problems economists, managers, and financial market agents face. Thus, we believe PBL enhances engagement and motivation, making it ideal for these subjects. We propose to assess whether students and instructors share this view.

The goal is to expose students to two distinct methodologies for empirical projects. TP and PBL have similarities; both aim for students to solve real data problems using quantitative tools in teams. The main difference lies in the roles of students and lecturers in task design, development, and evaluation. In TP, the lecturer directs the process: informing students what to do, providing materials, and evaluating outcomes. Students take a passive role, valuing the practice based on the grade needed to pass. Conversely, PBL centers on active student involvement in task design, with the lecturer acting as a supervisor and guide to ensure project success is viable.

The next objective is to evaluate the experience by gathering data on assessments from students and lecturers. This includes students' subjective learning evaluations for each project, the objective impact on academic results, and lecturers' overall assessments. Information was collected using evaluation questionnaires. Based on the data analysis, the final objective is to describe the experience, present student and lecturer assessments, and draw key conclusions.

The remainder of the paper is structured as follows. Section 2 reviews PBL literature to frame the study. Section 3 describes the methodology, and Section 4 details the results from student and lecturer perspectives. Section 5 concludes by highlighting the unresolved open questions.

2. Motivation

PBL is an active learning method to enhance students' problem-solving and critical-thinking skills (Chen, C. H. and Yang, Y. C., 2019; Guo et al., 2020; Andrés et al., 2022; Martínez

Casanovas et al., 2022). This student-centered approach promotes autonomy by fostering investigation, collaboration, communication, and reflection through practical exercises mimicking real-world situations (Alorda et al., 2011). PBL boosts students' motivation and engagement; although motivation stems from content, it ignites interest and encourages active learning in concrete projects. Krajcik and Blumenfeld (2006) state that PBL involves posing a question or problem, focusing on skill acquisition as a learning objective, ensuring proactive student participation, promoting collaboration, leveraging technology, and creating tangible products.

PBL resembles scientific research through problem-solving and creative collaboration. A key aspect is creating a final product that shows students' understanding of the topic. Wurdinger et al. (2007) note that as students design their projects, they encounter cognitive challenges and enjoy a level of freedom, leading to strong engagement. They gain self-reliance via goal setting, planning, and organization, enhance collaborative skills through social learning, and become intrinsically motivated by making decisions at their own pace (Bell, 2010).

The lecturer should create effective learning scenarios and serve as a guide rather than just transmitting knowledge. PBL success relies on the lecturer's ability to organize learning, motivate, support, and guide students, helping to reduce their cognitive load (Hmelo-Silver et al., 2007). He must discuss the project's purpose, assist in setting clear objectives, and decide on the pace and sequence of work (Helle et al., 2006).

3. Methodology

The methodology has focused on two main objectives: designing and implementing the learning experience, designing assessment questionnaires, and collecting and analyzing data. Figure 1 shows the steps followed in designing both types of empirical projects. It clearly shows that the difference lies in the degree of student involvement and level of responsibility, as TP is fully lecturer-directed. In all cases, the project is developed by a group of students. In the case of the PBL practice, under the lecturer's supervision, the group decided on the tasks to be carried out for each team member and the schedule to meet the required timing.

The methodology used to evaluate the learning experience was subject-specific questionnaires designed to collect the students' assessments using a Likert scale implemented through Google Forms. The student assessment questionnaires were designed in such a way as to state the students' views on the following clearly:

- The importance of PBL practice in the acquisition of competencies.
- The role of PBL practice in the improvement of subject knowledge.
- The importance of the different aspects relevant to the project's design.
- The assessment of the role played by the lecturer in the development of the project.

- The assessment of PBL methodology versus traditional practices.
- Other information they consider relevant.

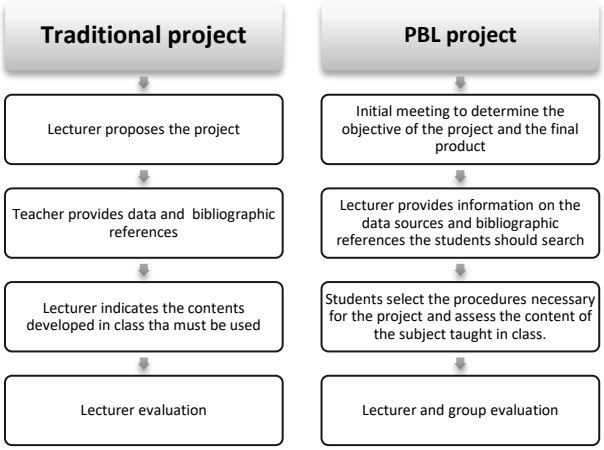


Figure 1. Project overview.

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- The importance of PBL practice in the acquisition of competencies.
- The role of PBL practice in the improvement of subject knowledge.
- The importance of the different aspects relevant to the project's design.
- The assessment of the role played by the lecturer in the development of the project.
- The assessment of PBL methodology versus traditional practices.
- Other information they consider relevant.

The lecturers' opinions and assessments have been collected through personal interviews, aimed at obtaining an overall assessment of the experience and its impact on the development of the course and on the attitude, performance, and results of the students.

4. Implementation of the learning experience and results

In all cases, participation in the empirical projects was voluntary. Students worked in groups of up to three members. Depending on their performance, the project could contribute up to one point to their final course grade. Table 1 displays the project titles, and the student participation rates by project type and subject.

It is worth noting that the voluntary nature of the activity may introduce potential selection bias, as only students with intrinsic motivation for the subject might choose to participate. This appears particularly concerning for EAFM, where only 30% of the projects were returned, while Econometrics shows a less pronounced pattern with a 75% submission rate.

Table 1. Empirical projects developed.

Subject	Title	Reception by students
EAFM		
TP	Estimating and testing the CAPM asset pricing model.	66 students enrolled/47 followed the course.
PBL	Valuation of interest rate variation scenarios to contribute to the Basel Committee's proposal.	There was an initial positive reception. Only 30% returned the projects.
Econometrics		
TP	Design a strategy to identify personal characteristics that affect health at birth and propose measures to increase it.	64 students enrolled/45 followed the course. There was an initial positive reception.
PBL	Study of birth weight depending on socio-economic characteristics of the family and the mother's habits.	75% returned the projects.

Delving deeper into the differences between the PBL projects and the TP, in the latter, students were provided with a complete bibliography related to the problem to be addressed, along with a previous example in which the task was nearly solved by the instructor during a seminar-type session.

In the case of Econometrics, the TP approach involved a practical example drawn from the recommended textbook for the course. For EAFM, the CAPM asset pricing estimation had already been covered using different data than that used in the TP assignment.

In contrast, for the PBL assignments, students were required to independently search for relevant literature to support their decisions and justify their actions. In Econometrics, for instance, students had to explore the literature on birth weight over recent decades and develop an estimation model based on their findings. They were expected to gather appropriate data, compare their results with those in the literature, and present a report summarizing their key findings, similar in format to a research paper.

For EAFM, students were asked to take the role of advisors to the Basel Committee legislators, drafting a formal letter evaluating the consequences of proposed legislation under various economic scenarios. To do so, they had to collect relevant data, carry out necessary estimations, and structure their letter as a real advisor would.

4.1. Results of students' assessment

The results concerning the improvement in the acquisition of competencies are:

- The competencies identified from the students' responses as most developed by PBL practice are problem-solving, teamwork, time management, and leadership.
- Students felt that the PBL exercises did not particularly contribute to developing Synthesis Skills, Oral Communication skills, Writing Skills, and Creativity.

Concerning knowledge of the subject, most students consider that the PBL practice has increased their interest in the subject, helped them understand its importance in their training, and calibrated the subject difficulty. Evaluating their attitude towards the project, the majority opinion is that they have found it interesting, that it has allowed them to learn the subject better, more than with other types of tasks, and that it has increased their interest in the subject. They consider that they have made good use of the time spent, although they do not consider it fun. Regarding the characteristics of the tasks, the majority are very satisfied with the aspects related to the formation of the groups and the interactions between their components. However, this opinion is not so unanimous regarding the distribution of tasks or the involvement of the members. Again, the opinion unanimously confirms that they would not have done better in individual work. The assessment of the lecturer's role in developing the empirical project also generates unanimity, valuing his role in the initial stage, providing accurate information to the students to carry out the empirical project, and his role as supervisor throughout the process. Finally, the students have a good or very good general assessment of the PBL practice and its role in the active learning of the subject; they are satisfied with the result obtained and would recommend using this methodology in other subjects.

4.2. Results of lecturers' assessment

Lecturers were interviewed about PBL practices versus traditional methods, costs to lecturers, practical implementation, and effects on academic results. They unanimously consider that PBL practices should encourage students to acquire and apply their knowledge to solve complex real-life problems with tangible results, enabling them to gain a deeper understanding of the subjects in question and lasting knowledge. However, they recognize that they pose a significant challenge for students, which impacted the implementation of this project.

PBL requires significant time investment for designing projects that integrate learning objectives, promote inquiry, develop problem-solving skills, and provide supervision and continuous feedback. However, students show some resistance to change, resulting in participation below expectations, as PBL demands personal responsibility for learning and adjustments in study habits. Many students prefer traditional methods and lack essential prior knowledge, particularly from the FBI grade. Additionally, their attitude isn't conducive to activities needing theoretical, practical, and reflective skills.

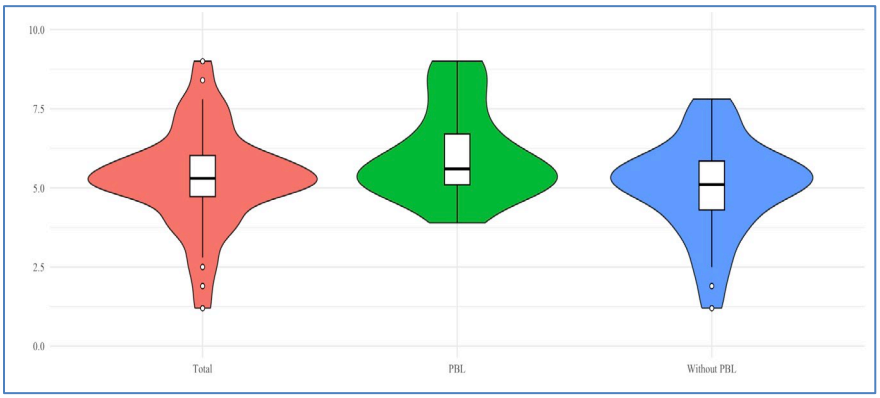


Figure 2. Academic performance by group of students: PBL vs not PBL.

Lecturers lack a definitive stance on academic results but noted that participants' final grades exceeded the group average. Figure 2 compares results between PBL participants and non-participants in EAFM using a violin plot, illustrating the distribution of marks. The median is slightly higher for PBL participants, with their marks skewed towards the upper tail, in contrast to the lower tail for non-participants, indicating superior performance. Additionally, both maximum and minimum grades are higher for PBL participants, suggesting a positive impact on their academic results.

Lecturers expected higher involvement of students, as PBL proposals were designed as real professional exercises, pushing to the limit of students' previous knowledge base. On the other hand, voluntary participation may have biased the results. Participants may have characteristics related to good performance, such as higher motivation, communication skills, teamwork skills, or prior knowledge. Finally, they consider that to overcome the problems detected, this type of practice should be given more importance, making it compulsory. This would thus overcome their resistance to change and their insecurities. It would also allow for a more effective evaluation of their usefulness in improving students' academic performance.

5. Conclusions

This project has allowed us to prove that PBL is an innovative educational methodology with great potential to transform the way students learn. It encourages active learning, collaboration, critical thinking, problem-solving, and the application of knowledge to real situations.

However, we have also encountered significant challenges in practical implementation, as it has required a significant restructuring of instructional planning and a change in the mindset of students and lecturers to overcome resistance to change. On the other hand, we have observed that the experience needs to be restructured to avoid the selection bias associated with asking students to do it voluntarily when assessing performance.

Finally, it is essential to continue implementing PBL in future courses better to understand its benefits and challenges in empirical subjects. This will allow informed decisions to be made about its larger-scale implementation and maximize its impact on student learning.

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References

Alorda, B., Suenaga, K., & Pons, P. (2011). Design and evaluation of a microprocessor course combining three cooperative methods: Sdla, pjbl and cnbl. *Computers & Education*, 57(3), 1876–1884.

Andres, B., Sempere-Ripoll, F., Esteso, A., & Torre-Martínez, M. R. D. L. (2022). Active learning methodologies at the university classroom. *EDULEARN Proceedings*, 2927-2935.

Bell, S. (2010). Project-based learning for the 21st century: skills for the future. *The Clearing House: A Journal of Educational Strategies, Issues and Id*eas, 83(2), 39-43.

Chen, C. H., & Yang, Y. C. (2019). Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators. *Educational Research Review*, 26, 71-81.

Guo, P., Saab, N., Post, L. S., & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. *International Journal of Educational Research*, 102, 101586.

Helle, L., Tynjälä, P., & Olkinuora, E. (2006). Project-based learning in post-secondary education – theory, practice and rubber sling shots. *Higher Education*, 51, 287-314.

Hmelo-Silver, C.E., Duncan, R.G., & Chinn, C.A. (2007). Scaffolding and achievement in problem-based and inquiry learning: a response to Kirschner, Sweller and Clark (2006). *Educational Psychologist*, 42(2), 99-107.

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving schools*, 19(3), 267–27.

Krajcik, J.S., & Blumenfeld, P.C. (2006) Project-based learning. In: Sawyer, R. K. (Ed.) *The Cambridge handbook of the learning sciences*. Cambridge University Press.

Martinez Casanovas, M., Ruiz-Munzon, N., & Buil-Fabrega, M. (2022). Higher education: The best practices for fostering competences for sustainable development through the use of active learning methodologies. *International Journal of Sustainability in Higher Education*, 23(3), 703-727.

Vogler, J. S., Thompson, P., Davis, D. W., Mayfield, B. E., Finley, P. M., & Yasseri, D. (2018). The hard work of soft skills: augmenting the project-based learning experience with interdisciplinary teamwork. *Instructional Science*, 46, 457-488.

Wurdinger, S., Haar, J., Hugg, R., & Bezon, J. (2007). A qualitative study using project-based learning in a mainstream middle school. *Improving Schools*, 10(2), 150-161.

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Rethinking Internationalization: Student Insights on Global Competence in Higher Education

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Abstract

This article explores student perspectives on Global Competence development in higher education, addressing a gap in internationalization research where student voices remain underexamined despite their relevance to effective policy and program design. Based on a survey of 900 undergraduate students at a mid-sized Spanish public university, the study reveals that students find Global Competence highly relevant, with particular emphasis on English proficiency and intercultural interaction. While differences in perceived importance are linked to sociodemographic and academic factors such as gender, international exposure, and field of study, interest in Global Competence remains consistently positive across all groups. These findings highlight the need for inclusive internationalization strategies that go beyond mobility programs, providing all students with opportunities to engage in global learning. By incorporating student perspectives, higher education institutions can better align internationalization efforts with student needs.

Keywords: *internationalization; global education; global competence; study-abroad; internationalization at home; student perspectives.*

1. Introduction

Higher education is undergoing a profound transformation, driven by rapid advancements in digitalization and artificial intelligence, which are reshaping how knowledge is created and shared (Robertson, 2021). At the same time, global challenges such as climate change, inequality, and sustainability are compelling universities to reassess their role in preparing students for an increasingly interconnected and complex world (de Wit et al., 2015). In this evolving landscape, internationalization has become a key strategy for fostering Global Competence (GC), equipping students with the skills, knowledge, and attitudes needed to engage effectively in a globalized society (Sandström & Hudson, 2018).

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1.1. Beyond Mobility: A Comprehensive Approach to Internationalization

Traditionally associated with student mobility, internationalization in higher education has evolved into a broader, institution-wide process that embeds international and intercultural dimensions across curricula and institutional strategies (Knight, 2004). While economic drivers such as global rankings have traditionally shaped internationalization efforts (Hauptman Komotar, 2019), there is a growing emphasis on its educational and societal impact, including curriculum transformation, intercultural learning, and global citizenship (De Wit & Hunter, 2015; Robson & Wihlborg, 2019). This shift reflects a recognition that internationalization should go beyond institutional benefits to foster inclusive and transformative learning experiences (Seeber et al., 2016).

At the core of this evolution is GC, which the European Commission identifies as essential for building socially responsible and inclusive societies (Sandström & Hudson, 2018). Defined by the OECD (2019, p. 167) as "the ability to critically examine local, global, and intercultural issues, appreciate and respect diverse perspectives, and act responsibly toward collective well-being and sustainability," GC encompasses cognitive skills, socio-emotional development, and civic engagement. HE plays a pivotal role in cultivating these competencies, equipping students to navigate complex global challenges and contribute meaningfully to society (Hunter et al., 2006; Reimers, 2009).

1.2. Employability and Citizenship: The Dual Impact of Global Competence

Beyond its educational value, GC is increasingly recognized as essential for employability. Employers seek graduates with multilingual communication skills, teamwork experience, problem-solving abilities, and cultural adaptability - key elements of GC (Di Pietro, 2015; Watkins & Smith, 2018). To meet these labor market demands, higher education institutions must strategically embed GC development into their curricula, ensuring that graduates possess both technical expertise and intercultural awareness (Jones & Killick, 2013; Ortiz-Marcos et al., 2020).

However, the relevance of GC extends beyond professional success. It plays a fundamental role in shaping responsible citizens who are committed to sustainability, ethical engagement, and social justice (De Wit, 2019; Killick, 2020). The OECD (2018) describes globally competent students as those who understand global interdependencies, recognize the socio-economic and environmental impact of their actions, and engage critically with global issues. HE must therefore not only prepare students for the workforce but also equip them to contribute to a more equitable and sustainable world (Mestenhauser, 2011).

1.3. The Missing Voice: Understanding Student Perspectives on Internationalization

Despite consensus on the importance of GC, student perspectives on its development remain underexplored. Most studies focus on mobile students or institutional strategies, often overlooking local students, who constitute the majority of the student body (Souto-Otero et al., 2013). This lack of insight can result in internationalization strategies that fail to align with student interests, reducing engagement and limiting learning outcomes (Lee & Stensaker, 2021). Buckner and Stein (2020) emphasize the need to move beyond one-size-fits-all internationalization models toward adaptive strategies that reflect students´ diverse aspirations.

1.4. Bridging the Gap: A Student-Centered Approach to Global Competence

This study addressed this gap by exploring students' perspectives on GC development in higher education. By listening to student voices, this research provides insights into refining curriculum design and internationalization strategies, ensuring they are inclusive, relevant, and responsive to student needs. Understanding these perspectives is crucial for designing effective programs that equip all students with the skills and competencies needed to thrive in an interconnected world. By shifting the focus toward a student-centered approach to internationalization, this study contributes to the ongoing discourse on higher education's role in preparing future generations for global challenges.

2. Methodology

2.1. Research Design and Sampling

This study is based on a quantitative survey conducted at a mid-sized Spanish public university. The final sample comprised 900 fully completed questionnaires from undergraduate students in their second to fourth year, who voluntarily participated in the study.

2.2. Sample Characteristics

The sample included students from five academic fields, ensuring broad disciplinary representation: Humanities (History), Sciences (Physics), Social Sciences (Business Administration, Primary Education), Health Sciences (Medicine), and Engineering (Industrial Technologies, Chemical Engineering, Telecommunications Technologies). Table 1 presents key sociodemographic and academic characteristics of the sample.

Table 1. Sociodemographic characteristics of the sample

Characteristics	Details
Gender	52.3% female, 47.0% male, 0.7% other
Age	22.3% < 20 years, 54.7% 20-21 years, 23.0% ≥ 22 years
Nationality	96.3% Spanish nationality
International Exposure	92.2% travelled abroad at least once 5.7% had participated in an international exchange program
Intercultural Relations	44.7% interact with at least one individual from other culture
Language Proficiency	71.1% intermediate English, 21.8% advanced, 7.1% basic 53.9% speak a second foreign language beyond English

2.3. Data Collection Process

Data was collected between November 2023 and March 2024 through in-class survey administration in 34 courses across the eight selected degree programs. The survey was administered in both digital (60%) and paper-based formats (40%), with paper responses manually digitized into SPSS for analysis.

2.4. Research Instrument and Validity

The structured questionnaire employed a 5-point Likert scale, assessing GC based on the OECD's Global Competence Framework (OECD, 2019), with eight items grouped into four key dimensions: foreign language skills, global knowledge, intercultural skills, and global action. The questionnaire was anonymous, and student participation was voluntary. To ensure validity and reliability, the questionnaire was reviewed by internationalization experts at the university and piloted in 2022 (n = 30). The Cronbach's Alpha test (α = .837) indicated high internal consistency.

2.5. Data Analysis

Quantitative analysis was conducted using SPSS. The study applied descriptive statistics to identify overall trends in student perceptions, while inferential tests (non-parametric Kruskal-Wallis and Mann-Whitney) were used to examine significant differences based on sociodemographic and academic variables.

3. Results

The findings of this study indicate that students perceive the development of GC as an essential aspect of their university education, evidenced by an overall mean score for the perceived importance of GC of 4.02 (Sd = 0.90, Md = 4.13). Among the assessed dimensions, English

proficiency (*M* = 4.37, *Sd* = 0.90, *Md* = 5.00) and interacting with people from other cultures (*M* = 4.26, *Sd* = 0.91, *Md* = 5.00) were rated the highest, while the ability to communicate in a second foreign language was rated the lowest (*M* = 3.41, *Sd* = 1.17, *Md* = 3.00).

3.1. Sociodemographic and Academic Factors

The study reveals significant differences in students' perceptions of GC based on sociodemographic and academic characteristics:

3.1.1. Gender

Female students (*M* = 4.16, *Sd* = 0.61, *Md* = 4.25) assigned significantly higher importance to GC development than male students (*M* = 3.88, *Sd* = 0.69, *Md* = 4.00, $p < .001$). This pattern was consistent across seven of the eight aspects of GC, except for understanding the connection between local and global issues.

3.1.2. Nationality and Intercultural Exposure

Students with non-Spanish nationality (*M* = 4.36, *Sd* = 0.56, *Md* = 4.5) rated the importance of GC significantly higher than those with only Spanish nationality (*M* = 4.01, *Sd* = 0.67, *Md* = 4.13, $p = .028$), particularly regarding multilingual abilities ($p = .001$). Similarly, students with numerous intercultural interactions (*M* = 4.13, *Sd* = 0.63, *Md* = 4.25) rated GC higher than those without links to people from other cultures (*M* = 3.96, *Sd* = 0.68, *Md* = 4,00, $p = .002$). A similar pattern was observed for international travel experience, where students who travel abroad at least once a year (*M* = 4.09, *Sd* = 0.71, *Md* = 4.25) assigned greater importance to GC than those with no international travel experience (*M* = 3.82, *Sd* = 0.74, *Md* = 4,00, $p = .003$).

3.1.3. Academic background

The results show that students' study area affects their GC perception. Students from Health Sciences (*M* = 4.30, *Sd* = 0.50, *Md* = 4.38) rated GC development the highest, significantly higher ($p < .001$) than those from Sciences (*M* = 3.90, *Sd* = 0.70, *Md* = 4.00), Engineering (*M* = 3.97, *Sd* = 0.57, *Md* = 4.00), Social Sciences (*M* = 3.96, *Sd* = 0.71, *Md* = 4.00), and Humanities (*M* = 3.96, *Sd* = 0.86, *Md* = 4.13), with significant differences in their interest in specific competence dimensions.

3.1.4. Language proficiency

Students with advanced English proficiency (*M* = 4.15, *Sd* = 0.65, *Md* = 4.25) perceived GC development as significantly ($p < .001$) more important than those with intermediate (*M* = 4.01, *Sd* = 0.43, *Md* = 4.06) and basic English skills (*M* = 3.79, Sd = 0.62, Md = 3.94). Similarly, students with knowledge of a second foreign language (*M* = 4.13, *Sd* = 0.61, *Md* = 4.25) rated

GC significantly higher ($p < .001$) than those without ($M = 3.89$, $Sd = 0.71$, $Md = 4.00$), in all aspects except "global knowledge".

3.1.5. Intention to Participate in International Mobility

Another relevant factor was students' intention to participate in international mobility programs. While those planning to participate in a mobility ($M = 4.09$, $Sd = 0.64$, $Md = 4.13$) rated GC slightly higher than those who had already participated in a mobility program ($M = 4.03$, $Sd = 0.64$, $Md = 4.00$) and those without mobility plans ($M = 3.97$, $Sd = 0.69$, $Md = 4.00$), the overall difference was minor ($p = .046$). This suggests that even students who do not intend to participate in international mobility recognize the value of developing GC.

3.1.6. No-Significant Factors

Age, academic course, health status and receiving financial aid did not significantly relate to students' perceptions on GC ($p > .05$).

4. Discussion and Conclusion

The findings of this study reveal strong student interest in developing GC during their university education, across all dimensions, from English proficiency to intercultural skills, global knowledge and the ability to contribute to global wellbeing, evidenced by median values equal to or exceeding 4.0 in seven of the eight assessed aspects, with the only exception being proficiency in a second foreign language.

These findings align with existing research emphasizing the importance of international and intercultural competencies for employability and participation in a globalized society (Jones & Killick, 2013; Ortiz-Marcos et al., 2020; Watkins & Smith, 2018). However, the lower importance attributed to acquiring a second foreign language suggests that while students acknowledge multilingualism as a valuable asset, they may not perceive it as an immediate necessity for their future careers or personal development.

Several factors are associated with differences in how students rate the importance of GC. Gender, nationality, intercultural interactions, and frequency of international travel were all statistically significant variables, indicating that students with previous international exposure tend to value GC higher. Similarly, academic background, study area, English proficiency, knowledge of a second foreign language, and intention to participate in international mobility were also relevant factors. However, even students with lower English proficiency and no plans for international mobility rated GC positively, suggesting a broad acknowledgment of its relevance across diverse student profiles.

4.1 Implications for Internationalization Strategies in Higher Education

These findings demonstrate that GC development is not only recognized by policymakers and the academic community as essential for students to thrive in a globalized world (De Wit, 2019; Killick, 2020; OECD, 2018; UNESCO, 2014), but students themselves also acknowledge its significance in their university education. Given this widespread recognition, higher education institutions must ensure that all students, regardless of background, discipline, language proficiency, or mobility aspirations, have equitable access to opportunities that support the development of key GC dimensions: language proficiency, intercultural engagement, global awareness, and active global citizenship.

Ultimately, these results highlight the need to reframe internationalization strategies to more effectively and equitably support GC development. This requires complementing traditional mobility - accessible only to a limited number of students - with comprehensive "internationalization at home" practices that embed global learning opportunities across curricular and extracurricular contexts. These include integrating global perspectives into curricula, fostering intercultural dialogue on campus, and promoting multilingualism (Clifford & Montgomery, 2017; Killick, 2020), as well as adopting digitally enabled approaches like virtual exchange (Helm, 2018; O'Dowd, 2021). Importantly, these practices must be tailored to students' diverse needs and include evaluation mechanisms to ensure their effectiveness in fostering students' GC development (Kjellgren & Richter, 2021). A student-centered, inclusive, and evidence-based approach is essential to providing all learners with meaningful opportunities to acquire the skills and values needed in a globalized world.

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References

Buckner, E. & Stein, S. (2020). What Counts as Internationalization? Deconstructing the Internationalization Imperative. *Journal of Studies in International Education, 24*(2), 151–166. https://doi.org/10.1177/1028315319829878

Clifford, V., y Montgomery, C. (2017). Designing an Internationalised Curriculum for Higher Education: Embracing the Local and the Global Citizen. Higher Education Research & Development, 36(6), 1138-1151. https://doi.org/10.1080/07294360.2017.1296413

de Wit, H. (2019). Internationalization of higher education: The need for a more ethical approach. *Journal of International Education in Business, 12*(2), 167-175.

de Wit, H. & Hunter, F. (2015). The future of internationalization of higher education in Europe. *International Higher Education, 83,* 2-3.

de Wit, H., Hunter, F., Howard, L., & Egron-Polak, E. (2015). *Internationalisation of higher education*. European Parliament. Directorate-General for Internal Policies of the Union. https://doi.org/10.2861/6854

Di Pietro, G. (2015). The impact of study abroad on graduates' employability: Evidence from the UK. *Journal of Studies in International Education, 19*(2), 121-138.

Hauptman Komotar, M. (2019). Global university rankings and their impact on the internationalisation of higher education. *European Journal of Education, 54*(2), 299–310. https://doi.org/10.1111/ejed.12332

Helm, F. (2018). The long and winding road… Journal of Virtual Exchange, 1, 41-63. Research-publishing.net. https://doi.org/10.14705/rpnet.2018.jve.3

Hunter, W., White, G. P., & Godbey, G. C. (2006). What does it mean to be globally competent? *Journal of Studies in International Education, 10*(3), 267-285. https://doi.org/10.1177/1028315306286930

Jones, E., & Killick, D. (2013). Graduate attributes and the internationalized curriculum: Embedding a global outlook in disciplinary learning outcomes. *Journal of Studies in International Education, 17*(2), 165-182.

Killick, D. (2020). Beyond competencies and silos: Embedding graduate capabilities for a multicultural globalizing world across the mainstream curriculum. *Research in Comparative and International Education, 15*(1), 27–35. https://doi.org/10.1177/1745499920901946

Kjellgren, B. & Richter, T. (2021). Education for a sustainable future: Strategies for holistic global competence development at engineering institutions. *Sustainability, 13*(20). https://doi.org/10.3390/su132011184

Knight, J. (2004). Internationalization remodeled: Definition, approaches, and rationales. *Journal of Studies in International Education, 8*(1), 5-31.

Lee, J. J., & Stensaker, B. (2021). Research on internationalisation and globalisation in higher education—Reflections on historical paths, current perspectives and future possibilities. *European Journal of Education, 56*(2), 157–168. https://doi.org/10.1111/ejed.12448

Mestenhauser, J. A. (2011). Outcomes of internationalization in higher education: A holistic perspective. *Journal of Studies in International Education, 15*(4), 358-373.

OECD (2018). *Preparing our youth for an inclusive and sustainable world: The OECD PISA global competence framework*. OECD Publishing.

OECD (2019). PISA 2018 *Assessment and Analytical Framework.* OECD Publishing. https://doi.org/10.1787/043fc3b0-en

Ortiz-Marcos, I., Breuker, V., Rodríguez-Rivero, R., Kjellgren, B., Dorel, F., Toffolon, M., Uribe, D., & Eccli, V. (2020). A framework of global competence for engineers: The need for a sustainable world. *Sustainability, 12*(22), 1–25. https://doi.org/10.3390/su12229568

O'Dowd, R. (2020). Virtual exchange and internationalizing the classroom. Journal of International and Comparative Education, 9(2), 85-97.

Reimers, F. M. (2009). Global competency: Educating the world. *Harvard International Review, 30*(4), 24-27.

Robertson, S. L. (2021). Global competences and 21st century higher education – And why they matter. International *Journal of Chinese Education, 10*(1). https://doi.org/10.1177/22125868211010345

Robson, S., & Wihlborg, M. (2019). Internationalisation of higher education: Impacts, challenges, and future possibilities. *European Educational Research Journal, 18*(2), 127-134. https://doi.org/10.1177/1474904119834779

Sandström, A.-M. & Hudson, R. (2018). *The future of internationalization in European higher education: Towards more inclusive, innovative, and connected approaches.* European Commission.

Seeber, M., Cattaneo, M., Huisman, J., & Paleari, S. (2016). Why do higher education institutions internationalize? An investigation of the multilevel determinants of internationalization rationales. *Higher Education, 72*(5), 685–702. https://doi.org/10.1007/s10734-015-9971-x

Souto-Otero, M., Huisman, J., Beerkens, M., de Wit, H., & VujiĆ, S. Č. (2013). Barriers to International Student Mobility: Evidence from the Erasmus Program. *Educational Researcher, 42*(2), 70–77. https://doi.org/10.3102/0013189X12466696

UNESCO (2014). Global *Citizenship Education: Preparing learners for the challenges of the 21st century. Paris, UNESCO.* Disponible en: https://unesdoc.unesco.org/ark:/48223/pf0000227729

Watkins, H., & Smith, R. (2018). Thinking Globally, Working Locally: Employability and Internationalization at Home. *Journal of Studies in International Education, 22*(3), 210–224. https://doi.org/10.1177/1028315317751686

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The Global South and the SDGs: Challenges and Opportunities for Higher Education in the Mexican Tropics from a case study

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Abstract

To achieve the objectives and goals of the 2030 Agenda for Sustainable Development, the Northern and Southern regions must outline their own roadmaps. This study presents a case exemplifying the challenges and opportunities that emerge through a local analysis of the interdependence between poverty and higher education, specifically SDGs 1 and 2, where the educational bottleneck in transitioning from secondary to tertiary education constitutes a critical issue. The case study is situated in a region of the Mexican tropics, where high natural capital contrasts with a low Human Development Index (HDI) and high poverty levels.

Keywords: *End of poverty; Quality education; Regional sustainable development; Challenges of the Global South; Educational bottleneck.*

1. Introduction

Since 2015, the United Nations' 2030 Agenda for Sustainable Development has become a global paradigm, structuring the achievement of 17 Sustainable Development Goals (SDGs). Among them, Goal 4: Quality Education is essential as it interconnects with others (United Nations, 2015; UNESCO, 2015). However, significant disparities exist across countries, leading to diverse challenges in sustainable development. Amorós Molina et al. (2023) identified variations in higher education approaches: high-income countries emphasize academic integration of SDGs, while low- and middle-income countries apply them to address local challenges. This divergence aligns with the broader geopolitical categorization of the Global North and Global South (Hollington, 2015).

The Global South, encompassing much of Africa, Latin America, Asia, and parts of Oceania, faces distinct economic and development challenges compared to the wealthier Global North.

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Additionally, 83.7% of the world's poor reside in rural areas (Global Multidimensional Poverty Index, 2024), necessitating targeted geopolitical and educational strategies.

While similarities exist among Global South nations, notable regional disparities highlight the need for tailored educational strategies. Mexico, despite being part of the Global South, displays sharp internal contrasts in human development and capital distribution. Therefore, a dual-level analysis is required: a macro-regional study (Latin America and the Global South) and a micro-regional study (a municipality within southeastern Mexico).

This study examines the educational bottleneck phenomenon, which limits access to higher education, within the context of SDG 1 (No Poverty) and SDG 4 (Quality Education). Furthermore, it proposes an educational strategy to facilitate the transition of upper secondary students into higher education, positioning them as agents of sustainable development.

2. Problem Statement

Education is a critical factor in economic growth and poverty reduction. It enhances employment and income opportunities but remains difficult to implement as a poverty alleviation tool (Berg, 2008). The relationship between low educational attainment and poverty creates a cyclical barrier to development.

Mexico's higher education system mirrors many regional challenges found across Latin America. According to IESALC (2025), inequality in access to higher education remains the greatest obstacle, particularly for students from low-income backgrounds and marginalized communities. Disparities within Mexico further complicate solutions, with southeastern states such as Veracruz, Oaxaca, and Chiapas demonstrating high biodiversity yet low Human Development Index (HDI) scores (UNDP, 2022; 2023).

A significant correlation exists between high poverty rates and low educational attainment. Several barriers contribute to this: limited access to education, high dropout rates, poor educational quality, negative intergenerational influences and sociocultural obstacles. Veracruz, for example, ranks below the national HDI average (UNDP, 2015), underscoring the urgent need for SDG 1 (No Poverty) initiatives. To effectively implement a sustainability roadmap, rural education systems require a systemic transformation. A key issue is the educational bottleneck, significantly reducing the progression of students to higher education.

Upper secondary education (bachillerato) is pivotal in shaping students' professional futures. According to ISCED, the Mexican bachillerato corresponds to ISCED Level 3. The Telebachillerato (TEBA) system, designed to expand rural education access, has not been updated pedagogically or technologically since its inception in 1980. Given that over 60% of Veracruz’s upper secondary institutions belong to TEBA, its modernization is crucial for regional sustainable development.

This study focuses on a territorial corridor spanning Veracruz and Oaxaca, where the Isthmus of Tehuantepec Interoceanic Corridor (CIIT) is being implemented. This regional development project demands educational innovations aligned with sustainability and workforce preparation. Notably, many municipalities within the CIIT corridor exhibit low HDI scores (0.709 in Oaxaca and 0.744 in Veracruz), high poverty rates, and declining natural capital—factors exacerbating educational exclusion.

3. Case Study

3.1. The Educational Context of Santiago Sochiapan Municipality

The socio-economic conditions of municipalities within the Isthmus of Tehuantepec Interoceanic Corridor (CIIT) highlight significant development deficits. A key example is Santiago Sochiapan, bordering Veracruz and Oaxaca, where 85.4% of the population lives in poverty. With 13,062 inhabitants dispersed across 39,740 hectares, the area has 65 schools, including four Telebachillerato (TEBA) institutions, serving 350 students per cycle (SEV, 2020). The primary sector employs 71.9% of the workforce, with 24,242 hectares dedicated to livestock farming (61% of the municipal area). Santiago Sochiapan has over 9,000 indigenous households, with Zapotec spoken by nearly 50% of residents (Secretaría de Finanzas y Planeación, 2022).

Higher education is absent, making TEBA the highest academic level available, yet only 14% of the population completes it (Data México, 2020). The 2021-2022 dropout rate reached 23.4%, and a declining enrollment trend is evident: 1,598 primary students (ISCED Level 1), 626 secondary students (ISCED Level 2), and 397 Telebachillerato students (ISCED Level 3) (SEV, 2020; UNESCO, 2012).

This study examines TEBA Santa Teresa (TEBA ST), located in a rural CIIT community (population: 1,233). The local economy relies on livestock farming, with subsistence agriculture playing a secondary role (Secretaría de Finanzas y Planeación, 2022). TEBA ST has three state-appointed teachers and one municipal assistant, each covering six to nine subjects per semester. In 2023, 68 students enrolled, half Zapotec speakers, many balancing studies with family agricultural duties. Challenges include limited infrastructure, lack of internet, and inadequate teaching materials, hindering educational continuity. Many students leave school for subsistence labor, perpetuating intergenerational poverty (SEV, 2020).

Until February-July 2025, TEBA institutions followed the 2018 Educational Model for Upper Secondary Education (MEPEO 2018), with 42 subjects over three years. The Ecology and Environment (EMA) subject, last offered in the sixth semester, was used in a pilot program for situated learning, integrating agricultural experiences with ChatGPT as an educational tool.

3.2. Analysis of the Educational Bottleneck

The educational bottleneck refers to the phenomenon where fewer students progress and complete higher levels of education. This study argues that reversing this trend requires a micro-regional analysis, examining socioeconomic processes to address the various factors contributing to school dropout rates.

The student group in this pilot program typically played complementary roles within their family dynamics, assisting with agricultural tasks seasonally or as needed. Those who attended farms daily were more involved in livestock care and crop maintenance. These young people learned various agricultural and livestock management tasks, such as feeding, vaccinating, and deworming cattle; fumigating and fertilizing crops; harvesting limes; repairing fences; and selling agricultural and livestock products. Under our guidance as an ecologist and a pedagogue, we supervised this pilot program, tracking the students' progress until graduation from TEBA ST.

At the national level, the INEGI (2021) data on the educational bottleneck is exemplified in the trajectory of the 19 students who participated in the case study. Despite completing upper secondary education, only three students managed to continue their studies—highlighting economic and social barriers to higher education in rural communities. Additionally, nine students joined local agricultural activities, while three emigrated to the United States in search of better opportunities. This demonstrates how a lack of resources, infrastructure, and educational support pushes students into the labor market before they can access higher education. Others pursued informal entrepreneurship, enlisted in the National Guard, or started families, showing that young people seek alternatives to sustain themselves in the absence of educational opportunities.

According to the National Survey on Access and Retention in Education (ENAPE, 2021), 71.8% of students who dropped out were from low-income backgrounds, compared to 12.9% from higher-income families. Additionally, dropout rates in upper secondary education remain significantly high. Data from the Ministry of Public Education (SEP), as reported by INEGI, indicate that over the last 20 years, while dropout rates have decreased in primary and secondary education, they have increased in higher education. These findings emphasize the educational bottleneck in Mexico, where economic and social factors constrain educational continuity, particularly in the transition to higher education. This underscores the interdependence between poverty and education.

3.3. The Situated Learning Experience at Telebachillerato Santa Teresa

Courses at Telebachillerato (TEBA) institutions are primarily lecture-based, despite the system's original design for pre-recorded video lessons with instructional materials. Each subject includes a Student Guide, yet poor academic performance in Ecology and Environment (EMA)

has been observed over three years at TEBA ST, attributed to structural and personal factors such as student interest, study habits, and learning conditions. However, the study group displayed enthusiasm, suggesting that innovative strategies could enhance student engagement and performance. Consequently, a situated learning approach using ChatGPT was introduced for the EMA subject, chosen for its relevance to local issues and practical application.

In 2023, a pilot program at TEBA ST involved 19 students, integrating traditional resources (Student Guide), practical knowledge from family farms (citrus and livestock), and ChatGPT. This novel approach facilitated the practical application of theoretical knowledge, strengthening the link between disciplinary cognitive learning (ecology) and environmental challenges. Students identified recurring patterns in their farm activities, connecting real-life experiences with academic content. Rural activities became learning experiences for scientific concepts, bridging the gap between text-based instruction and practical contexts while fostering critical and creative thinking. Students engaged in livestock care, tree planting, citrus harvesting, and farm maintenance. Notably, both male and female students were equally involved in these agricultural tasks, emphasizing the inclusive nature of situated learning. According to the student's assessment, the main results of this exercise are presented in the following table:

Table 1. Student Reflections on the Pilot Learning Experience

Aspect	Student Perception
Understanding of content	Improved through real-life application
Engagement	High interest due to relevance and context
Critical thinking	Enhanced via guided use of ChatGPT
Motivation	Increased by linking theory to daily life
Overall satisfaction	Positive; valued the practical approach

3.4. Key Outcomes of the Situated Learning Experience

As a conclusion, this experience enabled students to understand the complexity of the farms they frequently visit from a disciplinary perspective. They recognized themselves as active agents in their own learning, exploring new ways of thinking by linking theoretical concepts from the Student Guide with their practical applications in real-world contexts. Moreover, this methodology fostered a constructive vision of learning, facilitating the integration of applicable knowledge into everyday situations.

By connecting abstract theoretical-disciplinary concepts with the reality of citrus and livestock ecosystems, situated learning provided an immersive and meaningful experience. This approach enhanced critical thinking and the practical application of knowledge, while also strengthening key aspects such as active learning, interdisciplinarity, collaboration, reflection, and authenticity.

3.5. Evaluation and Future Implementation of the Pilot Program

To enhance future implementation, the evaluation of this pilot program was conducted from two complementary perspectives:

1. Practical Student Assessment: Students anonymously answered five final questions designed to assess the effectiveness of the methodology used, their perception of the learning process, and its impact on their academic and professional orientation. The responses were overwhelmingly positive, with some unexpected insights. Students reported that combining ChatGPT, the Student Guide, and farm experiences helped them understand topics with greater depth and clarity. They also noted that this approach was more effective compared to traditional abstract theoretical learning without practical connections. Furthermore, students highlighted that this methodology not only facilitated knowledge acquisition but also enabled them to visualize its real-world applications, reinforcing their interest in fields such as citrus production and livestock farming.
2. Expert Academic Analysis: The program was also evaluated by experts, who analyzed the structure and depth of the content covered, the relevance of the applied concepts, the coherence between theory and practice, and the development of students' critical thinking skills.

Based on these preliminary conclusions, we proposed the design of a complementary program to the EMA Student Guide, intended for use in 225 Telebachillerato institutions across the CIIT and its surrounding area. To this end, in 2024, we held working meetings with officials from the Veracruz Ministry of Education and analyzed alignment with federal programs in the region to initiate a series of workshops aimed at integrating federal and state sectoral policies necessary for regional sustainable development. Notably, our review of the budget allocated for the CIIT project revealed financial margins sufficient to scale up this pilot program at a regional level, aligning with CIIT's programmatic objectives.

Additionally, an agricultural sector analysis conducted by the federal government, using a logical framework approach to problem-solving, highlighted the need for professional training in this sector. This provided an opportunity to propose new educational programs in a hybrid higher education model (Technical University Degree with pathways to various Bachelor's Degrees related to regional sustainable development), based on our experiences (Rodríguez, Hernández & Ruiz, 2022; 2024) and other Latin American initiatives.

However, state and federal government transitions at the end of 2024 prevented the continuation of this proposal. Nevertheless, in the early stages of the new state and federal administrations, we identified opportunities that could ensure its feasibility in the near future, given the existing legal framework and the continuation of the CIIT project directives (Plan México, 2025).

The greatest challenge in achieving sustainable development goals lies in integrating sectoral policies and fostering institutional synergies to support viable regional proposals. In summary, this approach seeks to break the educational bottleneck and facilitate the transition of Telebachillerato graduates into higher education. We propose a situated teaching-learning model, focused on developing projects within the region's primary sector, enabling students to apply their knowledge directly to their local context and contribute to community development.

4. Conclusions

The analysis of this particular case, serving as a reference for the 240 Telebachillerato institutions within this territorial corridor of the Mexican tropics, allows us to identify both challenges and opportunities for regional sustainable development, aligning with those outlined for Latin America and the Global South.

Fundamentally, we confirm that designing and following a path toward sustainability is only possible through a historical and multidimensional regional analysis. Furthermore, while the United Nations' 2030 Agenda has been incorporated into development plans across all three levels of government (municipal, state, and national), the targets set for the designated timeframes have yet to be met in Mexico—a shortcoming also reflected in broader regional assessments (Latin America and the Global South). It is evident that without cross-sectoral policy integration and institutional synergy, achieving the 17 Sustainable Development Goals (SDGs) will remain out of reach.

References

Amorós-Molina, Á., Helldén, D., Alfvén, T., Niemi, M., Leander, K., Nordenstedt, H., & Biermann, O. (2023). Integrating the United Nations sustainable development goals into higher education globally: A scoping review. *Global Health Action, 16*(1). https://doi.org/10.1080/16549716.2023.2190649

Data México. (2020). Niveles de escolaridad de la población de 15 años y más en Santiago Sochiapan. (Distribución de la población total). https://www.economia.gob.mx/datamexico/es/profile/geo/santiago-sochiapan

Global Multidimensional Poverty Index. (2024). https://hdr.undp.org/system/files/documents/hdp-document/mpireport2024en.pdf

Gobierno de México (2020). Programa Regional Corredor Interoceánico del Istmo de Tehuantepec. Diario Oficial de la Nación. https://www.gob.mx/cms/uploads/attachment/file/568609/DOF_PDIT_040820.pdf

Gobierno de México (2025). Plan México: Estrategia de Desarrollo Económico Equitativo y Sustentable para la Prosperidad Compartida (Primer borrador).

Hollington, A., Salverda, T., Schwarz, T., & Tappe, O. (2015). *Voices from around the world: Concepts of the Global South*. Global South Studies Center Cologne. http://kups.ub.uni-koeln.de/6399/

IESALC. (2025). *La educación superior en América Latina y el Caribe: Avances y retos. Documentos de apoyo para los doce ejes de la CRES+5*. UNESCO.

INEGI. (2019). Encuesta Nacional de Inserción Laboral de los Egresados de la Educación Media Superior (ENILEMS) 2019. México: INEGI. https://www.inegi.org.mx/contenidos/programas/enilems/2019/doc/enilems_2019_nota_tecnica.pdf

INEGI. (2021). Encuesta Nacional sobre Acceso y Permanencia en la Educación (ENAPE) 2021. https://www.inegi.org.mx/programas/enape/2021/

Rodríguez-Luna, E., Hernández-Dávila, E. Y., & Ruiz-Ruiz, L. (2024). Case study for teaching tropical ecology. *In 10th International Conference on Higher Education Advances (HEAd'24)*, Valencia, 18-21 June 2024. https://doi.org/10.4995/HEAd24.2024.17377

Rodríguez-Luna, E., Hernández-Dávila, E. Y., & Ruiz-Ruiz, L. (2022). ¿Cómo enseñar ecología tropical en un espacio virtual? La enseñanza remota de emergencia como un medio para ensayar innovaciones educativas. En R. J. Mercado del Collado & A. D. Otero Escobar (Eds.), *Háblame de TIC* (pp. 123-156). Brujas – Social TIC. https://www.uv.mx/blogs/brechadigital/files/2022/05/hdt8_covid.pdf

SEV. (2019). *Programa Sectorial Veracruzano de Educación 2019 – 2024.* Consultado en https://www.sev.gob.mx/v1/files/2020/02/PSVE_2019-2024_24-oct-19_version_para_lectura.pdf

SEV. (2020). *Ficha del municipio de Santiago Sochiapan. Ciclo escolar 2019-2020.* http://www.sev.gob.mx/upece/investigacion/wp-content/uploads/sites/4/2020/08/SANTIAGO-SOCHIAPAN.pdf

SEP. (2022). *Marco Curricular Común de Educación Media Superior.* México: SEP. Available from https://www.dof.gob.mx/2023/SEP/ANEXO_ACUERDO_MCCEMS.pdf

Secretaría de Finanzas y Planeación. Sistema de Información Estadística y Geográfica del Estado de Veracruz de Ignacio de la Llave (SIEGVER). (2022). *Cuadernillo Municipal 2022, Santiago Sochiapan.* Consultado en http://ceieg.veracruz.gob.mx/wp-content/uploads/sites/21/2022/09/Santiago-Sochiapan.CM_.Ver_.2022.4.pdf

UNDP (United Nations Development Programme). (2024). *Human Development Report 2023-24: Breaking the gridlock: Reimagining cooperation in a polarized world.* New York. https://hdr.undp.org/content/human-development-report-2023-24

UNESCO. (2012). *International Standard Classification of Education ISCED 2011.* Montreal: UNESCO. https://uis.unesco.org/sites/default/files/documents/international-standard-classification-of-education-isced-2011-en.pdf

UNESCO. (2015). *Global Citizenship Education: Topics and Learning Objectives.* Paris: UNESCO.

United Nations. (2015). *Transforming our world: the 2030 Agenda for sustainable development.* Resolution adopted by the General Assembly on 25 September 2015. Available from https://sdgs.un.org/2030agenda

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From Missions to Indicators: An Analysis of University Contributions to the SDGs within Institutional Strategic Plans

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Abstract
This paper aims to enhance understanding of how universities contribute to sustainable development by examining which components of their strategic plans (SPs) contain segments identified as contributing to the Sustainable Development Goals (SDGs), following the framework developed by Di Nauta et al. (2020). It was found that SDG contributions appear predominantly in the missions, visions, strategies and objectives of the plans, and were less present in the values, means, indicators and targets. SDGs that touch on the themes related to university's triple mission of teaching, research and external engagement were predominant over those that do not. These results support the findings of a lack of transformative engagement for SD in the SPs of Canadian HEIs, as identified by previous studies.

Keywords: *Higher education governance; sustainable development; strategic planning*

1. Research Problem and Objective

Canada has dedicated itself to sustainable development (SD), particularly to the Sustainable Development Goals (SDGs), through the creation of its SDG Unit and a national strategy to contribute to the goals' achievement (Government of Canada, 2021). Ketlhoilwe et al. (2020) highlight that where national plans to achieve the SDGs exist, like in Canada, universities can contribute by identifying their impact on the SDGs and on the national strategic plan (SP) to reinforce support for intersectoral collaboration. Despite an uptick in adoption of the SDGs by Canadian universities, not all universities are measuring or reporting on their contributions to the SDGs and a national portrait of university contributions to the goals does not exist.

Universities can contribute to the SDGs through the core activities linked to their triple mission: teaching and learning, research, and contribution to society through external engagement. This contribution depends in part on an engagement at the highest level of university governance and

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the use of governance tools, such as plans, policies, and procedures, to integrate SD into the university's core activities. These documents offer an overall snapshot of the state of the university and its desired future state at a given point in time, designed as accountability and communication tools towards stakeholders both internal and external to the university. For authors interested in sustainability in higher education, these documents are seen as a reflection of the level of commitment and actions undertaken by the universities in their transition to SD (Bieler & McKenzie, 2017; Lozano et al., 2015). As Leal Filho et al. (2021) point out, "[i]t is believed that through a concerted institutional agenda, universities may not only make the SDGs central to their strategic institutional frameworks but also mobilize civil society and hence contribute to great visibility of the SDGs among their broad audiences and networks" (p. 27).

An 8-year "Canadian landscape analysis" found that Canadian universities engage shallowly with sustainability, and unevenly across their core activities (Bieler & McKenzie, 2017; Vaughter et al., 2016). Jorge et al. (2015) call for more research on sustainability uptake in strategic planning in higher education to better understand how universities engage with sustainability in their national and institutional contexts. Byrne, Savard & Larouche (in press) analyzed the SPs of 108 Canadian universities and identified segments associated with each SDG across all university core activities, to varying frequencies. However, this portrait does not allow a better understanding of the depth of the engagement of the universities studied. This paper aims to enhance understanding of how universities contribute to the SDGs by examining which components of their SPs contain segments identified as contributing to the SDGs. The strategic planning components are described in more detail in the conceptual framework section. There are two questions driving the analysis: (1) Where do SDG contributions appear throughout the SPs? and (2) What are individual SDG contributions' distribution across the SP components?

2. Conceptual framework

2.1. Strategic planning in higher education

Strategic planning is "a formal and rational process through which universities (re-) define their mission (what and for whom they stand for), elaborate their vision (what ambitions they have), their values (how they operate), define roles and allocate resources, design implementation, indicate how achievements will be assessed, as well as mechanisms for adaptation" (Fumasoli, 2018, p. 2587). SPs usually include: 1. A description of the mission, the values and a vision; 2. Strategic orientations; 3. The objectives and interventions selected; 4. the targeted results; and 5. The performance indicators used to measure the achievement of the targeted results (Larouche et al., in press). To facilitate understanding, terms often used interchangeably between university plans were regrouped into "strategies" and "objectives". Strategies (strategies, axes, priorities and orientations) are broad themes that the university has identified as strategically important to

address. These can range from single words used to structure the plan (ex: "People") to broad calls to action (ex: "Embody good governance"). Objectives (goals and objectives) are initiatives to be undertaken by the universities to respond to the strategies identified. Objectives are supported by means, which are concrete actions, indicators, which are measures to evaluate the actions put in place, and targets related to the action and its indicators.

2.2. The Sustainable Development Goals

The SDGs constitute a global framework for sustainable development: 17 goals, 169 targets, and 231 indicators that address elements influencing people, planet, prosperity, peace, and partnership. In the higher education context, these goals and targets can be complemented with the pillar framework of *Universities' key contributions to the SDGs* of SDSN-Australia/Pacific's *How universities contribute to the SDGs*, reinforced by Di Nauta et al. (2020). (Figure 1).

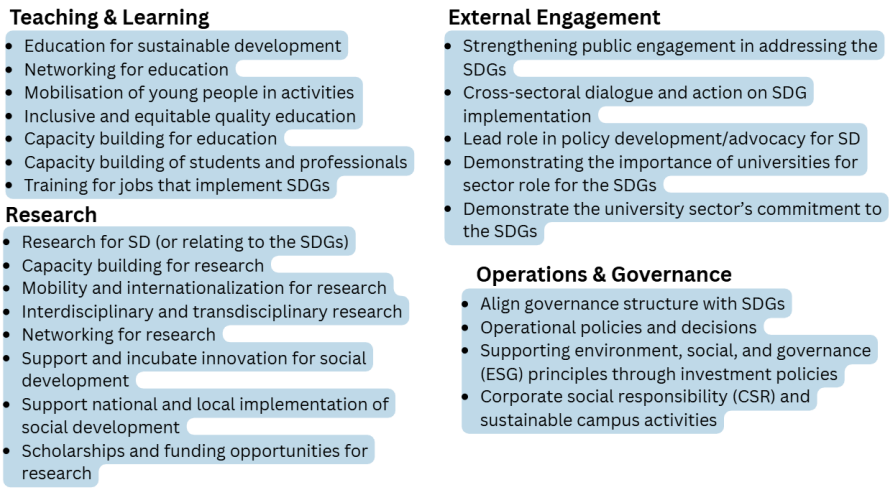


Figure 1. Universities' Key Contributions to the SDG. Source: Adapted from SDSN-Australia/Pacific (2017) & Di Nauta et al. (2020)

This model breaks down universities' key contributions to the SDGs according to their core activities: 1. Education (termed teaching and learning in figure 1); 2. research; 3. operations and governance; and 4. external leadership (termed external engagement in figure 1). Each pillar is accompanied by sub-themes, named "SDG Areas of Interest" added by Di Nauta et al. in 2020. We use this enriched version of the Key Contributions framework in the present study to identify contributions to the SDGs in SPs.

3. Methodology

3.1. Data collection

As part of a larger ongoing research project, governance documents of Canadian universities were collected between June 2019 and October 2022. For the present article, 97 universities with publicly available SPs were included, representing all Canadian provinces and the Yukon territory (75 % of Canadian universities). The universities were of varying sizes and types (research vs technical, public vs. private). In cases where the university had several SPs, the most recent plan was retained for this analysis. The planning cycles for these plans span from 2013 to 2045.

3.2. Analysis

Using the Qualitative analytic tool QDA Miner (Provalis Research Tools), the research team coded for SP components (mission, vision, values, axes, orientations, strategies, priorities, objectives, goals, means, indicators and targets), following the terminology used by the university within their plan. The contributions to the SDGs were identified with the aid of the Universities' Key Contributions to the SDGs framework and coded accordingly. Each segment, addressing a single topic or idea, was not limited to a single SDG, with most segments being associated to multiple SDGs due to the interconnected nature of the goals. The presence of general terms such as "sustainability" and "social, economic and environmental" were coded as "GEN.". A validation of the SDG codes for 30% of the corpus revealed an inter-coder reliability of 92.76% with Scott's pi being moderate ($\pi = 0.51$) (Scott, 1995).

4. Results

To respond to the first research question, we will look at the distribution of the segments identified as contributions to the SDGs across the SP components (Table 2).

Case occurrences of SP components show that most plans contain a mission (74 %), vision (78 %), values (66 %), strategies (91 %) and objectives (68 %). Less than half of the universities support these components with means (36 %), indicators (26 %), and targets (6 %). The percentage of overlap between the SDG segments and the SP components decreases chronologically as we proceed through the classic SP structure from 'mission' to 'targets', except for values (48 %) which is an outlier in this case. This suggests that broad statements of contributions to the SDGs are more prevalent than those detailing specific, measurable actions.

Table 2. Distribution of SP components in the sample and overlap with SDG segments

Component	Case occurence (%)	Frequency of SP components	SDG segment overlap*	Percentage overlap SDG segment and SP components
Mission	74.23	94	91	96.81
Vision	78.35	112	95	84.82
Values	65.98	429	207	48.25
Strategies	90.72	1374	832	60.55
Objectives	68.04	1806	1066	59.03
Means	36.08	1541	901	58.47
Indicators	25.77	778	300	38.56
Targets	6.19	112	13	11.61

*$N_{SDG\ Segments} = 3596$

To address the second research question, we examined the frequency of SDGs in relation to each SP component (Table 3). All SDGs appeared in co-occurrence with SP components at least once in the sample, with all SDGs co-occurring with the SP components 'objectives' and 'means.' Some SDGs (4, 8, 9, 10, 16, 17) were prevalent, constituting over 10 % of occurrences for several SP components. In contrast, other SDGs (1, 2, 6, 7, 14, and 15) co-occurred with less than 1 % of all SP component segments identified and, in most cases, not at all. The remaining SDGs (3, 11, 12, 13) co-occurred with nearly all SP components except 'targets' and, in the case of SDGs 12 and 13, 'indicators.' However, these co-occurrences were moderate compared to the prevalent SDGs mentioned above, making up less than 8% of each SP component's occurrences.

5. Discussion

In this article, we explored where segments identified as contributions to SDG appear throughout SPs. The analyses show that segments of text identified as contributions to the SDGs in Canadian university SPs co-occur more frequently with SP components that are broad, overarching statements or goals, such as missions, visions, strategies and objectives, as opposed to the action-oriented means, indicators and targets. This suggests that the identified contributions to the SDGs are more prevalent in broad statements than those detailing specific, measurable actions. This type of engagement with sustainability fits into the “accommodative responses” category of Bieler & McKenzie’s analysis, which was the dominant response amongst Canadian universities studied (Bieler & McKenzie, 2017). They describe this response to SD in SPs as “umbrella statements concerning general commitment to sustainability and [a lack of] details on how this commitment would translate in terms of strategic directions, goals, or specific policy actions” (p.11).

Table 3. Cooccurrence of SDG segments in relation to SP components

SDG*		Mis	Vis	Val	Strat	Obj	Mea	Indic	Targ
	N	94	112	429	1374	1806	1541	778	112
GEN.	n	14	20	27	81	90	53	20	-
	%	14.89	17.86	6.29	5.90	4.98	3.44	3.57	-
SDG 1: No poverty	n	-	-	-	-	4	3	-	-
	%	-	-	-	-	0.22	0.19	-	-
SDG 2: Zero Hunger	n	-	-	-	-	1	5	-	-
	%	-	-	-	-	0.06	0.32	-	-
SDG 3: Health & wellbeing	n	2	6	7	88	91	104	11	-
	%	2.13	5.36	1.63	6.40	5.04	6.75	1.41	-
SDG 4: Quality education	n	66	45	71	317	434	384	111	2
	%	70.21	40.18	16.55	23.07	24.03	24.92	14.27	1.79
SDG 5: Gender equality	n	2		4	38	37	34	26	-
	%	2.13		0.93	2.77	2.05	2.21	3.34	-
SDG 6: Water & sanitation	n	-	-	-	4	1	1	-	-
	%	-	-	-	0.29	0.06	0.06	-	-
SDG 7: Clean energy	n	-	-	-	2	10	7	1	-
	%	-	-	-	0.15	0.55	0.45	0.13	-
SDG 8: Work & growth	n	14	17	10	152	200	228	72	3
	%	14.89	15.18	2.33	11.06	11.07	14.08	9.25	2.68
SDG 9: Industry & innov.	n	14	31	28	220	266	211	51	5
	%	14.89	27.68	6.53	16.01	14.73	13.69	6.56	4.46
SDG 10: Equality	n	34	24	73	247	276	267	108	3
	%	36.17	21.43	17.02	17.98	15.28	17.33	13.88	2.68
SDG 11: Sustainable cities	n	4	5	18	97	73	113	14	-
	%	4.26	4.46	4.20	7.06	4.04	7.33	1.80	-
SDG 12: Consumption	n	1	-	2	8	12	10	-	-
	%	1.06	-	0.47	0.58	0.66	0.65	-	-
SDG 13: Climate action	n	1	2	1	6	16	20	2	-
	%	1.06	1.79	0.23	0.44	0.89	1.30	0.26	-
SDG 14: Life below water	n	-	-	1	4	1	3	2	-
	%	-	-	0.23	0.29	0.06	0.19	0.26	-
SDG 15: Life on land	n	-	-	2	6	4	3	2	-
	%	-	-	0.47	0.44	0.22	0.19	0.26	-
SDG 16: Peace & justice	n	9	19	77	162	246	200	49	4
	%	9.57	16.96	17.95	11.79	13.62	12.98	6.30	3.57
SDG 17: Partnerships	n	6	14	17	127	193	200	41	4
	%	6.38	12.50	3.96	9.24	10.69	12.98	5.27	3.57

*SDG labels have been modified to accommodate table size

With regard to the contributions to specific SDGs in co-occurrence with SP components, all SDGs were identified in relation to the SP components ‘objectives’ and ‘means’. The most

dominant SDGs, those easily associated with the university's triple mission (SDGs 4, 9, 17) and responsible and equitable institutional operations (8, 10 16), were present throughout the plans in co-occurrence with all SP components. It was hypothesized by the authors that the least common SDGs (1, 2, 6, 7, 14, 15) would be more present in action-oriented SP components, due to the precision of their themes. For example, that actions regarding clean water & sanitation would not appear within the overarching strategies of plans but instead within the concrete actions, indicators and targets. This, however, is not the case and only the dominant SDGs mentioned above co-occur with 'indicators'. This supports Leal Filho et al. (2021) finding that, of the 32 universities surveyed internationally in the study, only 13 % of the SDGs were identified as a priority focus. Among the lowest-priority SDGs were SDGs 1 (Poverty), 2 (Hunger), 12 (Consumption and Production), 14 (Life Below Water) and 15 (Life on Land) (Leal Filho et al., 2021).

6. Conclusion

This article presents a novel approach to studying university engagement with sustainable development through co-occurences of contributions to the SDGs with SP components. Despite that the presence of SD in the missions, visions, values, overarching strategies and objectives can be seen as an important step in aligning the university's governance and future with SD, these broad statements must be backed up by concrete action. As several authors have iterated, what is in a plan does not necessarily reflect the true level of action taking place on campus and within the university community (Bieler & McKenzie, 2017, Di Nauta et al., 2020).

Further reflection is required regarding what the strong absence of certain SDGs means in the university context. Is it acceptable that Canadian universities are not including strategies and actions to contribute to goals like SDG 1: No hunger and SDG 2: Zero poverty, or should they be doing more? Future studies could look at the perceived prioritization of the SDGs according to university planners, decision-makers and stakeholders in Canada. Beyond this, future studies could consider other, hopefully complementary, governance documents, such as sustainability policies and action plans, to see if this is where the low-frequency SDGs are addressed.

One limitation of this study includes moderate inter-coder reliability. Due to the interconnected nature of the SDGs, and the nature of coding implicit contributions to them, not just explicit mentions of SD, achieving a strong inter-coder reliability is difficult. The authors do not believe that this should discount the results, but instead that they should be interpreted with caution.

References

Bieler, A., & McKenzie, M. (2017). Strategic Planning for Sustainability in Canadian Higher Education. *Sustainability*, 9(2), 161. https://doi.org/10.3390/su9020161

Byrne, A., Savard, D. & Larouche, C. (in press). Canadian Universities Addressing the Sustainable Development Goals in their Strategic Plans: A Snapshot. In H. Scheute, M. Osborne, R. Zang & Adamu, A.Y. (Eds.), *Higher Education and its Contributions to the SDGs*. Manchester University Press.

Di Nauta, P., Iannuzzi, E., Milone, M., & Nigro, C. (2020). The Impact of the Sustainability Principles on the Strategic Planning and Reporting of Universities. An Exploratory Study on a Qualified Italian Sample. *Sustainability*, 12(18), 7269. https://doi.org/10.3390/su12187269

Fumasoli, T. (2018). *Strategic Planning in Higher Education*. In Encyclopedia of International Higher Education Systems and Institutions (pp. 1–6). Springer Netherlands. https://doi.org/10.1007/978-94-017-9553-1_530-1

Government of Canada. (2021). Canada's 2030 Agenda National Strategy. Retrieved from https://www.canada.ca/en/employment-social-development/programs/agenda-2030.html

Ketlhoilwe, M. J., Silo, N., & Velempini, K. (2020). Enhancing the Roles and Responsibilities of Higher Education Institutions in Implementing the Sustainable Development Goals. In G. Nhamo & V. Mjimba (Eds.), *Sustainable Development Goals and Institutions of Higher Education* (pp. 121–130). Springer International Publishing. https://doi.org/10.1007/978-3-030-26157-3_10

Larouche, C., Larouche, C., Savard, D., Byrne, A., Héon, L. (in press). La planification stratégique et les universités québécoises. In O. Bégin-Caouette, É. Maltais, J. Bernatchez, J. Luckerhoff, M. Maltais & M. Umbriaco (Eds.), *L'Université au Québec: Enjeux et défis*. Les publications du Laboratoire Interdisciplinaire de Recherche sur l'Enseignement supérieur.

Larrán Jorge, M., Herrera Madueño, J., & Javier Andrades Peña, F. (2015). Factors Influencing the Presence of Sustainability Initiatives in the Strategic Planning of Spanish Universities. *Environmental Education Research*, 21(8), 1155–1187. ERIC.

Leal Filho, W., Frankenberger, F., Salvia, A. L., Azeiteiro, U., Alves, F., Castro, P., Will, M., Platje, J., Lovren, V. O., Brandli, L., Price, E., Doni, F., Mifsud, M., & Ávila, L. V. (2021). A framework for the implementation of the Sustainable Development Goals in university programmes. *Journal of Cleaner Production*, *299*, 126915. https://doi.org/10.1016/j.jclepro.2021.126915

Lozano, R., Ceulemans, K., Alonso-Almeida, M., Huisingh, D., Lozano, F. J., Waas, T., Lambrechts, W., Lukman, R., & Hugé, J. (2015). A review of commitment and implementation of sustainable development in higher education: Results from a worldwide survey. *Journal of Cleaner Production*, 108, 1–18. https://doi.org/10.1016/j.jclepro.2014.09.048

Scott, W. A. (1955). Reliability of content analysis: The case of nominal scale coding. *Public Opinion Quarterly*, 19, 321-325.

SDSN Canada. (2023). *Reporting on the Sustainable Development Goals: A guide for Canada's universities & colleges (Canadian Edition)*. Sustainable Development Solutions Network Canada, University of Waterloo.

Vaughter, P., McKenzie, M., Lidstone, L., & Wright, T. (2016). Campus sustainability governance in Canada. *International Journal of Sustainability in Higher Education*, 17(1), 16–39. https://doi.org/10.1108/IJSHE-05-2014-0075

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Coping with the challenge from English-medium instruction (EMI): What learning strategies matter and how?

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Abstract

English-medium instruction (EMI) has witnessed an exponential growth in university education worldwide, especially in East Asian countries and regions in the past two decades. Previous studies have shown that students' learning of academic content might be adversely affected due to limited English proficiency. To overcome the challenges from EMI, students' first language is regarded as one of the resources to facilitate learning. Artificial intelligence (AI) technology is another tool which is increasingly popular yet controversial in teaching and learning. Based on the findings of a survey study conducted in a university in Hong Kong, this paper provides evidence on the effectiveness of the use of students' first language and AI tools in helping students cope with EMI in the university. It sheds light on how universities may respond to students' use of first language and AI in learning through English.

Keywords: *English-medium instruction (EMI); learning strategy; first language; artificial intelligence.*

1. Introduction

Over the past twenty years, there has been an increasing trend of using English as a medium of instruction (MOI) in the higher education sector in many non-Anglophone countries and regions, which is considered both an impetus and an outcome of internationalization (Curle *et al*., 2020). As defined by Macaro *et al*. (2018), EMI is "the use of the English language to teach academic subjects (other than English itself) in countries or jurisdictions where the first language of the majority of the population is not English". On the one hand, EMI is claimed to improve institutional ranking and foster the development of students' English competencies and employability. On the other hand, past studies have shown that learning through EMI may be challenging for students with limited English proficiency. For instance, Shepard and Rose

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(2023) found that EMI posed academic challenges to Chinese-speaking students who constituted the majority of student population in Hong Kong.

To overcome the challenges from EMI, university students deploy different resources and learning strategies. For instance, Soruç and Griffiths (2018) identified 36 strategies used by students in a Turkish university for coping with EMI. Most of them were cognitive strategies such as asking questions, using prior experience and looking for main ideas. Another study by Yu *et al.* (2021) classified the learning strategies used by Mainland Chinese students in a Macau university into four categories, which were first language (L1)-mediated strategy, second language (L2)-related strategy, tool-mediated strategy, and community-mediated strategy. Among them, L1-mediated strategy was found to be a major learning strategy that students used in comprehending course materials. Examples were reading Chinese translations of the original textbooks and translating course PowerPoint slides from English into Chinese. Students also made use of resources from the Internet to facilitate their learning through EMI. Given the rapid technological advancement nowadays, it can be expected that students may rely on online tools and resources more than ever to overcome learning challenges in general and EMI in particular.

According to a review study by Curle *et al.* (2020), the use of first language in EMI settings is generally viewed by content lecturers and students as a useful resource for comprehension of academic content, though translanguaging is often viewed as undesirable in an EMI classroom because it might exclude and disadvantage international students. Despite this generally positive view, it is not conclusive in past literature regarding the effectiveness of first language usage in improving student learning outcomes. On the other hand, with the emergence of tools such as Grammarly and ChatGPT, AI has become one of the most popular yet controversial buzzwords in higher education in the last decade. Students and teachers have mixed perceptions towards the use of AI in EMI settings given its potential benefits and drawbacks (Kikuchi, 2024). More importantly, there is an apparent lack of empirical evidence on the effectiveness of AI usage in higher education, especially in EMI settings.

To address the aforementioned knowledge gap, this study aims to examine the effects of first language usage and AI usage on how university students cope with EMI. It was conducted in a university in Hong Kong, where about two-thirds of lectures and about 80% of tutorials of undergraduate courses are conducted in either English or both English and Cantonese. Three research questions are addressed: Does the challenge from EMI affect student learning outcome in university (**RQ1**)? Does students' use of their first language in coping with EMI affect their learning outcome in university (**RQ2**)? Does students' use of AI tools in coping with EMI affect their learning outcome in university (**RQ3**)?

2. Method

Data were collected from 1158 undergraduate students in a university in Hong Kong by online survey using Qualtrics from May to June 2024. The variables analyzed in this paper include students' English Language results in the university entrance exam, that is, the Hong Kong Diploma of Secondary Education Examination (HKDSE); their cumulative grade point average (CGPA); and their use of first language and AI tools in coping with the challenges from EMI.

Students' English Language results in HKDSE is measured in seven levels, with Level 1 being the lowest and Level 5** the highest. These results are converted into grade points of 1 to 7 respectively in the analysis. Students' learning outcome in the university is measured by CGPA on a 4-point scale, which is the average of all GPAs that students have earned until they take the survey. The challenge from EMI is gauged by a question which asks, "Overall speaking, the medium of instruction in the university has made my study more challenging". It is measured by a 5-point scale which ranges from 'strongly disagree' (1) to 'strongly agree' (5). Finally, students were asked whether they had used different strategies to cope with the challenges from EMI in the university. Among them, the two learning strategies analyzed in this paper are reading textbooks and course materials published in students' first language; and checking grammar mistakes in writing by using AI tools, e.g., Grammarly. Students' responses were converted into dichotomous scores, i.e., 1 (yes) or 0 (no).

3. Results and Discussion

3.1. Descriptive Analysis

Results show that the sample has slightly more females (52.2%) than males. It comprises more students in Year 1 (29.6%) than students in Year 2 (25.9%), Year 3 (21.3%), and Year 4 or above (23.1%). Most of the sample students are local students (85.9%), and the remaining are either Mainland Chinese students (8.7%) or international and exchange students (5.4%). Cantonese is the first language spoken by the most sample students (79.9%), which is followed by Putonghua or Mandarin (11.3%), other Chinese dialects (3.2%) and English (2.6%).

For HKDSE results, a vast majority of sample students have attained Level 3 or above in the English Language exam (97.9%), which is the minimum university entrance requirement. The mean HKDSE English Language grade point is 4.36 which is above average on the 7-point scale. The mean of CGPA is 3.23 which corresponds to an average of B or better in course grade. The mean of the EMI challenge is 2.60 which is below average on the 5-point scale, indicating that in general, students did not think the MOI in the university was particularly challenging to their learning. As for students' use of the two learning strategies, less than one-third of the sample students (29.2%) reported that they read textbooks or reading materials published in their first language. On the other hand, about two-third of the sample students

(63.3%) reported that they checked grammar mistakes in writing by using AI tools, which indicates its popularity among students in polishing writing.

3.2. Correlation and Kruskal-Wallis Test

Correlation analysis shows that the two achievement variables correlate significantly with each other and with the EMI challenge. Specifically, HKDSE English Language grade point correlates positively with CGPA (r = 0.29, p < 0.001). On the other hand, the EMI challenge correlates negatively with HKDSE English Language grade point (r = -0.21, p < 0.001) and CGPA (r = -0.14, p < 0.001).

Results from Kruskal-Wallis test show that students who read textbooks or reading materials published in their first language have a significantly lower HKDSE English Language grade point (4.15) than those who did not (4.45) (p < 0.01). Similarly, students who checked grammar mistakes in writing by using AI tools have a significantly lower HKDSE English Language grade point (4.26) than those who did not (4.55) (p < 0.01). These results imply that the less English-competent students are more likely to make use of their first language and AI tools in learning through EMI.

3.3. Structural Equation Modelling

To investigate whether and to what extent the EMI challenge and the two learning strategies impact on student performance, structural equation modelling (SEM) is used for analyzing the data. To begin with, a base model is constructed which comprises students' HKDSE English Language grade point and CGPA. Mediation models are then constructed by first incorporating the EMI challenge and then the two learning strategies into the base model.

3.3.1. Base Model (Model 1)

The base model is a linear regression model which predicts students' CGPA with their HKDSE English Language grade point. As shown in Figure 1, students' HKDSE English Language grade point has a significant positive effect on CGPA (R^2 = 0.09, F(1,779) = 72.87, b = 0.09, p < 0.001). This is consistent with the findings of previous meta-analyses that university entrance exam score is a significant predictor of college performance (Richardson *et al*., 2012; Westrick et al., 2015).

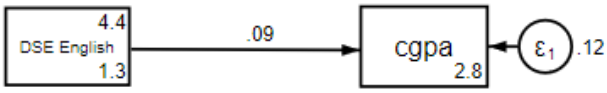


Figure 1. Model 1

3.3.2. Mediation Model (Model 2)

As shown in Figure 2, Model 2 is constructed by incorporating the EMI challenge into Model 1. Results show that students' HKDSE English Language grade point has a significant negative effect on the EMI challenge (b = -0.17, 95% CI [-0.227, -0.114]), and the EMI challenge has a significant negative effect on CGPA (b = -0.05, 95% CI [-0.074, -0.023]). The significance of the indirect effect is tested using bootstrapping procedures. The 95% confidence interval is computed for each of the 5000 bootstrap samples at the 2.5th and 97.5th percentiles. This results in a significant *positive* indirect effect on CGPA through EMI challenge (b = 0.01, 95% CI [0.003, 0.013]). In other words, students who were HKDSE high achievers perform better than HKDSE low achievers in the university partly because they perceive the university MOI as less challenging. On the other hand, students' HKDSE English Language grade point continues to have a significant positive direct effect on CGPA (b = 0.08, 95% CI [0.061, 0.103]). Overall, the results support a partial mediation model between HKDSE English Language grade point and CGPA through the EMI challenge.

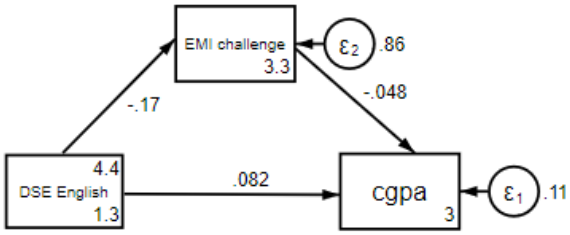


Figure 2. Model 2

3.3.3. Mediation Model (Models 3a and 3b)

Model 3a and 3b are constructed by incorporating the two learning strategies, i.e., the use of first language and AI tools respectively into Model 2. For Model 3a, results show that students with a higher HKDSE English Language grade point are less likely to use first language (relative-risk ratio (RR) = 0.79, 95% CI [0.690, 0.904]), but the use of first language has a significant positive effect on CGPA (b = 0.06, 95% CI [0.010, 0.113]) (Figure 3). By using the same bootstrapping procedures, a significant *negative* indirect effect is found on CGPA through the use of first language (b = -0.01, 95% CI [-0.033, -0.002]). On the other hand, students' HKDSE English Language grade point continues to have a significant positive direct effect (b = 0.08, 95% CI [0.063, 0.105]) on CGPA and a significant positive indirect effect through EMI challenge (b = 0.01, 95% CI [0.003, 0.014]). Hence, the results support a partial mediation model between HKDSE English Language grade point and CGPA through the EMI challenge and the use of first language.

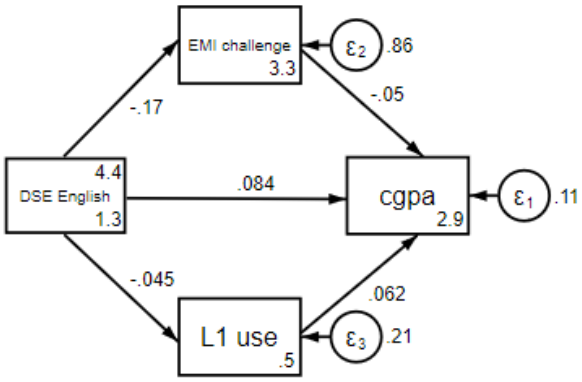


Figure 3. Model 3a

For Model 3b, results show that students with a higher HKDSE English Language grade point are less likely to use AI tools (relative-risk ratio (RR) = 0.80, 95% CI [0.711, 0.911]), but the use of AI tools has a significant positive effect on CGPA (*b* = 0.06, 95% CI [0.009, 0.108]) (Figure 4). By using the same bootstrapping procedures, a significant *negative* indirect effect is found on CGPA through the use of AI tools (*b* = -0.01, 95% CI [-0.028, -0.001]). On the other hand, students' HKDSE English Language grade point continues to have a significant positive direct effect (*b* = 0.09, 95% CI [0.064, 0.106]) on CGPA and a significant positive indirect effect through EMI challenge (*b* = 0.01, 95% CI [0.003, 0.014]). Hence, the results support a partial mediation model between HKDSE English Language grade point and CGPA through the EMI challenge and the use of AI tools.

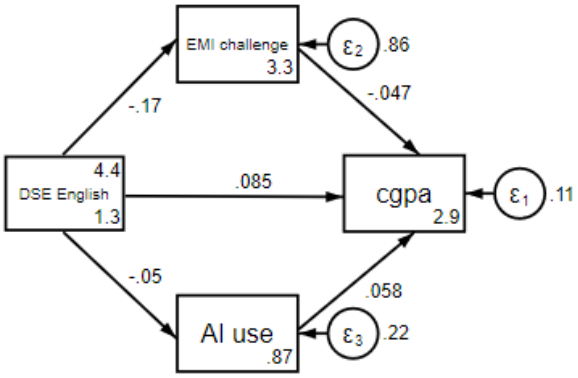


Figure 4. Model 3b

4. Conclusion

The present study provides empirical evidence on the relationships between students' prior achievement, university performance, EMI challenge and two learning strategies in coping with EMI, namely the use of students' first language and AI tools. On the one hand, it substantiates the role of prior achievement in student performance in the university, which has been well documented in past literature. On the other hand, it reveals how challenges from EMI may affect student learning in the university. In addition, the positive effect of the use of first language and AI tools on CGPA is paradoxical yet promising. While the low achievers in HKDSE are more likely to use first language and AI tools in coping with EMI, these two strategies are proved to play a supportive role in their learning. The positive effect of first language use is consistent with the findings of a review study by Chalmers (2019), which showed that systematic use of first language in teaching (e.g., translating key vocabulary into first language) could support student learning of content subjects and English. Chalmers (2019) therefore concluded by suggesting "a welcoming and inclusive attitude towards students' L1" and treating their L1 as "an asset rather than a liability". Regarding the use of AI in EMI settings, a finding in this study that warrants our attention is the high prevalence of use of AI writing tools among students, which reveals how student learning has been transformed by AI. Furthermore, the positive effect of AI usage on student performance as shown in this study may inform university policy and practice in the use of AI in teaching and learning. While the potential benefits of AI should not be neglected, university policymakers should set clear guidelines to delineate AI assistance and plagiarism in writing so that teachers and students can make optimal and effective use of AI. Given the fast-paced development of AI, it can be anticipated that the use of AI is unavoidable in university education. More concerted effort is needed to unveil the possibilities and complexities in using AI in higher education in future.

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References

Chalmers, H. (2019). *The role of the first language in English medium instruction*. Oxford University Press.

Curle, S., Jablonkai, R., Mittelmeier, J., Sahan, K., & Veitch, A. (2020). *English medium part 1: Literature review*. In N. Galloway (Ed.) *English in higher education* (Report No. 978-0-86355-977–8). British Council. https://www.teachingenglish.org.uk/article/english-higher-education-%E2%80%93-english-medium-part-1-literature-review

Kikuchi, H. (2024). Generative AI as a tool for enhancing English medium instruction. In Y. Choubsaz, P. Díez-Arcón, A. Gimeno-Sanz, J. Hriňák, X. Liashuk, S. Pokrivčáková & H. Vančová (Eds.), *CALL for Humanity - EUROCALL 2024 Short Papers.* https://doi.org/10.4995/EuroCALL2024.2024.19027

Macaro, E., Curle, S., Pun, J., An, J., & Dearden, J. (2018). A systematic review of English medium instruction in higher education. *Language Teaching*, *51*(1), 36–76. doi:10.1017/S0261444817000350

Richardson, M., Abraham, C., & Bond, R. (2012). Psychological correlates of university students' academic performance: A systematic review and meta-analysis. *Psychological Bulletin, 138*(2), 353–387. https://doi.org/10.1037/a0026838

Shepard, C., & Rose, H. (2023). English medium higher education in Hong Kong: Linguistic challenges of local and non-local students. *Language and Education, 37*(6), 788–805. https://doi.org/10.1080/09500782.2023.2240571

Soruc, A., & Griffiths, C. (2018). English as a medium of instruction: students' strategies. *ELT Journal*, *72*(1), 38-48. https://doi.org/10.1093/elt/ccx017

Westrick, P. A., Le, H., Robbins, S. B., Radunzel, J. M. R., & Schmidt, F. L. (2015). College performance and retention: A meta-analysis of the predictive validities of ACT® scores, high school grades, and SES. *Educational Assessment*, *20*(1), 23–45. https://doi.org/10.1080/10627197.2015.997614

Yu, S., Wang, Y., Jiang, L., & Wang, B. (2021). Coping with EMI (English as a medium of instruction): Mainland China students' strategies at a university in Macau. *Innovations in Education and Teaching International*, *58*(4), 462–472. https://doi.org/10.1080/14703297.2020.1784248

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Ecopedagogical approaches to language learning and cultivating eco-conscious learners

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Abstract

This paper explores how integrating ecological philosophy and ecolinguistics within teaching strategies can shape learners' attitudes toward the environment and enhance language learning. The project "In Your Own Backyard" involves English language learners in tasks that connect learning with nature. Learner-generated texts are created and analyzed using Ecolinguistic Discourse Analysis (EDA) to classify them as ecologically beneficial, ambivalent, or destructive. Learners also participate in student-led discourse analysis to evaluate these texts. Exploratory findings reveal a significant shift in learners' ecological orientation, with a notable increase in eco-beneficial texts and a decrease in eco-destructive texts. Quantitative data showed improved English proficiency among participants, while qualitative findings highlighted high levels of student satisfaction and engagement. The project demonstrated that integrating ecopedagogy and ecolinguistic discourse analysis in language learning can enhance both environmental awareness and language skills, fostering a deeper connection to nature and critical thinking competencies.

Keywords: *Language Learning; Ecopedagogy; Ecosophy; Ecological Discourse Analysis; Ecolinguistics*

1. Introduction

The theoretical framework of this paper builds on the fundamental principles of ecological philosophy and ecolinguistics. Ecological philosophy combines "a normative set of principles and assumptions about relationships among humans, other forms of life and the physical environment" (Stibbe, 2015, p. 202). It prompts evaluation of human impact in the global ecosystem against a criterion of sustainable harmony (Alexander & Stibbe, 2014, p. 9). Ecolinguistics, more specifically, focuses on "the role of language in the life-sustaining interactions of humans, other species, and the physical environment" (IEA, 2024). Ecolinguistic

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scholars ask how the symbolic verbal practices of humans affect their interaction with the physical environment and other living organisms (Steffenson & Fill, 2014, p. 9). They also seek to orient human language practices towards normative patterns that promote sustainability and safeguard delicate ecological systems (Alexander & Stibbe, 2014, p. 109). Ecolinguistics responds to the recognition that "language does not passively reflect reality; language actively creates reality… [it] shapes experience and transforms our perceptions into meanings" (Halliday cited in Law & Matthiessen, 2023, p. 65). Accessing ecological philosophy through a lens of ecolinguistics makes the abstract concepts of the discipline more tangible and accessible to everyone who uses interacting domains of language.

More specific to the context of language learning in higher education, the theories and practical approaches of ecopedagogy and ecological discourse analysis can be used to integrate ecological concepts in the classroom and beyond. Often attributed to Paulo Friere and his concept of praxis as a strategy of "reflection and action upon the world in order to transform it" (1970, p. 51), ecopedagogy promotes equity and sustainability in the context of social and environmental ecologies to bring justice and harmony to environmental and social systems (Goulah & Katunich, 2020, pp. 2-3). Ecopedagogy in the context of teaching English to speakers of other languages (TESOL) means incorporating a sensory-rich, ecologically-based, and emotionally-considerate approach by integrating all domains for effective language learning (University of Madison, Wisconsin, 2020, p. 12). This approach provides opportunities for learners to take part in dialogue that addresses climate and social justice, such as reflective exercises on the learners' place in the natural ecosystem and society. Another student-centered approach empowers the learner as a discourse analyst (Stibbe, 2015, p. 202), giving them the tools such as the evaluation of appraisal, framing, foregrounding and backgrounding, erasure, agency, and metaphor to evaluate narratives in consideration of their ecological stance (Penz & Fill, 2022, p. 239; Shamaieva et. al., 2023, p. 141). Cheng (2022) explains how Ecological Discourse Analysis (EDA) encourages producers and receivers of language to examine "the stories we live by" and to consider the extent to which nature appears as ecological property. Language learners, guided by a framework of ecological philosophy, can determine whether narratives communicate beneficial (harmonious), ambivalent (not conscious), or destructive (parasitic) relationships with the natural environment. Guided by ecological philosophy, this paper examines how integrating ecological perspectives within teaching strategies can shape learners' attitudes toward the natural environment and enhance language learning. It aims to 1) assess how ecological philosophy and ecolinguistics influence learners' environmental orientation through analysis of learner-produced texts, and 2) explore how ecopedagogy and ecological discourse analysis can enrich second language learning in higher education.

2. Project Description

2.1. Production of Learner Texts

2.1.1. Description of learner participants

The data for this study corresponds to the ongoing project "In Your Own Backyard" and has been compiled using data from 79 high school English language learners from Polish schools in Koluszki, Puszcza Mariańska, and Łódź with a parallel control group of 29 undergraduate English language learners from the University of Puerto Rico at Cayey who produced learner texts and completed analysis of peer texts. Students in the Polish public high school system were in 9th, 10th, and 11th grades, preparing for the national matriculation exam in mixed-ability groups. Their English language levels varied from A2 to B2 in the Common European Framework of Reference for languages (CEFR). The 79 Polish students involved in the project came from diverse backgrounds and regions of Poland including rural communities (Puszcza Mariańska), small townships (Koluszki) and urban centers (Łódź). Student profiles varied in a fairly even distribution, including students focused on natural sciences and the humanities. The 29 undergraduate English language learners attending the University of Puerto Rico at Cayey were all first-year students enrolled in an intermediate English class, required for those who scored 540-640 on the College Board Entrance Exam. The 29 students involved in the project came from diverse socioeconomic backgrounds with significant representation of students from families with modest incomes who qualified for the PELL scholarship. Students mostly came from the catchment area of the university with a high representation of rural communities (e.g., Monte Llano) and small townships (e.g., Cidra). Undergraduate profiles included a high representation of students majoring in the natural sciences and the social sciences, reflective of the wider student population.

2.1.2. Production of learner texts

The project began with a questionnaire collecting ethnographic data on students' status as English learners, their relationship with nature, and project expectations. Over 10 meetings and 5 units, students engaged in tasks that connected language learning with nature. For example, in a community garden task, students raked leaves and practiced using sensory description and figurative language to describe their actions. In another unit, learners were asked to describe their commute to school and then juxtapose their real-life observations with their ideal commute. Then the participants took an online carbon footprint calculator and made a final judgement on weighing the importance of transportation to a place against the ecological impact they have on the planet. These, along with all other units, called for learners to address their real-life interactions with the world in the context of their impact on the world, or in other words, reflecting in ecopedagogical praxis. In each unit, students used online web-based word processing software to draft multimedia texts that integrated the language skills targeted during

the tasks. For example, after tasks related to figurative language and sensory description, students were asked to choose a favorite food and describe it using the five senses and integrating comparative analogy, metaphor or simile. Interaction among students and the instructor was supported through online comments, allowing discussion and motivating learners to improve their work. In addition to descriptive writing, elements of structuring sentences, paragraphs, and evaluative language were included to support both English for academic purposes and general language syntax and phrasing. The focus on standard language skills aligned the project with the established curriculum for both high school and post-secondary level English classes focused on communication for academic purposes. At the end of the project, students completed an exit questionnaire reflecting on their personal experience and the success of the project.

2.2. Analysis of Learner Texts

2.2.1. Ecolinguistic Discourse Analysis

Learner-generated texts are analyzed by the instructor using Ecolinguistic Discourse Analysis (EDA), described by Wu (2018, pp. 646–647) as critical examination of language from an ecological perspective. Wu details a strategy of EDA that identifies the use of framing, metaphor, simile, analogy, symbolism, foregrounding, backgrounding, actor, agency, and appraisal to reveal the explicit and implicit discourses present in the text. Texts were also analyzed in terms of their expressions of ecological property, which are then measured against expressions of sustainability and the ecological philosophy of "diversity and harmony, interaction and coexistence" (Cheng, 2022, p. 189). Overall, the qualitative analysis focused on whether representations of nature in learner texts promote biodiversity, symbiosis, and sustainable coexistence with the more-than-human world, and how they change over time. Each learner text was then classified as either ecologically beneficial, ecologically ambivalent, or ecologically destructive.

2.2.2. Student-Led Discourse Analysis

After determining the viability of the first two stages of the project focused on learner text generation and ecolinguistic analysis, in the third stage of the project, undergraduate students were trained in ecolinguistic discourse analysis. This stage was completed with the 29 undergraduate English language learners from the University of Puerto Rico at Cayey. They first generated learner texts to understand the project context, then analyzed each other's texts using ecolinguistic methods. To simplify the process, students were given an easier version of the EDA, asking them to review learner-generated texts in four areas: 1) Framing Devices—identifying familiar ideas used to present new ones, such as symbolism or metaphor; 2) Foreground and Background—highlighting what is prominent and what is less emphasized; 3) Appraisal Items—identifying direct judgments or opinions; and 4) Actor/Participant Roles—

noting what actions people in the text or image are doing or talking about. Students then used a color-coded 15-point scale to evaluate the extent that the learner text was either pro-nature (green) or anti-nature (red). This scale was then used to classify the text as either ecologically beneficial, ecologically ambivalent, or ecologically destructive, see Figure 1.

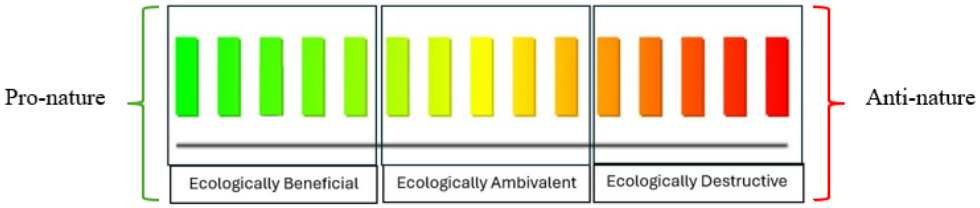


Figure 1. Color-coded 15-point scale used with students to classify the ecological status of the learner text

2.3. Analysis of language proficiency

Methods for assessing learners' language competencies varied by educational context and course. In Poland, high school students' English proficiency was measured using the standard and extended versions of the English section of the Polish national secondary matriculation exam. Their results were compared with peers not involved in the ecopedagogical project. In Puerto Rico, English proficiency was assessed based on the INGL 3103 “Intermediate English” syllabus, comparing project participants with previous cohorts and other course sections. All project participants completed entry and exit surveys to measure engagement, satisfaction, and self-evaluation of language competencies. Instructors also continuously monitored engagement and language competency through formative evaluations in both face-to-face and online modality.

3. Exploratory Findings

Trend analysis in the ongoing project is divided into two sections that respond to the project aims to 1) assess how ecological philosophy and ecolinguistics influence learners’ environmental orientation through analysis of learner-produced texts, and 2) explore how ecopedagogy and ecological discourse analysis can enrich second language learning in higher education. The mixed methodology generated both quantitative and qualitative findings.

3.1. Ecological Orientation in Learner-Produced Texts

Quantitative findings based on instructor-led ecolinguistic discourse analysis of high school English language learners’ texts revealed that there was a significant reduction in ecologically ambivalent narratives over ten meetings and that eco-beneficial texts increased in inverse proportion to the decrease of eco-destructive texts. In response to the first writing prompt in unit

1, 62% of learner-produced texts were eco-ambivalent, compared to only 24% in response to the last prompt (see Figure 2). An increase in ecologically beneficial texts over time is shown in the data, with texts corresponding to prompt 1 (unit 1) indicating that 23% of respondents composed an ecologically beneficial text, and by the last prompt, 72% of learners composed eco-beneficial texts. A comparative decrease in ecologically destructive texts over time is also shown in Figure 2, with analysis corresponding to prompt 1 indicating that 15% of respondents composed an eco-destructive text, but by the last prompt, only 4% of learners composed eco-destructive texts. Refer to Table 1 for a breakdown of numbers and corresponding percentages that determined the trends represented in Figure 2.

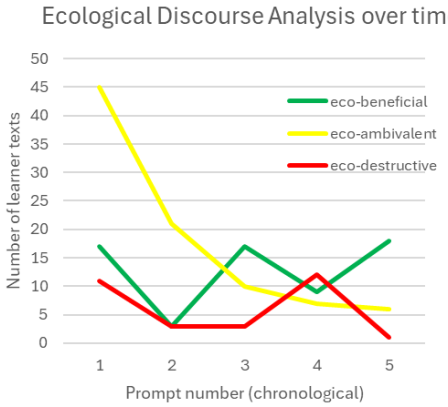


Figure 2. Line graph showing the number of learner texts classified as either ecologically beneficial, ecologically ambivalent, or ecologically destructive over time by the chronological sequence of prompts (1-5) based on instructor-led EDA of high school English language learners' texts (n=79)

3.2. Enhancing Language Learning with Ecopedagogy

3.2.1. Improved English proficiency

Quantitative data based on formal evaluations of high school and undergraduate English language learners reveals increased levels of achievement after participation in project activities. For example, learners who participated in the production of learner texts at Puszcza Marianska, Poland, seemed to benefit from the project in terms of their matriculation exam. Compared with other groups in their graduation year that did not take part in the project, learners scored an average of 83% compared to 66% in the English standard exam and also showed improvements in the extension exam and speaking exam. The undergraduate students who participated in the student-led ecological discourse analysis at the University of Puerto Rico also demonstrated increasing levels of English proficiency as a result of project participation. The EDA analysis, compared to a previous analytical task completed by the same group of students, showed a 2-point percentage increase over time from 88% to 90%. Instructor-led formative evaluation also indicated increasing levels of oral confidence and class engagement over the duration of the project.

Table 1. Data table (corresponding to the Figure 1 line graph) indicating the number of learner texts classified as either ecologically beneficial, ambivalent, or destructive by the chronological sequence of prompts (1-5) with totals and averages indicated, based on instructor-led EDA of high school English language learners' texts (n=79)

Prompt #	# of responses (n=79)	eco-beneficial		eco-ambivalent		eco-destructive	
1	73	17	23%	45	62%	11	15%
2	27	3	11%	21	78%	3	11%
3	30	17	57%	10	33%	3	10%
4	28	9	32%	7	25%	12	43%
5	25	18	72%	6	24%	1	4%
Total #	183	**64**		**89**		**30**	
Average %			**39%**		**44%**		**17%**

3.2.1. Student satisfaction and engagement

Qualitative findings from exit questionnaires among learners revealed high levels of comprehension of ecological philosophy and satisfaction with language-learning. Learners in Polish high schools showed that most (83%) understood that language influences behavior, and one participant realized: "Through using teaching methods related to nature, we were shown that we need to take care of it." Learners also highlighted the value of learning in their own ecology and commented that nature is not abstract, but "something local surrounding us." High school learners also expressed satisfaction regarding academic competencies, shown in comments like "My language skills really increased." Similarly, the undergraduate learners at the University of Puerto Rico found the EDA analysis beneficial for critical thinking and connected ecological philosophy to broader concepts like lifestyle, mental health, and political policy. They learned strategies for critical analysis and connected the relevance of ecological philosophy to individualism, for example, one student recognized, "Thinking that people are independent of nature is a misconception. We actually need nature more than it needs us." Another commented, "This assignment has taught me [a] process of critical analysis [that has] helped me view the text from different angles." Overall, learners enjoyed the project and found its activities enriching both academically and personally.

4. Discussion

4.1. Ecological Orientation in Learner-Produced Texts

Over the course of the project, eco-pedagogical strategies shifted learners' attitudes positively, reducing ambivalent and destructive views in alignment with theoretical insights from

ecological philosophy. There was a 49% increase in ecologically beneficial narratives, a 38% reduction in ambivalent narratives, and an 11% decrease in destructive narratives, reflecting the impact of ecopedagogical praxis, which uses sensory-rich language learning to encourage reflection on students' immediate ecology. Prompts encouraging participants to track their carbon footprints reinforced the idea that ecological impact is within their control, rather than a distant issue. This aligns with ecolinguistic literature suggesting that the stories we live by influence behavior (Halliday, 1990, in Law and Matthiessen, 2023, p. 65). By the end of the course, learners demonstrated a stronger sense of agency and a shift toward more sustainable attitudes, supported by exit questionnaires and ecological discourse analysis. However, prompt four revealed an anomaly, showing a 43% increase in eco-destructive narratives, likely due to its direct focus on consumer habits, with 57% of learners explicitly acknowledging the need for change. Exit questionnaire trends further indicated that learners embraced the idea that language influences behavior, as Halliday notes: "language has the power to shape our consciousness…and manipulate their environment" (2001, p. 180). By the end, learners overwhelmingly viewed nature as "home" and expressed a strong sense of shared responsibility, reflecting Paulo Freire's praxis of "reflection and action upon the world in order to transform it" (1970, p. 51), evident in their use of collective pronouns like "our," "us," and "we" in the exit questionnaire.

4.2. Enhancing Language Learning with Ecopedagogy

Increased levels of learner achievement related to language competencies may be a direct result of their engagement and satisfaction with the project and its environmental immediacy. For example, the learners at Puszcza Marianska who saw a 17% average increase in English standard exam compared to students not involved in the project also reported a consistent sense of positivity during project activities. It is also notable that most students in the standard exam stream typically have less exposure to English and experience lower motivation to learn it. In contrast, teacher evaluations from Tanski Public High School in Puszcza Marianska highlighted how students developed intrinsic motivation and a collaborative mindset through tangible outcomes, like garden harvests and growing vegetation, rather than relying on grades (M. Drazikowska, personal communication, September 29, 2024). At the University of Puerto Rico, student-led EDA proved effective not only in revealing attitudes toward natural ecology but also in teaching critical thinking skills. Integrating the eco-pedagogical and ecolinguistic theories of scholars like Arron Stibbe, Arne Naess, Ming Cheng, and Changchen Ha fosters multi-disciplinary spaces that help students address growing eco-anxiety. Bhaskaran and Muralidharan note that this anxiety is particularly prevalent among young people who feel overwhelmed by the rapid pace of climate change and guilty about their perceived powerlessness (2025, p. 61). Yet, in this context of potential despair, multi-sensory expressions emerged as key indicators of effective language learning and increased mental health, as students in the project expressed meaningful emotional response with nature foregrounded in

the articulation of their experiences. From a teaching perspective, evaluations suggest that learner achievement stems from being immersed in meaningful contexts of language learning and use.

4.3. Challenges

Although we believe that the results of this study are reliable and replicable, we acknowledge the challenges that may have impacted the data. One challenge was the consistency of lessons. For instance, in Poland, lessons were conducted at varying intervals when the researcher was available to volunteer to teach at participating institutions, which was further complicated by a period of medical leave and heavy workload. Given this situation, there were sometimes inconsistent timetables for completion and different modalities between lessons for different groups. Another challenge was completion of exercises since not all learners finished their work. Specifically, in Puerto Rico, undergraduate participants sometimes missed class and were not responsible for completion of the generation of their own texts or analysis of each other's texts. To mitigate the effect of such challenges, future work could integrate strategies for more consistent lesson schedules and build in procedures to strive for full participation.

5. Conclusion & Closing Thoughts

This project achieved its aims to 1) assess how ecological philosophy and ecolinguistics influence learners' environmental orientation through analysis of learner-produced texts, and 2) explore how ecopedagogy and ecological discourse analysis can enrich second language learning in higher education. Our data and analysis show that student engagement with the project and its ecopedagogical praxis not only increased environmental awareness and the production of eco-beneficial texts but also increased levels of learner achievement related to language competencies. The relevance of these findings is significant in a world where humans are becoming increasingly disconnected from the natural world due to a growing detachment from the sensory experiences that link us to our interdependent ecology (Abram, 2012, p. 22). This disconnection is furthermore reinforced by recurring narratives of consumption. By engaging with nature and enabling learners to critically examine the narratives they (re)produce, we can re-establish a conscious connection to our ecosystem. The "In Your Own Backyard" project draws from ecosophy to emphasize the importance of addressing ecologically harmful language in communication and education. We propose that through eco-pedagogical strategies for composition and critical analysis, learners can develop language competencies whilst also returning to fundamental human values inspired by principles of diversity, harmony, and coexistence with nature. This study will be of interest to educators, linguists, environmentalists, and researchers focused on ecological pedagogy and language learning. Its relevance extends to those seeking innovative methods to integrate ecological awareness into educational practices. By highlighting the intersection of language and environmental consciousness, this research

contributes to broader discussions on sustainable education and the role of language in shaping our relationship with nature.

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References

Abram, D. (2012). *The spell of the sensuous: Perception and language in a more-than-human world*. Vintage.

Alexander, R. & Stibbe, A. (2014). From the analysis of ecological discourse to the ecological analysis of discourse. *Language Sciences, 41* (A), 104-110. https://doi.org/10.1016/j.langsci.2013.08.011.

Bhaskaran, A., & Muralidharan, S. (2025). Mental health risks due to climate change: Eco-anxiety amidst the challenges of climate change. In J. Kurebwa & D. Makwerere (Eds.), *Managing the health risks of climate change*, 57-82. IGI Global Scientific Publishing.

Cheng, M. (2022). Theoretical framework for ecological discourse analysis: A summary of new developments of Ecological Discourse Analysis. *Journal of World Languages*, *8*(1), 188-226. https://doi.org/10.1515/jwl-2021-0030.

Freire, P. (1970). *Pedagogy of the oppressed*. Continuum.

Goulah, J. & Katunich, J. (2020). *TESOL and sustainability: English Language teaching in the anthropocene era.* Bloomsbury Academic.

Law, L. & Matthiessen, Ch. M. I. M. (2023). Revisiting Halliday (1990) "New ways of meaning: The challenge to applied linguistics": What has changed and what still needs to be done? *ResearchGate*. https://doi.org/10.13140/RG.2.2.15700.48001

Penz, H., & Fill, A. (2022). Ecolinguistics: History, today, and tomorrow. In M. H. Chau & G. M. Jacobs, (eds.), *The Journal of World Languages, Special Issue: Practical applications of ecolinguistics.* # issue. Journal of World Languages, 8(2): 232-253. https://doi.org/10.1515/jwl-2022-0008

Shamaieva, I., Paschal, M. J., & Gougou, S. A. M. (2023). The ECOSOPHY concept in discourses of language education: A cross-cultural perspective. *Cognition, Communication, Discourse*, 26,140-151. https://doi.org/10.26565/2218-2926-2023-26-08

Stibbe, A. (2015) *Ecolinguistics: Language, ecology and the stories we live by.* Routledge.

Steffensen, S. V. & Fill, A. (2014). Ecolinguistics: The state of the art and future horizons. *Language Sciences*, 41, 6–25. https://doi.org/10.1016/j.langsci.2013.08.003

IEA [The International Ecolinguistics Association]. (2024). Home page. University of Gloucestershire, UK. https://www.ecolinguistics-association.org/

University of Madison, Wisconsin. (2020). WIDA [World-Class Instructional Design & Assessment]:English Language development standards framework. University of Madison, Wisconsin.

Wu, Y. (2018). Ecological Discourse Analysis. In X, Xiao, T. Hauer & S. A. Rehman Khan (eds.) *Proceedings of the 2018 4th International Conference on Social Science and Higher Education (ICSSHE 2018),* 646-649. Atlantis Press. https://www.atlantis-press.com/proceedings/icsshe-18

Zhou, W. (2021). Ecolinguistics: A half-century overview. *Journal of World Languages* 2021;7(3): 461-486. https://doi.org/10.1515/jwl-2021-0022

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Challenges in Tandem Language Learning

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Abstract

This study explores the challenges and dynamics of tandem language learning, where two individuals from different linguistic backgrounds collaborate to improve their language skills. Through a questionnaire and analysis of reflection papers, the research investigates three key areas: organizational aspects, language proficiency, and personal interaction. Findings reveal that while scheduling conflicts and time zone differences are common, most participants manage to maintain regular contact through flexible and digital communication tools. Language barriers were primarily addressed through clarification and paraphrasing, with cultural misunderstandings occurring less frequently. The study also highlights the importance of motivation and balanced engagement, noting that unequal commitment between partners can impact the experience. Despite these challenges, participants reported high satisfaction, demonstrating that tandem learning is an effective method for fostering linguistic and cultural exchange. The research suggests strategies to improve engagement for future programs.

Keywords: *Tandem language learning; autonomous learning; learning challenges.*

1. Introduction

In an increasingly globalized world, the ability to communicate across languages is not only a valuable skill but often a necessity. Tandem language learning, a method in which two individuals with different native languages collaborate to learn each other's language, has gained prominence as an interactive and learner-centered approach. Unlike language learning in traditional classroom settings, tandem learning offers students the opportunity to engage in authentic communication, fostering both linguistic and cultural exchange. Since the learners can choose topics and decide individually which areas of language they want to improve, this approach offers benefits that regular language classes cannot.

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Despite its benefits, this learning method presents unique challenges that can influence its overall effectiveness. These challenges stem from various factors, such as differing levels of linguistic proficiency, unequal commitment or motivation between partners, and the complexities of providing constructive feedback in a foreign language. Furthermore, sociocultural dynamics and the absence of structured guidance often influence the learning outcomes.

Previous studies have examined challenges and issues related to tandem language learning from the perspective of the organizer (Helm, 2015) or with regard to tandems as part of a formal educational context, i.e., classroom tandems (Elo & Pörn, 2021). This paper seeks to explore the key challenges faced by learners in tandem language learning and their impact on the efficacy of the process.

2. Data and method

To investigate the challenges faced in tandem language learning, a questionnaire was designed as the primary data collection tool. The questionnaire consisted of three sections, each addressing a specific category of potential challenges:

1. Organizational Aspects – This section addressed challenges related to scheduling, balancing responsibilities, and maintaining consistent participation.

2. Language Aspects – Questions in this category examined issues related to linguistic proficiency, error correction, and language practice.

3. Personal Interaction – Questions focused on interpersonal dynamics, including cultural differences, levels of engagement, and mutual support within partnerships.

The questions were based on assumed and previously reported challenges. Participants completed the questionnaire anonymously to encourage honest and reflective responses.

This questionnaire study involved 25 participants, comprising 16 females and 9 males, who engaged in tandem language learning partnerships in the current or previous semesters. The participants were university students from the Ruhr-Universität Bochum in Germany and the Virginia Tech in the U.S. On the German side, the group included both native German speakers and international students with various linguistic and cultural backgrounds, fostering a diversity of perspectives and experiences. The U.S. participants were native English speakers learning German, with no international students included in this group. The participants in this study were drawn from two distinct tandem learning settings. The first group consisted of students enrolled in a regular tandem program, which runs over the course of an entire semester. This program is open to any language combination, provided that suitable matches between participants can be found. In this setting, participants are responsible for managing their own

schedules as well as choosing when and where to meet their partners and which material to work with. The second group consisted of students who participated in a group tandem program held on campus. This program provided a more structured environment, as sessions were held at predetermined times and locations, and material was made available upon request.

In addition, 30 reflection papers from previous participants were evaluated and compared to the results from the survey.

3. Findings and discussion

In this section, we analyze the findings of our study, focusing on three key areas of investigation: challenges in organizational aspects, language aspects, and personal interaction. Each section had 9 to 11 questions.

3.1. Organizational challenges

Among the various challenges identified in tandem learning, organizational issues often prove to be more complex than expected and may impact the structure, coordination and overall success of collaborative efforts.

3.1.1. Differences in academic calendars, program timeframes, and local time

A major challenge is the different academic calendars followed in both countries. Whereas German semesters run from October through February and April through July, the U.S. system has a fall semester from late August to December and spring semester from January to mid-May. The tandem program requires at least 13 weeks, which is likely to result in one participant having to meet during a semester or holiday break. The semester breaks posed a particular problem because many students (at the German university) work a lot during that time while also writing exams.

More than ¾ of the respondents indicated that time challenges were the major reason for difficulty in scheduling meetings. Finding a meeting time was more difficult than expected for slightly more than half of the respondents. U.S. students reported difficulties in planning meetings especially during holiday breaks but also during the semester given academic workloads. This was confirmed by German students who worked with partners abroad. The timeframe of early morning in the U.S. and mid-afternoon in Germany seemed to be the best solution. One American student reported missing meetings because of miscalculations due to the switch to and from daylight savings time, which occurs on different days in Germany and the U.S.

Even within the structured framework of the group tandem, participants encountered difficulties with meeting times; a recurring issue was partners failing to arrive on time for meetings, which was unexpected given the program's clearly defined schedule and timeframe.

However, the majority of respondents indicated that they encountered no or minimal challenges in establishing regular meeting times. Consequently, the challenges posed by time constraints did not prove to be significant enough to interfere with the regularity of meetings. In general, the significant portion of participants found it relatively easy to stay connected, even though most respondents experienced occasional challenges in remaining in contact. The majority of respondents, 11 out of 24 (about 46%), reported that there were periods of time during the program when it was sometimes difficult to remain in contact with their tandem partner. A smaller group, 5 respondents (around 21%), found it seldom difficult, while an equal number, 5 respondents (also 21%), said they never had difficulty staying in touch. Only 3 respondents (12%) indicated that it was very often hard to maintain communication.

Some students continued to meet with their tandem partner after the program had officially concluded. However, time constraints ultimately led to an end to the meetings. This suggests that the clear structure of the program, with an official start and end, plays a crucial role in helping participants navigate time management challenges effectively.

3.1.2. Logistics

For the majority of participants (76%) it was not a problem to agree on a meeting format. For pairs consisting of an American and a German student, the format was largely predetermined, as they had to rely on video conferencing tools such as Zoom to conduct their sessions. Some participants from the German university who could have met in person chose to hold their tandem sessions via video conferencing tools as well. Their differing class schedules made it easier to meet in the evening online, avoiding the need for additional travel.

Technological advances have made online tandems much easier to initiate. There are now a variety of online exchange opportunities, including Microsoft Teams, Skype, WhatsApp Video, and Zoom. This made the challenge of selecting an appropriate format for online tandem sessions obsolete. The most common online meeting formats were Zoom and WhatsApp with 11 of 23 respondents (48%) identifying the former and 9 (39%) the latter. The American students preferred Zoom 4:1, whereas the German students were almost evenly divided between the two platforms (7:8). A 2020 survey corroborates the preference for Zoom (Di Gennaro & Ojeda, 2021, p. 16). However, although WhatsApp has traditionally been associated with text messaging, recent developments have made it popular for audio/video calls as well, and it is perceived as providing a more casual video calling experience than Zoom, which offers a more structured environment geared toward professional interactions. As O'Dowd (2021, p. 220) notes, students also have begun using communication tools in tandem programs that they use

regularly in their everyday lives; this would also explain the shift to WhatsApp. It is unclear what functions on WhatsApp students in this study used.

American students reported more technical difficulties than the German students, although only one of the 21 respondents indicated that difficulties occurred very often. A majority of the German students (75%) indicated that they never encountered technology issues; however, this may include students who met at least occasionally in person. Nonetheless, such concerns did not appear to have any negative impact on the tandem experience for either group of students.

Out of the 15 participants who met face-to-face, 4 were part of the group tandem that provided designated rooms. However, two participants still reported difficulties in finding an ideal meeting place due to the main room being very noisy and the limited availability of smaller rooms, which prevented each group from having its own space. One participant reported that even working in a room with only one other tandem pair was distracting, especially during challenging phases. The availability of quiet workspaces was also mentioned as an issue by one student from the regular program who worked on campus. However, it appeared that this issue was not as significant as initially anticipated. Nevertheless, making students aware of ideal working environments and encouraging them to avoid noisy places, such as cafés, could help them work more efficiently from the outset.

Interestingly, 10 out of 25 participants (40%) reported that finding suitable materials was never difficult. This contrasts with the fact that it was a common complaint raised during the reflection sessions and frequently mentioned in the final reflection papers. Of those who encountered difficulties, 8 participants (32%) indicated that it was very often difficult, and 7 (28%) stated that it was sometimes challenging. This issue persisted even in the group tandem, despite the possibility of asking for materials or receiving suggestions on how to proceed if necessary.

3.2. Language challenges

3.2.1. Linguistic Proficiency and Educational Background and Misunderstandings

The prerequisite for participation in the tandem program is at least B1 level of proficiency in the target language and C1 in the primary language. Neither the American nor the German students were tested to confirm linguistic proficiency; students self-identified their level as part of the application process.

As foreign language learning, especially at the university level, continues to plummet in the United States (Quinn, 2023), it seems likely that the linguistic gulf between American and German students will continue to increase. Although many U.S. students who study a language in college began learning it in secondary (and occasionally grade) school, the experience cannot be compared to the 8 years of English typical of the curriculum of a German secondary school student who attends the university. To this may be added the likelihood of German students

having visited an English-speaking country, whereas American students often have not traveled to a German-speaking country, or if so, only for a very short period of time.

While 32% of participants reported experiencing communication problems often or very often due to differences in language abilities, a larger proportion (44%) indicated that they needed to ask for clarification often or sometimes during their sessions. This suggests that outright communication barriers due to language skills were less frequent, but misunderstandings requiring clarification were more common. Among those who had communication problems, 12 participants attributed the need for clarification to their own lack of language abilities, while 6 participants pointed to their partner's linguistic abilities as the reason. This tendency to attribute misunderstandings to their own language abilities rather than those of their partner could also reflect a sense of modesty or self-criticism among participants, as they might hesitate to place responsibility on their partner.

Except for one pair, participants found effective ways to navigate communication difficulties by using translation tools, paraphrasing, or simplifying their language. However, one pair struggled significantly because one partner was uncooperative and had to be repeatedly asked to slow down and allow the other person time to write down new words and sentences. Since this occurred during the group tandem, it was easy for the foreign language teachers, who also served as tandem organizers, to intervene and address the situation by providing immediate assistance and suggestions. For the regular tandem, coaching and general availability of the organizers can help overcome such problems before the struggling participants decide to quit.

Students were generally able to resolve communication challenges through a variety of methods. English was used as an intermediate language by some pairs, whereas others defaulted to the language they determined as the easier one and paraphrased their ideas. Not surprisingly, online translation tools such as DeepL and Google Translator were employed as well. Students noted the importance of having time to write down new words and sentences.

3.2.2. Cultural Dynamics

Challenges in communication seemed to result primarily from linguistic issues. Misunderstandings on account of cultural differences occurred very often or sometimes only 17% of the time. Although the tandem experience is ostensibly focused on language skills, the students commented frequently on how interesting it was to learn about another culture and how much fun they had talking about cultural differences.

3.3. Challenges in personal interaction

3.3.1. Power Dynamics and Role Negotiation

Tandem learning, by its nature, involves a partnership where learner autonomy develops interactively. According to Little (2001, pp. 31–32), "accepting responsibility for one's own

learning necessarily entails accepting responsibility also for the learning of one's partner". However, the traditional pedagogy model, where the teacher holds the initiative, might lead participants to believe that the native speaker should dominate in their language (Little, 2001). This dynamic may exacerbate the asymmetry between the less and more proficient speakers (Vassallo & Telles, 2006), but this has only been mentioned by one person whose partner had significantly stronger language skills, creating a pronounced imbalance in their linguistic competencies. In general, participants seemed to negotiate a balanced conversation with their partner during tandem meetings, with the majority (79%) indicating that they seldom or never encountered difficulties because one partner monopolized the conversation, and they did not have an adequate opportunity to speak.

Difficulties resulting from personal differences were seldom or never an issue 88% of the time. Only one participant reported that a partner had asked an inappropriate or awkward question during a tandem conversation.

3.3.2. Motivation and Engagement

Motivation and engagement among respondents were notably high, as all students had voluntarily applied to participate in the tandem program, demonstrating their genuine interest in the opportunity. While students could earn credit for the experience by completing additional assignments, the majority of German participants joined primarily to improve their language skills rather than to fulfill academic requirements. Out of 25 respondents, 24 indicated that they were either very motivated or motivated to meet regularly with their tandem partner. However, only 18 of these felt that both they and their partner were equally engaged in the partnership. Usually initial enthusiasm is high, but motivation sometimes declines over time due to additional responsibilities or challenges in managing the partnership. The need for partners to take responsibility for their own learning—and, by extension, their partner's learning—can make sustaining motivation more difficult. It is interesting that even though the majority felt that they were not equally motivated, this did not seem to stem from preparation. 76% of respondents reported no difficulties due to inadequate preparation by their partner. The remaining 24% attributed the lack of preparation to their partner rather than themselves. Notably, none of the American students reported difficulties stemming from their partner's lack of preparation.

During the program orientation, the importance of identifying tandem learning objectives was emphasized. Nonetheless, 16% of respondents (4 of 25) admitted they had no specific learning objectives. Among those who did, 86% claimed to have achieved their goals. The most challenging areas for improvement were speaking fluently (for both German and American students), vocabulary (for German students), and producing spontaneous responses. Pronunciation was identified as a concern only by German participants.

3.3.3. Feedback and Interaction

Providing and accepting feedback was generally simple for participants. 84% of respondents reported that it was very easy or easy to provide constructive feedback to their partner. The German participants were evenly divided on grammar, pronunciation, and vocabulary as the most difficult areas to correct (28-32% each), while American participants focused almost exclusively on grammar (80%) and pronunciation (20%). This discrepancy may stem from the lack of emphasis on grammar explanations in U.S. English classes.

All respondents indicated that it was either very easy or easy to accept constructive feedback from their partners. This suggests a high level of comfort between partners and the development of effective feedback strategies. Despite differences in age, personal backgrounds, academic experiences, and expectations, participants negotiated these factors effectively to achieve their tandem program goals. The importance of providing and receiving feedback was stressed in the tandem orientation which may have led to few problems in this area as students were aware of it beforehand.

4. Conclusion

The initial aim of this study was the assumption that there are several challenges that hinder effective learning. However, the findings indicated that while these challenges are indeed present, they are not as substantial as originally presumed, and participants appear to be generally capable of identifying solutions. This study has highlighted several key challenges within the tandem learning process, including organizational issues, language proficiency discrepancies, and personal dynamics between partners. Although logistical challenges such as differing academic calendars and time zones were common, the majority of participants were able to navigate these with flexibility and technology. Linguistically, communication barriers were most often resolved through clarification, paraphrasing, and translation tools, with participants demonstrating adaptability in overcoming these difficulties.

Cultural differences, while present, did not significantly hinder communication, and students enjoyed learning about each other's cultures. The power dynamics and motivation levels between partners showed variation, with some instances of imbalanced engagement. However, the overall high motivation to improve language skills and the ability to provide and receive constructive feedback contributed to a positive tandem experience. Despite the occasional challenges, the study demonstrates that tandem learning remains an effective method for language acquisition, offering valuable opportunities for personal growth and intercultural communication. The set structure of the program, which begins with an introduction and orientation for all participants may play a crucial role in helping participants overcome challenges. Future research could compare less structured tandems to assess the impact of guidance.

References

Di Gennaro, C. M., & Ojeda, Y. E. V. (2021). Telecollaboration in the Era of Coronavirus. *International Journal of Language and Literature*, *9*(2). https://doi.org/10.15640/ijll.v9n2a2

Elo, J., & Pörn, M. (2021). Challenges of implementing authenticity of tandem learning in formal language education. *International Journal of Bilingual Education and Bilingualism*, *24*(6), 771–784. https://doi.org/10.1080/13670050.2018.1516188

Helm, F. (2015). The Practices and challenges of telecollaboration in higher education in Europe. *Language Learning & Technology*, *19*(2), 197–217.

Little, D. (2001). Learner autonomy and the challenge of tandem language learning via the Internet. In A. Chambers (Ed.), *Language learning and language technology: Vol. 1. ICT and language learning: A European perspective* (pp. 29–38). Lisse, Netherlands: Swets & Zeitlinger Publishers.

O'Dowd, R. (2021). Virtual exchange: moving forward into the next decade. *Computer Assisted Language Learning*, *34*(3), 209–224. https://doi.org/10.1080/09588221.2021.1902201

Quinn, R. (2023). Foreign Language Enrollment Sees Steepest Decline on Record. Retrieved from https://www.insidehighered.com/news/faculty-issues/curriculum/2023/11/16/foreign-language-enrollment-sees-steepest-decline-record

Vassallo, M. L., & Telles, J. A. (2006). Foreign language learning in-tandem: Theoretical principles and research persepctives. *The ESPecialist*, *27*(1), 83–118.

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Open Educational Resources in Science Education: A Case Study from an American University

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Abstract

The high cost of textbooks and educational resources presents a significant barrier to student success, particularly in science education, where course materials can be prohibitively expensive. Open Educational Resources (OER) provides a promising solution by offering free and accessible learning materials. This paper presents a case study on the implementation of OER in several science courses at Georgia Southern University, USA. It highlights the state and institutional efforts that promoted and supported OER initiatives, discusses the specific courses that created and adopted OER and their impact on student outcomes. The paper outlines some important considerations in how to make OER initiatives sustainable.

Keywords: *OER; science education; affordability, library support*

1. Introduction

The need for affordable learning resources is well established, as are the benefits of leveraging open resources in the classroom. In 2023, Smith et al. published a profound work detailing the connection between affordable course materials and student pedagogical enhancement. Additionally, OER has been shown to mitigate the financial burden associated with acquiring textbooks among first-generation students (LeMire et al., 2024) and facilitate students' financial well-being (Lo et al., 2023). Cho and Permzadian (2024) further highlighted the academic benefits of using OER, such as higher course completion rates and increased accessibility to higher education. A brief review of the literature demonstrates the revolutionary potential of OERs in the classroom and beyond. From making higher education more affordable to increasing student success rates and grades, OER is a powerful force whose benefits extend into the workforce. If the goal of higher education is to prepare students to be critical thinkers in the workforce, then OER has the potential to diversify the workforce. This is crucial for all professions, but the

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sciences especially benefit from OER's advantages. According to Vichare et al. (2024), "Diversity in the health care workforce is essential for addressing racial health inequities. Policies need to address problems in pathways to medical education, including failures to recruit, nurture, and retain URiM [underrepresented in medicine] students" (p. 383). OER directly addresses that need. This proposal, then, is situated within two scholarly paradigms: OER and sciences. The authors hope to bridge the discourse and demonstrate how OER can be implemented successfully in science education.

2. Strategies for promoting and sustaining OER use in higher education

2.1. Institutional effort

The Open Educational Resources Team at Georgia Southern University is a university-level-committee dedicated to promoting and supporting OER and Open Educational Practices (OEP) within the institution. The committee plays a key role in advocating for OER adoption and serving as a resource for faculty and staff engaging in OER initiatives. The committee is formed of both faculty and staff from diverse academic backgrounds and represents a grassroots effort, indicative of faculty leadership in the field. The goals of the committee include:

- Increasing awareness and institutional support for OER through events such as OpenEd Week and Open Access Week.
- Monitoring OER adoption and usage in university courses by gathering data from Affordable Learning Georgia and faculty reports.
- Supporting faculty in recognizing OER's role in tenure and promotion processes
- Encouraging faculty research initiatives related to OER.

Committee members actively contribute to achieving semester-specific goals through collaborative efforts between meetings. As a team, members presented on-campus and at national and international conferences, developed a rubric identifying how OER can contribute to teaching, research and service areas and strengthened institutional commitment to affordable and inclusive education while supporting student success and faculty development.

2.2. State effort

Affordable Learning Georgia (ALG) started as a pilot initiative in the state of Georgia, USA, to reduce the cost of course materials for students and enhance the discovery of library materials through GALILEO (GeorgiA LIbrary LEarning Online). This is a University System of Georgia initiative that provides subscription-based access – via public schools, academic libraries, and public libraries – to a wide variety of digital resources, which would otherwise be inaccessible to the general public. ALG aims to promote the use of no-cost and low-cost educational resources in place of commercial textbooks and mirrors the University System of Georgia's

strategic plan to address affordability. To achieve these goals, ALG offers grants that support faculty, librarians, instructional designers, and other staff in transitioning to more affordable course materials. These grants help expand the adoption, adaptation, and creation of OER, encourage the use of free materials available through the libraries, and ultimately contribute to student retention, progression, and graduation by lowering material costs (Affordable Learning Georgia, n.d.). ALG offers two main grants for OER adoption.

- Transformation Grants: These grants assist individual instructors, teaching teams, or entire departments in replacing commercial textbooks with no-cost or low-cost learning resources. By facilitating the transition to alternative educational materials, Transformation Grants help improve affordability without compromising educational quality.
- Continuous Improvement Grants: Focused on the sustainability and enhancement of existing OER, these grants support projects that involve significant revisions, the development of supplementary resources, or the replacement of current OER with improved versions. This category ensures that open educational materials remain relevant, high-quality, and effective for student learning.

Several years ago, ALG added a third type, a research grant, whose main goal is to research the impact of OER. By providing these grant opportunities, ALG fosters the growth of affordable learning initiatives across institutions, supporting faculty and staff in their efforts to create a more inclusive and cost-effective academic environment. Since its inception in 2014-2015, ALG have saved students more than $195 million, affected more than 1.4 million students and funded projects at all 26 USG institutions (800 applications received and over 600 projects funded). In the last ten years, our institution was awarded 57 grants for a total of $766,956. These grants led to total savings of over $8mln and benefited over 52,000 students (Affordable Learning Georgia, n.d.)

3. OER in science classes

We discuss two examples of funded ALG projects at our institution that focused on two science classes.

3.1. Forensic Chemistry

3.1.1. Course Context

The Forensic Chemistry course is an undergraduate specialized course that is offered only in the face-to-face format, once per academic year. The prerequisites are a full year of general chemistry, organic chemistry, and analytical chemistry courses, one of which already uses OER materials (organic chemistry). The course enrolls 31 students (undergraduate and graduate level)

on two separate campuses and for that reason was offered on a site-synchronous platform. In addition, the course is set to align with the techniques of a Course-based Undergraduate Research Experiences (CURE) learning environment. Students were able to describe and define the major topics in forensic science such as demonstrating lab safety, processing a crime scene, collecting, and analyzing evidence, critique the use of forensic evidence in historical crime scenes and finally drawing conclusions based on collected data and key findings.

3.1.2. Goals of the Project

The goal of our project was to develop online OER material for the course and provide supplementary materials such as case studies, investigative approaches, technique videos, etc. that align with the course materials, and departmental and institutional needs. All developed resources were shared with the department, as well as on the OER commons platform.

3.1.3. Process

The project team consisted of three faculty members from two departments, one of which was our assessment lead, three professional staff (libraries and teaching center) and two undergraduate students. One more faculty member from the chemistry department was involved in the content creation of the course to identify, align, prepare, adapt, and assess videos for the Forensic Chemistry course. All the material for the course material was generated in the department. Some material was also adopted from libretexts or Merlot websites. The materials were linked with the library guide (see Figure 1) as modules (15 weeks) during the semester on the GS library webpage and on various OER platforms. The libguide was also shared on USG – Affordable Learning Georgia website under the CC BY 4.0 license.

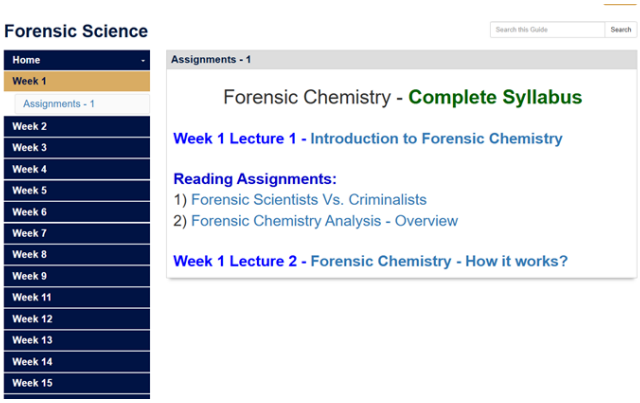


Fig. 1. Library guide for the forensic chemistry course (https://georgiasouthern.libguides.com/forensicchemistry)

3.1.4. Results

The forensic chemistry course was offered to both undergraduate and graduate students through hands-on experience in a lab (a lab component was part of the course). All students had to engage in a forensic chemistry project and presented their findings at the annual Georgia Southern University Research Symposium (2022). The topics ranged from studying lab grade caffeine's effect on DNA preservation to characterizing fingernail surface morphology exposed to common household cleaning agents using Scanning Electron Microscopy. Almost every student enrolled in the course mentioned that the research component and the ability to present were the portion of the course they enjoyed the most.

3.1.5. Strengths of the project

The project's primary achievement was the development and presentation of a CURE course using newly created OER materials. This course covers fundamental concepts in forensic chemistry, including physical evidence examination, crime scene processing, and the application of chemistry principles to evidence analysis, toxicology, and microscopy. It also benefits other forensic science disciplines at our university, such as Forensic Anthropology, Forensic Biology, and Introduction to Forensic Nursing and the Law. Additionally, the course has supported the planning of a separate Center for Forensic Science. Providing free access to course materials enhanced student success, as reflected in improved retention, progression, and graduation rates.

3.2. Human Anatomy and Physiology course

3.2.1. Course Context

The Human Anatomy and Physiology (HAP) lab course is a two-semester undergraduate requirement for health majors, including nursing, exercise science, biology, nutrition, athletic training, and public health. The course is offered in both face-to-face and online formats, enrolling 30 students per section. It introduces and reinforces topics from lecture classes, covering anatomical structures through models and human cadavers, as well as physiological concepts through lab activities. HAPI focuses on cells, tissues, the integumentary, skeletal, muscular, and nervous systems, while HAPII covers the circulatory, endocrine, digestive, urinary, immune, and reproductive systems.

3.2.2.Goals of the Project

The goal of our project was to redesign the HAP laboratory course at our institution and create no-cost learning resources for all students. The project aimed to improve curricular alignment between lecture and lab courses, standardize the course across sections normally taught by teaching assistants, and provide students with freely accessible resources by eliminating the need for a traditional textbook. The initiative also sought to enhance student success, particularly

in HAPI, where failure rates were high, and to offer materials that could be used beyond the HAP course for review in advanced health classes.

3.2.3. Process

The project team consisted of five faculty members from one department (Health Sciences), two professional staff (libraries and teaching center) and two undergraduate students. Faculty members teaching advanced kinesiology courses were involved with the purposes to emphasize the course's relevance beyond the introductory level. The project adopted OpenStax Human Anatomy and Physiology as the primary textbook (OpenStax, n.d) and developed weekly modules that included structured learning outcomes, ancillary materials and assignments. This approach reduced cognitive overload by structuring content into manageable weekly segments. The newly designed modules were integrated into a library guide (see Figure 2) that was made publicly available under a Creative Commons license (CC BY-NC-ND) on the institution's library page. For ancillary materials, we created 31 videos of lab models, and adopted a low-cost digital platform to add virtual physiology labs into the course curriculum. The videos were uploaded to YouTube on the course channel, meeting accessibility standards and ensuring students had access to resources outside regular class time.

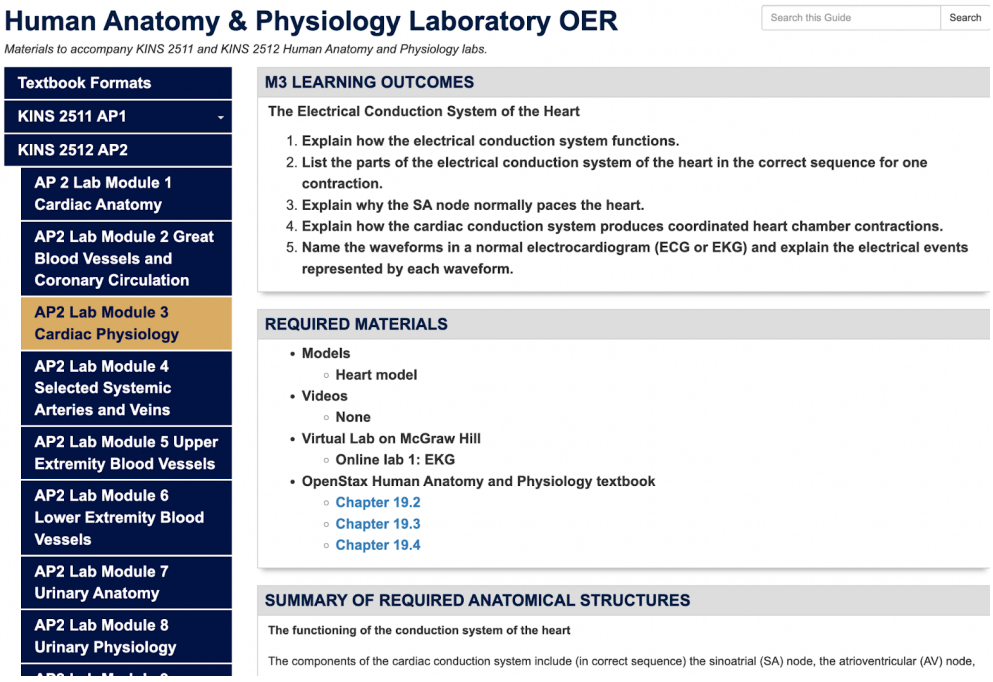


Fig. 2. Library guide for the HAP course

3.2.4. Results

The project impacted 2,700 HAP students annually, saving them at least $53,000 per year. A survey conducted in Spring 2022 received 528 responses (response rate of 74%) from 710 students, with the majority expressing positive feedback. Between 73-78% of students found the search capabilities better than traditional textbooks, 80-84% rated the visuals as high-quality, and 72-74% found the materials helpful for studying. Additionally, 66-75% reported that the OER materials helped them retain information, while 68-76% felt better prepared for class activities. The standardized course format improved consistency across sections and instructors. During the first semester of implementation, the HAP library guide became the most viewed guide at our institution with 28,000 views.

3.2.5. Strengths of the Project

A key strength of the project was its pedagogical transformation. The shift to a modular structure improved organization and enhanced alignment between lab and lecture components. The integration of videos, virtual labs, and freely accessible materials ensured access to high-quality educational resources. The collaborative approach, involving faculty, library professionals, and student assistants, contributed to the project's success. By scaling the initiative department-wide, the project not only improved the student learning experience but also set a precedent for future OER adoption in other courses.

4. Conclusion

The successful adoption of OER in our institution was achieved through a three-pronged approach that incorporated both state-level and institutional support. First and foremost, it has been largely driven by the dedication and passion of our instructors. Their commitment to improving student learning experiences and reducing costs through OER adoption has yielded significant benefits to students. Secondly, at the state level, initiatives such as ALG played a crucial role in providing grants that facilitated OER adoption and development. However, for long-term sustainability, higher education institutions must prioritize internal funding mechanisms that can ensure the continuous improvement and expansion of OER initiatives. Lastly, mentoring played a vital role in the successful implementation of OER at the institutional level. Faculty members often face time constraints and workload challenges that limit their ability to engage in OER development and implementation. Librarians, instructional designers, and OER committees can provide invaluable assistance in curating and developing OER materials, navigating copyright and licensing issues and ensuring compliance with open-access guidelines. Institutions should consider investing in supporting on-campus OER mentoring groups to facilitate smoother adoption and long-term sustainability.

A key challenge in OER implementation is ensuring the consistent updating and maintenance of materials. One effective solution is department-wide OER adoptions, which promote uniformity in instructional resources and facilitate collective responsibility for updates. This approach also fosters a collaborative environment in which faculty members share best practices and contribute to the ongoing refinement of OER materials.

The adoption of OER has resulted in pedagogical improvements within our courses. Faculty members who have transitioned to OER reported increased flexibility in tailoring course materials to better align with learning objectives and student needs and encouraged more interactive and student-centered teaching approaches. These benefits extend beyond cost savings for students. While much of the existing research on OER focuses on its benefits for students, there is a critical need to study its impact on instructors and teaching practices. We believe that faculty members who dedicate time and effort to creating, curating, and maintaining OER should receive institutional recognition for their contributions. Higher education institutions should consider integrating OER-related activities into promotion and tenure guidelines, recognizing them as valuable scholarly and pedagogical contributions. Establishing clear policies that reward faculty engagement with OER will encourage broader participation and sustained commitment to open education initiatives.

The successful implementation of OER in higher education requires a multifaceted approach that includes financial support, mentorship, professional staff support, and institutional recognition. While passionate educators are at the heart of OER initiatives, their efforts must be complemented by robust support systems that ensure sustainability and continuous improvement. If adopting these recommendations, higher education institutions can foster an environment in which OER flourishes, ultimately benefiting both faculty and students.

References

Affordable Learning Georgia.(n.d.). https://www.affordablelearninggeorgia.org/

Cho, K. W., & Permzadian, V. (2024). The impact of open educational resources on student achievement: A meta-analysis. International Journal of Educational Research, 126. https://doi.org/10.1016/j.ijer.2024.102365

LeMire, S., Anders, K. C., & Pantuso, T. (2024). Exploring First-Generation Student Experiences with OER Textbooks. College & Research Libraries, 85(7), 952–965. https://doi.org/10.5860/crl.85.7.952

Lo, L. S., Lo, L. S., Jordan, J., & Surbaugh, H. (2023). The Cost of Success: Exploring the Impact of Textbook Costs at a Hispanic-Serving R1 Institution. *Open Praxis., 15*(2), 134–148. https://doi.org/10.55982/openpraxis.15.2.554

OpenStax, n.d. https://openstax.org/

Smith, C., Babich, C., & Lubrick, M. (2023). An Open Education Journey: Connecting Student Affordability with Pedagogical Enhancement. Collected Essays on Learning and Teaching, 14(1).

Vichare, A., Bodas, M., Jetty, A., Luo, Q. (Eric), & Bazemore, A. (2024). A Few Doctors Will See Some of You: The Critical Role of Underrepresented in Medicine (URiM) Family Physicians in the Care of Medicaid Beneficiaries. Annals of Family Medicine, 22(5), 383–391. https://doi.org/10.1370/afm.3140

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Analyzing Student's Perceptions and Learning Outcomes of Wooflash application in Undergraduate Cell and Developmental Biology Courses

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Abstract

The article evaluated the integration and effectiveness of Wooflash, an online learning platform, and JoVE Science Education Library videos in undergraduate cell and developmental biology courses. Surveys of second- and third-year students assessed how these tools impacted learning strategies, course comprehension, and exam preparation. Both resources were well-received, helping students identify weaknesses and reinforce concepts. However, most students used them only shortly before exams, limiting their potential for deep learning. Barriers included lack of time and unfamiliarity. Despite these challenges, Wooflash users showed modestly higher exam scores (6.7/15 vs. 5.4/15), and 66% of students found JoVE videos helpful for understanding course content. The study highlights the benefits of integrating digital tools in education while emphasizing the need for earlier adoption and better guidance to enhance consistent engagement. ***Keywords: wooflash,*** *flashcards, evaluation, quiz, pedagogical alignment*

1. Introduction

Teachers, and students alike, are constantly seeking innovative tools and methods to enhance the learning experience. There is a growing body of literature on potential effective strategies for supporting multimedia learning (Mayer, 2009; Henderson et al., 2015). Among these strategies, quizzing promote self-regulation processes and reinforce learning performances (Yang et al., 2021). To this extend, we have been experimenting tools that have gained significant consideration in recent years, namely, quizzes, flashcards and supplementary video resources.

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Flashcards have undergone a digital transformation. At their core, flashcards are simple yet powerful devices that leverage key principles of cognitive psychology to facilitate learning and retention. These systems are based on two fundamental concepts: active recall and spaced repetition. Active recall involves actively stimulating memory during the learning process, forcing learners to retrieve information from memory and thereby strengthening neural connections. Spaced repetition, on the other hand, involves spreading out learning sessions over time, which has been proven to improve long-term retention (Kang, 2016). Benefits of flashcards are numerous, offering flexibility, allowing students to study anytime and anywhere. They promote active learning, helping students quickly identify knowledge gaps. Many digital flashcard applications incorporate gamification elements, which can increase student motivation. Furthermore, flashcards have been shown to improve concentration, accelerate learning speed, and enrich vocabulary, the latter being of high interest in discipline where memorization of glossaries is crucial. However, one shall recall that flashcards are not without limitations. There is a risk of encouraging superficial learning, if not designed to promote deeper understanding. Their effectiveness is heavily dependent on the quality of their design and the user's discipline in regular usage. Additionally, creating effective flashcards requires skill and time investment from both educators and students.

Wooflash is an online learning platform, provided by Wooclap (www.wooclap.com). Wooflash is an innovative educational revision platform, accessible via computer, tablet, and smartphone. This application offers the possibility to provide students with varied content and diverse questions. This platform was chosen because was currently being tested in our institution, where our colleagues are already using Wooclap quite intensively. The teachers of the University of Lille who use Wooclap were satisfied with the interface and the features offered by the platform.

Complementing flashcards, video resources have become common and efficient tools in education (Brame, 2016). The Journal of Visualized Experiments (JoVE) is a peer- reviewed scientific journal that publishes experimental methods in video format. The JoVE Science Education Library is a comprehensive video resource dedicated to teaching scientific experiments through engaging visual demonstrations. The library covers a wide range of disciplines, including Advanced Biology, Basic Biology, Chemistry, Clinical Skills, Engineering, Environmental Sciences, Physics, and Psychology. Such video-based approach offers several advantages like (i) enhanced understanding through visual learning (ii) accessibility to standardized experimental techniques demonstrated by experts, (iii) accessibility to complex scientific concepts for students at various levels, (iv) potential supplementary material for traditional lectures and textbooks, and (v) opportunity for students to review procedures multiple times at their own pace.

This article evaluates the integration and effectiveness of Wooflash and JoVE videos in undergraduate biology courses, examining their impact on student learning strategies, comprehension, and exam preparation. Therefore, the resources' objectives were to develop

students' understanding and reasoning in the fields of developmental biology and transgenesis methods. Mastering the glossary of terms in developmental biology, for example, is a recurrent difficulty encountered by students. Thus, it was tested whether these resources could affect the students' learning experience and could influence preparation for assessments. Results of questionnaire and recommendations for effective integration of such resources into curricula are provided.

2. Methods

2.1. Participants

The use of the Wooflash application was tested with two groups of students, in the second (L2) and third (L3) years of the Bachelor's program in Cellular Biology and Physiology (LBCP). L2 students have taken developmental biology courses. Two types of teaching are carried out: lectures in amphitheaters on the major stages of development (fertilization, cleavage, gastrulation, neurulation, sea urchin development, human development), and small group teachings (<30 students; amphibian development, bird development, experimental embryology). The course entitled 'Animal Transgenesis' is mandatory for all third-year undergraduate students (L3) majoring in Cellular Biology and Physiology (BCP). This course is only taught in large classes (amphitheater). It covers gene transfer methods, theoretical and practical approaches to transgenesis, with analysis of application cases of genetic modifications in animals. This lecture is placed within the regulatory and ethical framework of animal experimentation.

2.2. Wooflash

The courses / quizzes created are available online. The educational content was presented in a linear format, with the slides in a predetermined order. When appropriate, feedback was provided automatically by the Wooflash platform. The platform offers the possibility to easily create educational content using Artificial Intelligence. Questions can include video, slide, or PDF content. Among the 17 question types offered by the tool, the multiple-choice questions (MCQ), short answer questions, and flashcards options were used.

For the L2 students, 3 courses were created, respectively addressing the principles of developmental biology (41 questions, code : 7AA829R0), bird development (60 questions, code : N791TSXR), and human development (23 questions, code : 419KQ4E7). For the L3 students, a course including 85 questions was created and subdivided in 3 sections : ethical aspects of animal experimentation, gene transfer methodologies, course comprehension questions. Quizzes are available using the code AESL8CZ6.

2.3. Survey

At least three weeks after sessions ended, a global online questionnaire with 19 questions was administered. The questionnaire was made with socrative (www.socrative.com, Showbie Inc.) and directly sent to students by e-mail. Responses were totally anonymous, as mentioned in the e-mail sent to the students. It was indicated that the questionnaire is part of the evaluation of teaching by students, with the aim of improving teaching practices. 13 questions used a scale from 1 to 5 to measure students' perception (Do you find that Wooflash adds value to teaching? Do you find that the Jove capsules, underlining key concepts, bring added value to teaching? Do you think Wooflash helped you prepare for your exams? Do you think Wooflash helped you better understand any points in the course? Do you think Wooflash helped you to identify your weaknesses? Do you think Wooflash has helped you memorize more easily? Do you think Wooflash has improved your relationship with the teacher? Do you think Wooflash is an easy app to use? Do you think the questions offered on Wooflash are appropriate? The questions in the JoVE capsules helped you prepare for your exams?? Do you think that the JoVE video clips have helped you better understand course points? Do you think that the JoVE videos have helped you memorize concepts more easily? Do you think the JoVE video clips are suitable?). Four questions were proposed, and two open-ended questions closed the survey : What other resources/applications would you like? (open-ended), free comments.

No statistical comparison was made of the results of the questionnaires of L2 and L3 students since multiple variables may be taken into account. The relevance of such an analysis would be questionable.

3. Results and discussion

The questionnaire exhibited that overall, the resources were perceived positively by students, both at the L2 and L3 levels (Figure 1). Open-ended responses of the survey highlighted the suitability and advantages of Wooflash and its utility : (1) "We can better understand and identify our weak points », (2) « I was able to notice some of my confusions and other errors in my course without having to send a question message (to the teacher). I wish I had organized my time better to take advantage of Wooflash in advance » and (3) « It allows me to confirm my knowledge and to learn and revise in a fun way ». A L2 student stressed that "you have to use it correctly (...) you shouldn't rely solely on Wooflash to succeed ».

Did the students feel that the proposed resources were enough? To the question "Which applications would you like?", the majority of students respond that they did not want additional resources. A few students mentioned applications like Gizmo (1), Anky (1), and Quizlet (4). Given that these applications are similar to Wooflash, it is reasonable to think that these students have not fully adopted and used the proposed application.

It was observed that students only connected lately to the tools, in the days preceding the final evaluations: the attendance rate doubled in the 72 hours preceding the terminal exams (data not shown). The number of students who quickly and regularly adopted the tool remained modest. The majority of students estimated that they used the tool between 5 and 10 times (Figure 1A). The fact that students did not make "intensive" use of the tool and that this use occurred quite lately in their learning strategy did not facilitate a deep learning. A low and late frequency of tool use did not allow students to benefit from the advantages of this tool in terms of memorizing terminology or understanding key points. The main barriers to using these tools are lack of time and unfamiliarity with the tool (Figure 1B). The lack of time was highlighted by a student in the open-ended responses of the survey : "the resources are a very good idea but unfortunately complicated to look at in addition to other courses and other subjects". Beyond the intrinsic qualities of the tool, acknowledged by the students (figure 1C&D), teachers must consider how they have integrated the tool into their teaching approach (scenario), and the time available for students to appropriate these tools/resources. These factors can limit the performance induced by the tools. As mentioned previously, usability of these tools requires minimal investment on the part of students. Technical problems were very rare (only one student mentioned that «JOVE videos cannot be opened on all devices »). The user-friendliness and ease of use of the application are highlighted by students (1C, 1D). The questionnaire also highlighted that use of the tool did not increase interactions with teachers; in fact, as student autonomy is encouraged, interactions with teachers tend to decrease (1C, 1D). While our survey identified lack of time and unfamiliarity as primary barriers (Figure 1B), other factors likely contributed to this pattern of late adoption. This behavior could be tied to students' existing study habits and beliefs about effective learning strategies, where last-minute review and cramming are often prioritized over distributed practice. Furthermore, the perceived 'stakes' of using the tools might have been low early in the semester. Since Wooflash and JoVE were presented as supplementary resources, students may not have fully appreciated their value until the pressure of the impending exam motivated them to seek additional support. The concentrated use of Wooflash prior to exams suggests that students primarily leveraged these tools for knowledge retrieval and reinforcement rather than for initial learning and conceptual understanding. Spaced repetition, a key principle behind effective flashcard use (Kang, 2016), is undermined when learning is compressed into a short period. Additionally, the limited timeframe may have prevented students from engaging with the resources in a more exploratory or self-directed manner, such as identifying knowledge gaps early on and seeking clarification from the instructor.

Was there a positive effect on student results? Students who used Wooflash showed an average score of 6.7/15 (+/-2), while students who did not use Wooflash exhibited an average score of 5.4/15 (+/-2). An average increase of one point was observed; the distribution of grades exhibited better results for wooflash users in final exams, in contrast to non users (data not

shown). This result seemed modest and needs to be confirmed by further experiences using this tool in the coming years.

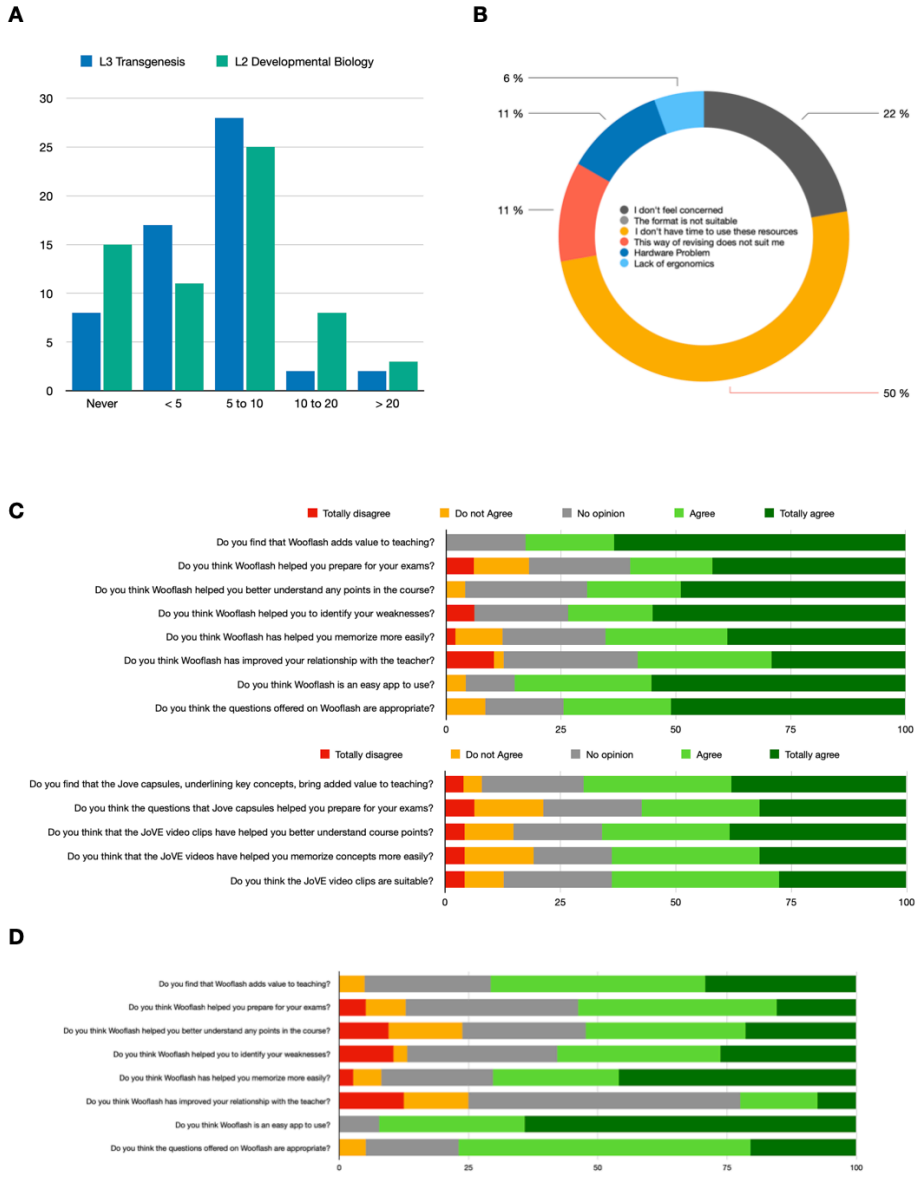


Figure 1. Student survey ; A : Comparison of the frequency of use of Wooflash among L2 (n=62) and L3 participants (n=57) . B : Reasons evoked by L3 participants not to use the tools or resources ; student survey among participants in developmental biology courses (L2) or transgenesis (L3

The advantages of providing supplementary video content are manifold. Videos allow for the visualization of complex concepts and the demonstration of practical techniques, offering an alternative to traditional learning methods. Videos also allow students to review material at their own pace, reinforcing understanding and retention. Use of video resources also presents challenges (Ramachandran et al., 2019). The production of high-quality educational videos can be costly and time-consuming. There is also a risk that students may become passive in their learning if they rely too heavily on videos at the expense of other forms of engagement with course material. The JoVE Science Education Library was only used in the context of the lessons in L3. The main advantage of this platform is to provide turnkey, clear, relevant and short videos. Seven videos were proposed, illustrating key concepts : transgenic organisms, genetic engineering, CRISPR, reproductive cloning, embryonic stem cells, induced-pluripotent stem cells, gene therapy. These resources are received very positively by students, who consider them "suitable", "clear" and "very good ». 66% of the students agreed that the videos helped to understand course points and 64% considered that it helped them to memorize key concepts (Figure 1C). Efficiency of the use of JoVE videos in chemistry lessons was elsewhere observed and documented (Ramachandran et al., 2019). Feedback encourages the use of new videos, which will be used in other courses, like developmental biology and bioethics.

At last, two points should be highlighted, regarding the teacher teaching-experiment. First, the existence of a dashboard within the Wooflash application allows teachers to follow students' responses in real time. This feature enables teachers to identify students who have difficulty answering questionnaires or memorizing terms, and to identify questions or key points where students encounter difficulties, and to be able to re-explain them in class, or to suggest alternative resources. Second, the teacher must ensure, in his syllabus, or during his course, to explain the contributions of the application. These explanations could have a positive impact on the 1 in 5 students who do not feel concerned by the tool (1B). The demonstration can be done in front of the students, or offered in the format of a short video, explaining for example how wooflash can help the student in their learning experience.

4. Conclusion

The article addressed the use of Wooflash and JoVE video resources in undergraduate cell and developmental biology courses. The survey suggested that these tools are generally well-received by students and can potentially enhance their learning experience. Indeed, students perceived Wooflash and JoVE videos positively, finding them useful for identifying weaknesses and reinforcing key concepts. JoVE videos were particularly well-received for their clarity and relevance. A modest improvement in exam scores was observed for Wooflash users, though further research is needed to confirm this effect. One shall remained aware of the biases and possible variables in these observations : bias of complacency in the questionnaire, inter-individual variability in the appetite for digital tools, motivation, etc. A comparative analysis of

the wooflash, anki and quizlet tools could be conducted in order to determine the advantages and limitations of the practices enabled by these tools.

However, several challenges were identified, including late adoption by students and limited impact on exam performance : late and infrequent use of the tools may limit their effectiveness in promoting deep learning, and time constraints and unfamiliarity with the tools are primary barriers to adoption. Therefore, there is a need to determine the nature of the factors that lead students to procrastinate (Steel, 2017). Future implementations should focus on earlier integration of these tools into the curriculum and providing more guidance to students on their effective use.

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References

Brame CJ. (2016) Effective Educational Videos: Principles and Guidelines for Maximizing Student Learning from Video Content. *CBE Life Sci Educ*. 15(4):es6.

Henderson, M., Selwyn, N., & Aston, R. (2015). What works and why? Student perceptions of 'useful' digital technology in university teaching and learning. *Studies in Higher Education*, *42*(8), 1567–1579.

Kang, S. H. K. (2016). Spaced repetition promotes efficient and effective learning: Policy implications for instruction. *Policy Insights from the Behavioral and Brain Sciences*, 3(1), 12-19.

Mayer, R. E. (2009). Multimedia Learning: Second Edition. *Cambridge University Press*.

Ramachandran, R., Sparck, E. M., & Levis-Fitzgerald, M. (2019). Investigating the effectiveness of using application-based science education videos in a general chemistry lecture course. Journal of Chemical Education, 96(3), 479-485.

Steel, P. (2007). The nature of procrastination: A meta-analytic and theoretical review of quintessential self-regulatory failure. *Psychological Bulletin, 133*(1), 65-94.

Yang, C., Luo, L., Vadillo, M. A., Yu, R., & Shanks, D. R. (2021). Testing (quizzing) boosts classroom learning: A systematic and meta-analytic review. *Psychological Bulletin*, 147(4), 399–435.

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Creating an Open-Source Ecosystem for Contextualized Learning in Software Engineering

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Abstract

Software engineering education is often detached from real-world practices: demonstrations and exercises are limited in scope and fail to capture the complexities and architectures found in industrial projects. Smaller tasks might not demand effective software design so students may neglect these principles in projects.

We present a contextualized learning approach to software engineering education: within our Computer Science department, we develop bespoke software to support teaching and learning with source code made open to student contributions, following open-source software practices. This philosophy enables the use of our code in lectures as real-world examples and allows students to directly shape the evolution of software they use daily, both through occasional contributions and broader internship-like summer projects. These initiatives combine theory and practice so students can experience software evolution, maintenance, and collaboration first-hand in a meaningful context. Our experience could assist other institutions seeking to provide authentic, practical experiences in software engineering.

Keywords: *Contextualized learning; software engineering; open-source; real-world experiences; professional skills.*

1. Introduction

Students enrolling on a specialized computer science or software engineering program aim to acquire industry-relevant skills and knowledge to advance their careers in the technology sector (Kori & Luik, 2020). One problem in teaching these topics effectively is that many aspects of software engineering are only visible in large scale software applications and disappear if small example systems are used (van Deursen et al, 2017). Notably, many of the challenges in software engineering stem from evolving and maintaining a system over time: adding new features to meet user needs, or fixing problems, while maintaining correct behavior for existing

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users (Winters, Manschreck, & Wright, 2020). Creating an authentic scenario where students can experience these dynamics is difficult, especially if we teach with synthetic examples that exist purely for courses and assignments.

In this paper, we present our experiences in adopting an educational approach based on *contextualized learning*: we have developed custom departmental software systems with their source code open to our students. Our software suite includes a bespoke Virtual Learning Environment (VLE) which our students use for all materials and assignments. Building our own software has given us three benefits in terms of contextualized education: 1) we can teach students how software works using examples from familiar systems; 2) we continuously evolve and update these systems, modelling practices of a professional software engineering team; 3) we invite students to contribute to the evolution of these systems, particularly by developing features that assist in their studies. We encourage collaboration between students and staff, allowing students to participate meaningfully in a real open-source software ecosystem.

2. Contextualizing Learning for Software Engineering

Computer Science students typically study both theoretical and practical subjects; some of the most fundamental technical skills to learn are programming and systems design. Curricula often teach several programming paradigms supported by specific programming exercises and assignments. However, projects that are small in scope and short in duration do not provide a context that necessitates the use of broader software engineering practices. Maintaining a system over time is what differentiates programming from software engineering (Winters et al., 2020). Only with a longer-term view does the need for "professional" practices such as diligent use of version control systems, peer code review, or automated quality assurance pipelines (Humble & Farley, 2010) become apparent.

Among several learning theories that provide models to understand and explain how people learn, our work is framed in *contextual learning* theory, or *context-based learning* (Abu-Rasheed, H., Weber, C., & Fathi, M., 2023; Perin, 2011), also denoted as *Contextual Teaching and Learning* (CTL) (Hudson & Whilser, 2008). CTL allows teachers to relate subject matter content to real world situations (Berns & Erickson, 2001) and states that learning takes place when students can construct meaning according to the context of their own lived experiences (Berns & Erickson, 2001; Blanchard, 2001). The learning context - the situation in which learning takes place - describes not only the learner's situation, but also the environment and the interaction between them. CTL has been applied in teaching other domains such as Industrial Engineering and Management (Kukliansky & Rozenes, 2015), giving us confidence to apply it in Computer Science. We believe that an appropriate context to build software engineering skills is one involving systems of a complexity representative of those found in industry, in a domain familiar to the students, with real users to service and demands to be met.

While the wide variety of open-source software (see Section 3) available online offers many real-world examples, most of these are related to domains unfamiliar to our students. We instead chose to make our own software systems open-source, thus creating an effective and accessible learning experience for the students in a directly relevant context.

3. Open-Source Software Development

The software industry has widely adopted practices of *open-source* software development (Fitzgerald, 2006). Open-source software is that whose source code is made freely available, together with a license that permits anyone to view, use, modify, and distribute that source code. Open-source software can provide a valuable educational resource by allowing students to see "inside the box" of real software systems to understand their workings (Brown & Wilson, 2011). Exploring open-source projects is valuable for understanding how real software is structured and implemented, but simply browsing their code does not offer the experience of contributing code, maintenance over longer time periods, or managing changes in response to real-world needs. We think it is valuable to give students experience of contributing to an open-source community as part of their education (Spinellis, 2021) and believe that this can help them to develop important professional skills during their studies.

There are millions of open-source software projects (GitHub, 2022). While many are small hobby projects, there are significant and widely used open-source projects such as the Firefox web browser and the Android operating system for mobile devices. A common characteristic of open-source projects, beyond their free availability, is that any software developer in the world can submit a code change to implement a new feature or fix a bug. Changes are normally considered for inclusion through rigorous review processes. In this way, strong communities of maintainers build up around popular projects, and participating in these communities can become a key part of a professional software developer's work.

Each project has a team of trusted core maintainers. These people have access to edit the code directly. For contributions from the wider community, a contributor creates their own copy of the code (a *fork*), modifies their version to add a new feature or fix a problem, and then makes a *pull request* if they would like their changes to be integrated into the main version. These core maintainers act as gatekeepers for approving pull requests, reviewing any proposed changes carefully and often with extra scrutiny if the author is not a regular contributor to the project. The review process typically involves an extended back-and-forth of feedback and amendments until the maintainers are satisfied and happy to accept the change.

This pattern of interaction is standard in open-source communities. A similar style of code review process is also typical within commercial software development teams to ensure consistent style and high-quality, even if the code in that case is proprietary and closed-source

(Capraro & Riehle, 2016). We believe that providing students with an environment in which they can practice this type of collaborative development is highly valuable.

4. Creating an Internal Open-Source Ecosystem

Our Computer Science department has a long history of developing software to support learning and teaching. Although previously more ad-hoc, we took a more structured approach in 2018, establishing an internal professional software development team. This team has a dual mission: to build systems to facilitate departmental work and support teaching of modern software engineering practices. Its software suite includes a VLE, feedback collection systems, project allocators and an online examination platform.

We made a policy decision to make all our new software open-source and accessible to everyone in the department, including students and staff. This decision has several benefits. First, exposing our software to scrutiny from the very students we train as professional engineers motivates our team to uphold the same coding and process standards we teach. This puts us in a position to use our software as a real-world example in class. Second, it gives students the unique opportunity to contribute as developers to systems they already know as users. This not only provides valuable experience for their résumés but also immerses them in an open-source development culture. Some staff initially worried that exposing our systems' inner workings might enable student exploitation, raising concerns about potential disruption or misuse, especially in areas involving assessment. Despite this, we decided that transparency was the best policy, especially given the benefits of student partnership and collaboration.

We welcome individual student contributions throughout the year, each of which goes through the typical process of code review described in Section 3. As students are busy, these tend to be small but useful changes. Where students have a deeper interest that relates to the educational software context, such as working on learning analytics, we can support this as a capstone project, which allows more time for development and research to be carried out. We also enable more structured forms of partnership with students by offering funded internship-like experiences lasting from six to ten weeks over the summer break, where students work embedded in our team, developing larger features. In total, there have been 31 distinct student contributors on record across our whole ecosystem from 2021-2025. Participating in these projects encourages students to engage with professional practices on long-term collaborative projects, complementing the technical skills they acquire in the formal curriculum.

A recent improvement to our VLE arose from informal discussions between students about navigating their long student record pages. One student took the initiative to develop filters affording a simpler view of upcoming assignments or already graded work. The student coded this feature, which the core development team reviewed and integrated. Small improvements like this occur naturally to students as some of the primary users of our platforms and these

quality-of-life improvements are fundamental for maintaining useful software tools. Being able to contribute in this way, to the benefit of themselves and their peers, gives students a strong sense of ownership over the software they use and contextualizes their learning.

In the following section, we present experiences and reflections from students who have contributed to these software systems in recent years.

5. Insights from Student Contributors

We offer our students the opportunity of joining our team as interns over the summer. We started with just two students in the first summer and refined the experience year on year, most recently welcoming a cohort of five. The students were involved in the design and development of different systems and platforms (often *mission-critical*) currently in use in the department.

We conducted a qualitative survey with our past interns, with a mix of open-ended and closed questions, and collected 8 responses. In their responses, students reflected on their experience with professional software engineering practices, particularly agile workflow, code review, deployment with cloud services and task management.

Respondents recalled several key moments that had a particular impact on the way they approach software engineering. A second-year student who worked on our core VLE software remarked: *"[the team's] push for small PRs that [they] could review quickly […] set me up well to work on changes in a much more incremental manner vs one massive PR in future projects"*. Directly exposing students to tools that the team uses to ensure rigor and consistency across our codebases also seemed to have a long-term impact on the students' software engineering habits: *"dev tools like commitlint are pretty much a staple of any project I work on now and are one of the first things I set up"*. Another student positively emphasized the degree of autonomy and initiative they experienced during the project, and how this contributed to their sense of ownership over the software: *"it was a great experience to design the app outline as a team and having the freedom to make these design decisions"*.

Some students reflected on how their placements provided a *"first exposure to the public cloud"* and valued all the skills they developed with respect to cloud technologies. By gaining experience with container and virtualization technology, they learned to deploy their work with different resources to real users, often with system architectures consisting of multiple services.

All respondents described their placement experience as integral to their learning within the context of their degrees: "*It really helped my understanding and made me realize that learning these tools is what makes the whole software engineering experience worthwhile".*

The closed questions were framed within a 5-point Likert ordinal scale. Table 1 shows the responses to these questions.

Table 1. Responses to scaled questions of the survey completed by 8 summer placement students.

Question	Strongly Agree	Agree	Neither	Disagree	Strongly disagree
My experience in the team improved the way I approach software engineering projects	6	2	-	-	-
The software engineering skills I learnt during my time with the team helped me in the following academic year(s)	6	2	-	-	-
I would like to contribute to other open-source projects after this experience	2	4	2	-	-
The experience helped me improve the way I collaborate in a team	3	4	1	-	-
The experience helped me develop my soft skills	4	3	1	-	-
Overall, the experience helped me grow as a professional beyond what is taught in class and labs	6	1	1	-	-

These responses show that students felt working in this context helped them grow as professionals. Notably, students declare the experience has helped them improve their approach to software engineering projects. This aligns with the contextual teaching and learning theory cited in Section 2. However, we are aware of the survey's limitations, especially its small sample size and the time elapsed from the end of the placements. We do not present these results here as a systematic study from which definitive conclusions can be drawn; nonetheless, these preliminary outcomes and anecdotal experiences suggest there is educational value in the approach we followed. This is reflected in the students internalizing our team's software engineering methodology, then applying it of their own accord in subsequent projects.

6. Recommendations for Educators and Institutions

Where educators and institutions have the flexibility to select tools for teaching and learning, we recommend, where possible, prioritizing the use of open-source software. Open-source tools provide rich opportunities for contextual learning: students can explore how the tools they use every day actually work, deepening their understanding of complex software systems in an environment that feels familiar and meaningful. They may even be able to extend these tools themselves and experience contributing to an open-source community.

While we have chosen to build bespoke tools from scratch, we believe that many of the same educational benefits could be achieved by adopting and engaging with third-party open-source software. Open educational tools —such as learning management systems, assignment

submission platforms, or testing frameworks— can serve as authentic case studies in class, or as the basis for exercises and assignments. The key is to allow students to investigate the inner workings of real systems in ways that are closely connected to their own lived experiences.

Some institutions may be understandably hesitant to expose the internals of their software to students, however, we encourage a culture of transparency. We do not rely on "security through obscurity" in which a system is protected by hiding details rather than effective security measures. Instead, we develop application logic in accordance with modern engineering practices, keeping confidential configuration and user data isolated and independent. This separation of concerns makes the code generally safe to open and is in itself a good lesson in software engineering. In our case, sensitive credentials —like those for our databases— are stored as secret variables, which are injected into the code at deployment time and are only accessible to core maintainers. For local development, we auto-generate realistic yet fake data, allowing contributors to work freely without the risk of divulging real information.

By choosing transparent, open tools and building systems with openness in mind, educators may not only enhance learning but also model professional practices that prepare students for working with open systems in the real world.

7. Conclusions

Our open-source ecosystem, giving students the opportunity to work on large projects relevant to their learning, demonstrates the value of contextualized learning in software engineering. By making the internals of our departmental software accessible to students, we provide them with a real-world environment where they can see professional practices in action, contribute meaningfully, and develop skills beyond what is covered in coursework.

This initiative bridges the traditional gap existing between software engineering theory and practice. Through individual contributions and structured internships, students experience working with live systems, engage with peer code review, and follow professional quality assurance processes, gaining exposure to professional practices commonly used in industry. While there were initial concerns about transparency and security, our experience shows that an open, collaborative development model fosters accountability, quality, and engagement. Allowing students to contribute to the tools they use daily creates a virtuous cycle where software development becomes both a learning opportunity and a service to the community.

Moving forward, we aim to further refine and expand this approach, integrating more structured forms of engagement. One possibility is to move beyond contribution being an extra-curricular activity and to create an assignment within the curriculum where all students propose and

implement a change to our software systems: this would better enable us to assess long-term impact on student learning and career readiness. Overall, we believe that this model could serve as a blueprint for other institutions seeking to provide authentic, hands-on learning experiences in software engineering teaching and learning.

References

Abu-Rasheed, H., Weber, C., & Fathi, M. (2023). Context based learning: a survey of contextual indicators for personalized and adaptive learning recommendations – A pedagogical and technical perspective. *Frontiers in Education, 8*.

Berns, R.G., & Erickson, P.M. (2001). *Contextual teaching and learning: Preparing students for the new economy.* (The Highlight Zone: Research @ Zork No. 5).

Blanchard, A. (2001). *Contextual Teaching and Learning*. Educational Services.

Brown A. & Wilson, G. (Ed.). (2011). *The architecture of open source applications: elegance, evolution, and a few fearless hacks.* Lulu.com. https://aosabook.org/en/

Capraro, M., & Riehle, D. (2016). InnerSource definition, benefits, and challenges. *ACM Computing Surveys*, *49*(4), Article 67.

Fitzgerald, B. (2006). The transformation of open source software. *MIS Quarterly, 30*(3), 587–598. https://doi.org/10.5555/2017296.2017298

GitHub. (2022, December 6). Octoverse 2022: 10 years of Tracking Open Source. GitHub Blog. https://github.blog/news-insights/research/octoverse-2022-10-years-of-tracking-open-source/

Hudson, C.C., & Whisler V.R. (2008). Contextual teaching and learning for practitioners. *Journal of Systemics, Cybernetics and Informatics, 6*(4). pp. 54-58.

Humble, J., & Farley, D. (2010). *Continuous Delivery: Reliable software releases through build, test, and deployment automation.* Addison-Wesley.

Kori, K., & Luik, P. (2020). Upper- and lower-secondary students' motivation to study computer science. In: Kori, K., Laanpere, M. (eds) *Informatics in schools. Engaging learners in computational thinking (ISSEP 2020)*. Lecture Notes in Computer Science, 12518. Springer. https://doi.org/10.1007/978-3-030-63212-0_6

Kukliansky, I., & Rozenes, S. (2015). The contextual learning approach in engineering education. In *1st International Conference on Higher Education Advances (HEAd'15)*. Universitat Politècnica de València, Spain. http://dx.doi.org/10.4995/HEAd15.2015.280

Perin, D. (2011). Facilitating student learning through contextualization: A review of evidence. *Community College Review*, *39*(3), 268-295. https://doi.org/10.1177/0091552111416227

Spinellis, D. (2021). Why computing students should contribute to open source software projects. *Communications of the ACM*. https://cacm.acm.org/opinion/why-computing-students-should-contribute-to-open-source-software-projects/

van Deursen, A., Aniche, M., Aué, J., Slag, R., De Jong, M., Nederlof, A., & Bouwers, E. (2017). A collaborative approach to teaching software architecture. In *Proceedings of 2017 ACM SIGCSE Technical Symposium on Computer Science Education (SIGCSE '17) (pp.* 591–596). Association for Computing Machinery. https://doi.org/10.1145/3017680.3017737

Winters, T., Manschreck, T., & Wright, H. (2020). *Software Engineering at Google: Lessons Learned from Programming Over Time*. O'Reilly Media.

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When does it start? The gender gap and the university-work transition

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Abstract
Gender inequality persists globally, evident in the gender pay gap and women's underrepresentation in leadership roles. While much research exists on workplace equality, there is limited understanding of when and where these gaps emerge. Many economists cite human capital theory to explain these disparities, but this approach faces significant criticism. This study analyzes early indicators of gender pay and leadership gaps among students, challenging human capital explanations and offering a more nuanced view of how these gaps develop. Focusing on the university-to-work transition, it examines gendered experiences before and during early career stages. Using data from annual surveys of STEM and business graduates in an Australian University, we uncover a gender pay gap at entry-level, particularly in Business, and highlight the early underrepresentation of women in leadership programs. These findings underscore the importance of university data in understanding and addressing gendered inequalities, offering insights for policy and career preparation

Keywords: *Higher education; University-work transition; gender-gap.*

1. Introduction

Workplace gender inequality persists globally, as evidenced by the enduring gender pay gap and women's underrepresentation in leadership roles. While considerable research exists on workplace equality, there's a gap in understanding when and why these disparities emerge. Determining how early gendered gaps emerge is particularly important for students, as gender inequality considerations can have significant implications for their career. Students may encounter gender inequalities during work-integrated learning, which may negatively influence future career choices.

There have been many studies of the gender pay gap and inequity in various sectors of the workforce (Lo Sasso et al. 2020; Roy 2018; Whoodhams, Trojanowski and Wilkinson et al.

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2022). However, few address the question of exactly when the gender pay gap, underrepresentation of women in leadership, and gendered attitudinal differences about employment begin. Universities act as a base for the transition of students from education to the workforce; hence university data can provide further insights and alternative perspectives on this problem.

This study analyses the results of annual surveys conducted on graduates of an Australian university who received a specialised scholarship targeting skilled students in STEM and business. The University of New South Wales' (UNSW), The Co-op program is both a scholarship and a leadership program, guiding promising students identified as likely to emerge as leaders in their chosen field. We have purposely chosen this dataset for this study as the Co-op graduate surveys offer significant insights into areas of the gender pay and leadership gaps that are under-researched due to limited data availability. Because the Co-op Program fosters leadership potential in its students, graduate surveys can be used as a proxy for leadership data, or data on graduates' progression towards leadership roles. As a result, this data offers insight into the emergence of gender pay and leadership gaps early in graduates' careers which is highly relevant to discussions of workplace gender inequality. As such, while this dataset is limited to one university program in Australia, it is not localised: it gives insight into ongoing questions about gendered inequalities in the workplace, how they emerge, and how they influence students' decisions related to career and training. In this way, Co-op surveys present a rich and scalable set of data on the presence of gender gaps among high-achieving graduates in the traditionally male-dominated sectors of STEM and business.

Our research builds upon existing literature on the gender pay gap among early-career graduates by drawing data from groups of students controlled for skills and experience (Sterling et al. 2020; Chevalier, 2007; Morgan 2008; Chia and Miller 2008). By analysing early indicators of gender pay and leadership gaps among students together, this study sheds further light on the limitations of human capital explanations of gaps and indicates a need for nuanced understandings of how gender gaps in the workplace emerge and interact with one another (Greer and Carden 2021; Ochsenfeld 2014). While previous research exists exploring the limitations of human capital explanations of gender pay gaps more broadly, they do not test these limitations using data from groups which are controlled, insofar as is possible, for skills, experience and education, nor does it explore how human capital explanations could obscure issues of gender inequality in the workplace beyond the pay gap (Tharenou, 2013, Lips, 2012, Ishikawa & , 2002).

Our study produced two main findings. First, it appears that a gender pay gap is present at the graduate entry level, and this gender pay gap is most prevalent in the Business sector, compared to other sectors such as Engineering, Science and Technology. Secondly, an underrepresentation of females in leadership track options can be found as early as enrolment in university programs.

These findings offer significant insights into the question of when gender pay and leadership gaps begin to occur, challenging human capital theory applications.

This study explores the university-to-work transition, shedding light on students' gendered experiences before entering the workforce and during early career stages. In doing so, it contributes to advancement in understandings of workplace gender inequality and how to address it, encouraging a nuanced understanding of how and when social inequalities are replicated in the workplace.

2. Hypotheses

Based on research on the gender pay gap, the gender leadership gap and critiques of the human capital theory, two working hypotheses guide analysis and discussion of this study.

Hypothesis 1: *Female Co-op graduates are likely to receive equal salary male graduates, as both groups being similarly highly career-ready and experienced.*

Based on human capital theory, graduates with similar working experience and grades should receive similar renumeration regardless of gender. Students in the Co-op program must maintain high grades and receive similar training and experience in the form of prestigious internships. As such, they graduate with very similar levels and types of human capital. As such, based on human capital theory, male and female Co-op students should receive roughly the same graduate salaries.

Hypothesis 2: *There is equal female student representation in applications for the leadership program*

From a human capital perspective, the pay and leadership gaps are explained by differences in work experience and lifestyle between men and women The Co-op application data concerns high school students, who are unlikely to have encountered gendered factors that unevenly impact their human capital. In 2019, women represented 59.0% of all undergraduate and postgraduate university course enrolments in Australia, so there should not be a gender gap in applications based on differences in post-high school education plans. As high school students in STEM and business classes, applicants have roughly the same human capital, we hypothesise that, based on human capital theory, there should be an equal, if not slightly higher, representation of women to men in applications to the leadership program.

3. Data

A unique dataset from the Co-op Scholarship Program enabled a longitudinal case study of a signature work-integrated learning program of UNSW. UNSW is a public research university based in Australia, ranked 19th in the 2024 QS World University Ranking and 1st in Australia

for Employment Outcomes by The Australian Financial Review in 2023. The Co-op is both a scholarship and a specialised leadership program, offering three industry placements throughout university degrees.

3.1. Co-op Application Dataset (2012-2022)

The Co-op application dataset comprises information about the entire scholar application process onto the program. It consists of basic information regarding the applicant, indicators of the success of the application process, and enrolment details of applicants. Sample size of the data shown in Table 1.

Table 1. Co-op applicants dataset sample (2012-2022)

	All	Business	Engineering	Science	Technology
Frequency					
Male	6002	3019	2595	1002	1761
Female	3637	2280	1180	515	974
%					
Male	0.62	0.57	0.69	0.66	0.64
Female	0.38	0.43	0.31	0.34	0.36

3.2. Co-Op Graduate Exit Survey Dataset (2008-2022)

The Co-Op exit survey dataset comprises information about scholars who have completed the UNSW Co-op Program including job status after the program, starting salary as well as survey responses regarding pre-defined factors considered in choosing an employer. Sample size shown in Table 2.

Table 2. Co-op graduate exit survey dataset sample (2007-2022)

	ALL	Business	Engineering	Science	Technology
Frequency					
Male	496	206	115	18	155
Female	341	179	52	9	101
%					
Male	59.26	53.51	68.86	66.67	60.55
Female	40.74	46.49	31.14	33.33	39.45

4. Methodology

To test the hypotheses on gender differences between male and female scholars (Ethics approval code HC220392), comparison will be based on their relative proportion differences in three stages:

The first stage involved considering male and females as two separate populations and calculating the proportion of each.

$$Proportion_{Male} = \frac{No\ of\ Males\ with\ Attribute\ A}{No.of\ Males\ applicable\ for\ AttributeA} \quad (1)$$

The second stage involved calculating the proportion difference between Male and Female populations.

$$Difference\ = Proportion_{Male} - Proportion_{Female} \quad (2)$$

The last stage involved testing the statistical significance for the differences between Male and Female populations at a 10% level.

5. Results

5.1. Hypothesis 1

A gender pay gap is evident at the graduate commencement level.

There is a significantly higher proportion of Males (35.08%) occupying the highest salary bracket ($80,000+) as opposed to 28.15% for females ***(Figure 1).*** Conversely, a higher proportion of Females occupy the middle and lowest salary bracket of $65,000-$80,000 and $0,000-$65,000. The statistical difference results are provided in Table 3.

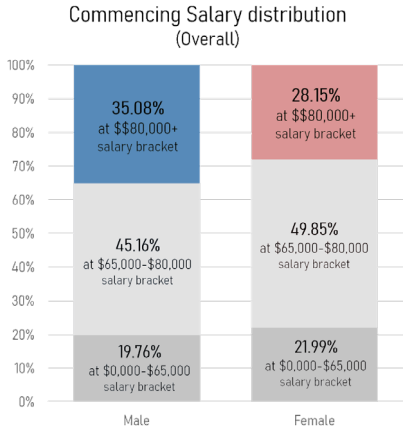


Figure 1. Graduate Gender Pay gap

Table 3. Graduate Gender pay gap statistical difference.

	Difference	Z-test statistic	p-value
$0,000 to $65,000	-2.2%	-0.78	0.4325
$65,000 to $80,000	-4.7%	-1.34	0.1815
$80,000+	6.93%	**2.11**	**0.0351**

Partitioning the data into 5-year intervals shows that the gender pay gap has not improved over time (Results will be provided upon request).

Further, sectoral analysis shows that the gender pay gap is most prevalent in the Business sector and the remaining sectors of Engineering, Science and Technology showed insignificant results (Results will be provided upon request).

5.2. Hypothesis 2

In understanding whether there is less female representation in leadership based on hypotheses 2 this study has found that women are heavily underrepresented as early as the application stage for the Co-op Program. Roughly twice as many Males (62.27%) as Females (37.73%) applied for the UNSW Co-op Program between 2012 to 2022 *(Figure 2)***.** Further partitioning the data to gain insight on whether there has been improvement in female representation across time and across sector shows that there is no improvement of Female representation, as the proportion of Female applicants hardly changed (Results will be provided upon request).

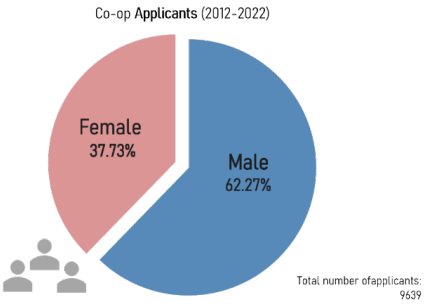


Figure 2: Gender Representation in leadership program

6. Conclusion

The longstanding issue of gender pay gap and leadership gaps and their presence at the university enrolment and graduation levels is alarming. The findings of this study are particularly notable as they reveal a significant gender pay gap among a relatively controlled and high-achieving university graduate cohort as well as heavily underrepresented female students in leadership programs as early as the university application stage.

The results discussed in this paper are valuable in revealing how early workplace inequalities based on gender emerge, demonstrating a need for institutions to develop effective policy interventions to address these gaps. Higher education could play a pivotal role in instilling equal practices in the labour force at large, targeting workers at an early age to produce life-long value of gender equality. The data analysed in this study exemplifies the valuable contribution higher education institutions can and need to make, especially through Work Integrated Learning, where students are exposed to work environment early during their studies. Though this dataset is limited to a single work integrated learning program in one Australian school, its implications are nonetheless far-reaching, both as an insight into the origins of gender inequality, and a demonstration of an underutilised area of study

References

Chevalier, A. (2007). Education, occupation and career expectations: Determinants of the gender pay gap for UK graduates. *Oxford Bulletin of Economics and Statistics, 69*(6), 819–842.

Chia, G., & Miller, P. W. (2008). Tertiary performance, field of study and graduate starting salaries. *Australian Economic Review, 41*(1), 15–31.

Greer, T. W., & Carden, L. L. (2021). Exploring the gender wage gap among project managers: A multi-national analysis of human capital and national policies. *International Journal of Project Management, 39*(1), 21–31.

Ishikawa, M., & Ryan, D. (2002). Schooling, basic skills and economic outcomes. *Economics of Education Review, 21*(3), 231–243.

Lips, H. M. (2012). The gender pay gap: Challenging the rationalizations, perceived equity, discrimination, and the limits of human capital models. *Sex Roles, 68*(3–4), 169–185.

Lo Sasso, A. T., Armstrong, D., Forte, G., & Gerber, S. E. (2020). Differences in starting pay for male and female physicians persist; explanations for the gender gap remain elusive. *Health Affairs, 39*(2), 256–263.

Morgan, L. A. (2008). Major matters: A comparison of the within-major gender pay gaps across college majors for early-career graduates. *Industrial Relations, 47*(4), 625–650.

Ochsenfeld, F. (2014). Why do women's fields of study pay less? A test of devaluation, human capital, and gender role theory. *European Sociological Review, 30*(4), 536–548.

Roy, B. (2018). Gender pay gaps in medicine: Moving from explanations to action. *Journal of General Internal Medicine, 33*(9), 1413–1414.

Sterling, A. D., Thompson, M. E., Wang, S., Kusimo, A., Gilmartin, S., & Sheppard, S. (2020). The confidence gap predicts the gender pay gap among STEM graduates. *Proceedings of the National Academy of Sciences, 117*(48), 30303–30308.

Tharenou, P. (2013). The work of feminists is not yet done: The gender pay gap—A stubborn anachronism. *Sex Roles, 68*(3–4), 198–206.

Whoodhams, C., Trojanowski, G., & Wilkinson, K. (2022). Merit sticks to men: Gender pay gaps and (in)equality at UK Russell Group universities. *Sex Roles, 86*, 544–558.

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University-to-Work Transition: Resources and Challenges for Students with Disabilities

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Abstract

The paper presents the first results of a doctoral research project in Social Pedagogy. It is based on the analysis of twenty interviews with graduates and students with disabilities in Italy. The subject of university-to-work transition is explored in relation to the legislation, as well as the characteristics and experiences of interviewees. The data collected highlights the possibility of pursuing a degree and working, even in the presence of significant functional limitations. Universities are poorly connected to the world of work, despite their ability to support higher education pathways. Job placement services remain underutilised and are not well known. The study proposes the implementation of qualitative research, with the participation and contribution of all stakeholders, in order to deepen the knowledge of the issues under investigation, balancing protection and promotion of the rights to training and work for all.

Keywords: *students with disabilities; workers with disabilities; university-to-work transition; social pedagogy; pedagogy of work; qualitative research*

1. Introduction

Higher education pathways aim to provide better employment opportunities, although the knowledge and skills acquired are not always immediately transferable in today's labour market. The factors involved in finding and keeping a job are multiple, and university-work transition theories (Kyndt et al., 2017) explore this area, also with the aim of improving interventions and policies. For people with disabilities, in particular, access to higher education and employment is hampered by cultural and environmental barriers which demand the attention of educational institutions and other social actors. According to the surveys conducted, job placement is more difficult for people with disabilities (European Disability Forum, 2023; Istituto Nazionale di Statistica [ISTAT], 2022).

In light of the significance of work for an independent life, international documents place particular emphasis on the rights to education and employment (United Nations Convention on

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the Rights of Persons with Disabilities, 2006; The European Disability Strategy 2021-2030; The Charter of Solfagnano, 2024). In Italy and in most countries, these rights are protected by national laws which establish specialised services and introduce obligations on public and private employers.

In academic literature, there is now a growing interest in and focus on issues related to the adult life of people with disabilities. This includes higher education and employment opportunities (Aust et al., 2014; Bellacicco & Parisi, 2020; Cottini et al., 2016; Giaconi, 2015; Friso & Scollo, 2018; Israelite et al., 2005; Lascioli et al., 2022). The studies explore the challenging issues that the independent living movement, disability studies and the bio-psycho-social paradigm have raised in recent decades. If the rights of people with disabilities are recognised and regulated, their implementation requires the design of integrated and multidisciplinary interventions to foster, at all stages of life, a balance between protection and promotion.

This paper presents the first results of a doctoral research project in Social Pedagogy, still in progress. It analyses the results of a first phase survey on the university studies and working conditions of twenty university graduates or students with disabilities enrolled at university, in the Rome area. The study describes some characteristics of their study and employment pathways based on the, sometimes dichotomous, demands of protection and promotion. Graduates (and university students) in university-to-work transition go from an educational environment, which accompanies and protects them, to the world of work where productivity and competitive skills, reduce or significantly change this protection. In this regard, it is important for the university (but also for schools and vocational training) to understand how to realistically co-design interventions concerning people and environments, in collaboration with all stakeholders, to improve students' skills and promote processes of full socio-occupational participation in today's labour market (Santi & Di Masi, 2018).

2. Protection vs promotion for people with disabilities

International and national legal systems provide specific rules to recognise and safeguard the rights of the most fragile people. The protection of the right to study and work entails the promotion of the person who, in the enjoyment of these rights, can find possibilities for social and professional fulfilment. Pedagogical studies and practices, in formal and non-formal educational contexts, must take into account the dual purpose of these laws and avoid that protective measures reduce the developmental capacities of people with disabilities (Biagiotti & Sannipoli, 2022; Marchisio & Curto, 2019).

The protection and promotion issues in the university-to-work transition proposed here require a brief examination of the rules governing university studies and access to the world of work. Since there exist various laws and policies at the national level, the study considers two important Italian legal references to define the topics of interest: Law No 17/99 on University

Studies, and Law No 68/99 on Job Placement. Two national laws, enacted in the same year: a) Law No 17/99 has increased the protection of the rights of people with disabilities on university courses, following the recognition of their right to access to university studies by Law No 104/92; b) Law No 68/99, which repealed Law No 482/68, has introduced important changes in job placement (Bombelli & Finzi, 2008). Labour regulations have been further amended through various legislative measures (e.g. D.M. n. 43/2022, D.lgs. n. 62/2024). Despite these interventions, especially by employers, there is a need to review the placement system (Fasola, 2025), also in view of changes in the labour market.

Law No 17/99, on the other hand, would better respond to the needs arising in university settings, although it is worth noting that these conditions are also protected by other laws for students with specific needs (e.g. Law No 170/2010). Some parts of the training pathway (such as the internship) are regulated at university or specific degree course levels, and in professional contexts, but are not generally specified.

In the following paragraphs, overall reflections will be proposed in order to focus attention on how these laws protect and promote the development of people with disabilities. It should be noted that the analysis aims to focus only on a few macro-elements, which are relevant for the purposes of this paper.

2.1. Protection

Law No 17/99 identifies for students with disabilities an articulated offer of services, figures and supports, which universities have introduced to improve the accessibility to study pathways. To be eligible for benefits, students must present a certificate of their status. Special needs protection therefore is not automatic, but can be granted on request by the student. In addition, due to the objectives to be achieved on each course of study and activity, professors and university staff may identify appropriate pathways to enable participation in learning activities and examination tests.

Law No 68/99 regulates the conditions for workers and employers. It identifies the categories of people entitled to be included in Targeted Employment. People with disabilities can access a dedicated channel for seeking employment by registering in the Targeted Employment lists. Public or private employers are obliged by the same law to employ a number of people with disabilities (based on the number of workers employed), and can then find candidates on these lists. The registration also allows participation in public competitions that take into account special needs. Targeted Employment and related services are managed by regional offices, as the Regions have shared competence in labour matters.

2.2. Promotion

Current legislation, as reported, regulates protection for people with disabilities in higher education and work. Protection, however, does not automatically translate into promotion and better opportunities for socio-economic fulfilment. Laws must be properly understood by the person with disabilities and all stakeholders in the education and labour system.

With regard to higher education, the recognition of rights must be the guiding principle in designing pathways that put the student at the centre. University courses must be embedded in a broader project with positive effects on the individual and on living environments (Callegari & Sandri, 2024; Estima & Carvalho, 2024; Giannoccolo & Aluffi Pentini, 2023). The university, according to this logic, can therefore play a key role in research and educational innovation in order to integrate theoretical and practical knowledge and make it applicable in the labour market.

In the context of work, the law raises several issues concerning the promotion of people with disabilities. In the first instance, it would be necessary to investigate what the real needs of people registered for Targeted Employment are, to draw up a realistic profile of the person's skills and placement possibilities (Bottà, 2024). Moreover, it is not possible to take care of the worker without taking care of the employer’s interests, without knowing the needs of the productive world, and the skills required by the labour market. Promoting people with disabilities in the workplace is only possible if it becomes also a place of training and real participation (Alessandrini, 2017; d’Aniello, 2019; Dato, 2022; Caldin & Friso, 2019).

3. Methodology and first research results

The article, as indicated, presents the first results of a doctoral project, which is still in progress. The research design aims to investigate the structures and characteristics of social networks that support graduates and students with disabilities in their job placement in the Rome area. In the first phase, a qualitative survey employed the instrument of semi-structured interviews and involved: a) representatives of associations of people with disabilities, active in the protection of workers' rights (16); b) representatives of institutions and organisations engaged in active labour policies (28); c) graduates and students with disabilities (24).
The themes proposed in the interviews were identified from an analysis of the cited legislation and the academic literature. Thematic analysis of the interview texts is currently underway; the NVivo software is used for text encoding. The data collected will then be discussed in focus groups with the aim of bringing out shared proposals to improve the functioning of social networks, which can facilitate the university-to-work transition.

In the following section, some data collected in interviews with graduates and university students are reported and analysed in order to explore the experiences of participants and

highlight forms of protection/promotion. The analysis is based on twenty interviews conducted between May 2024 and January 2025. Four interviews were excluded, as two were conducted with people with psychological disorders and two with parents of students with disabilities. The information gathered covered the following areas: age, impairment, degree or course of study, access to university services, registration for Targeted Employment, current job position, other work/training/volunteering experience. The elements that emerged are summarised below, starting with the description of the characteristics of the sample (non-probability).

The average age of the participants is 32, the youngest is 21 and the two 'oldest' respondents are 43. A prevalence of men is observed, with twelve interviewees. This element refers to biological data and is interesting since academic research and statistical data indicate that women with disabilities are at greater risk of social and labour market exclusion (Taddei & Alesi, 2024). The functional limitations are physical (fourteen), of which seven are sensory (two with blindness, five deafness); related to neurodevelopmental disorders (five); in one case, there are limitations due to a rare disease, not yet certified.

At the time the interviews were conducted, there were four university students, although two had already completed all examinations. The other participants have a university degree (three or five years), six have postgraduate training. Seven respondents have completed - or are studying to complete - a degree in the Humanities; five interviewees, economic and legal disciplines; four participants, in psycho-pedagogical disciplines; two, in health professions; one, in Engineering; one, in Life Science.

Although the data set can only be used in an exploratory way, it shows a lower attendance in scientific courses. Overall, the lack of accessibility of study materials in Mathematics, Statistics and Science was highlighted. Almost all interviewees emphasised the challenges of the academic experience: attending courses and receiving support in studying and testing requires students a high level of autonomy and awareness of the services. In the presence of relational difficulties, as in the case of neurodevelopmental disorders, students tend to seek (integrative) support from their families. Some interviewees underline the differences between study and work environments, as employers show less willingness to accommodate special needs. School and university would not prepare adequately for the working world. In relation to the issues, therefore, the university would seem to guarantee access to study paths and perform a function of protection and promotion of people with disabilities in studies, without adequately addressing what happens afterwards.

Concerning the work situation, sixteen respondents are registered in the Targeted Employment lists (Law No 68/99). In contrast to this, participants' information about the functioning of the Service is insufficient. Graduates enrol at the end of their university studies or at a later stage. In most cases, they are concerned that registration may limit the possibilities of choice in the private labour market, while the usefulness of registration to participate in public job

competition is sufficiently recognised. Respondents recognise the need for the protection offered by work integration regulations. However, they do not consider them relevant to professional fulfilment.
Regarding the employment, twelve interviewees are employed; two participants are not looking for a job because they are studying; one interviewee with a bachelor's degree in Engineering, who has completed the examinations of the Master's Degree, has already signed the proposal for a work contract; one young woman, who reported some difficulties in her university career, is working. The last two interviewees found work through their internship, before completing their degree, in two different fields (banking services market, culture and tourism).
The average age of the twelve workers is over 35. There are five people working in the public sector, one participant employed in the private sector and three people employed in associations and cooperatives. Interesting facts: two interviewees are self-employed, one participant is an entrepreneur in the tourist sector. Among public sector workers, three persons found employment through a reserved competition; one participant is a teacher in a public school. A job with Targeted Employment was found by only one person.
Among the respondents who do not have a job, the position of two requires special attention. Despite participating in various experiences promoted by the Services, they have not found employment. In one case, the person has a postgraduate education and excellent foreign language skills.

The situation of graduates with disabilities in the world of work appears to be positive, but it deserves further analysis to explore data from work environments regarding existence and efficacy of inclusion practices, job tasks, professional development, and relations with colleagues. In the public sector, the protection system also appears to be a promotional tool. Personal factors would seem to influence the achievement of success in the field of work for those who practice the professions. Despite some substantial difficulties in the university pathways, these interviewees have achieved important milestones. The only woman entrepreneur, on the other hand, took a friend's advice: 'Start your own business!'

4. Conclusions

Interviews with graduates and students with disabilities provided an insight into their study and work experiences, as well as some information about research topics and services. These are people who today have a different set of resources than they did in the past. They have studied and can design their own future work, even with significant functional limitations. Their desire for professional fulfilment and active participation in social and economic life has not been diminished by the effort (and for some, 'fatigue') required to achieve success in training.

The challenge for teachers, trainers, service managers and employers, both public and private, is to create favourable conditions for cultural and professional development by integrating

interventions and resources in a labour market that is constantly and rapidly changing. The experience of the two interviewees who found a job through internships, for instance, emphasising the importance of this tool to facilitate the university-to-work transition, is not fully utilised.

The data collected highlights the importance of implementing qualitative research, with the participation and contribution of all stakeholders, also from a multidisciplinary and comparative perspective, in order to improve knowledge of the topics under investigation and customise training proposals, balancing protection and promotion concerning the rights to study and work for all.

References

Alessandrini, G. (Ed.). (2017). *Atlante di pedagogia del lavoro*. Milano: FrancoAngeli.

Aust, R., Cao, U., Drinck, B., & Chattat, R. (2014). European action on disability within higher education. The beginning of a more inclusive process. In: *AHEAD conference 2014 summary publication*, 35-42.

Bellacicco R., & Parisi T. (2020). L'inserimento lavorativo dei laureati con disabilità. Uno studio esplorativo sull'Ateneo torinese. *Scuola democratica*, *XI*(1), 99-119.

Biagiotti, G., & Sannipoli, M. (2022). Garantire l'accesso e il successo universitario agli studenti con disabilità: costruire regie inclusive. *Italian Journal of Special Education For Inclusion*, *10*(2), 102-110.

Bombelli, M.C., & Finzi, E. (2008). *Oltre il collocamento obbligatorio. Valorizzazione professionale delle persone con disabilità e produttività nel mondo del lavoro*. Milano: Guerini e Associati.

Bottà, M. (2024). *L'inclusione lavorativa delle persone con disabilità. Metodi e strumenti per l'accompagnamento, l'inserimento e la valutazione*. Trento: Erickson,

Caldin, R., & Friso, V. (2019). Pedagogic commitment and prospects for integration of persons with disabilities into the labour market. *Education Sciences & Society*, *2*, 42-60.

Callegari, L., & Sandri, P. (2024). Guardare oltre per abitare il mondo, avendo un progetto: una ricerca per promuovere l'operosità delle persone a occupabilità complessa. *Education Sciences & Society*, *1*, 203-232.

Cottini, L., Fedeli, D., & Zorzi, S. (2016). *Qualità di vita nella disabilità adulta. Percorsi, servizi e strumenti psicoeducativi*. Trento: Erickson.

d'Aniello, F. (2019). Il lavoro per la persona. La storia della pedagogia del lavoro per il futuro dell'educazione. *STUDIUM EDUCATIONIS-Rivista semestrale per le professioni educative*, (3), 117-126.

Dato, D. (2022). Un obiettivo audace. Pedagogia e professioni educative in azienda per il welfare aziendale. *Pedagogia oggi*, *20*(2), 34-41.

Estima, A., & Carvalho, A. C. (2024). Strategies for Inclusive Learning: A Marketing Faculty's Journey with Students with Intellectual and Developmental Disabilities. In: *10th International Conference on Higher Education Advances (HEAd'24)*. Valencia, 18-21 June, 327-334.

European Disability Forum (2023). The Right to Work: The employment situation of persons with disabilities in Europe. European Human Rights Report, Issue 7. https://www.edf-feph.org/content/uploads/2023/05/hr7_2023_press-accessible.pdf

Fasola, G. (2025, 28 gennaio). Disabilità e la chimera del lavoro. *Corriere della Sera*, 30.

Friso, V., & Scollo, S. (2018). Il Disability Manager e le competenze di tutoring, a sostegno dell'inclusione lavorativa. *CQIA RIVISTA*, *8*(25), 107-116.

Giaconi, C. (2015). *Qualità della vita e adulti con disabilità. Percorsi di ricerca e prospettive inclusive*. Milano: FrancoAngeli.

Giannoccolo F., & Aluffi Pentini A. (2023). Il tirocinio nei percorsi universitari professionalizzanti: dare parola agli studenti con disabilità. *I Problemi della Pedagogia*, *2*, 307-328.

Israelite, N., Swartz, K., Huynh, J., & Tocco, A. (2005). Post-secondary students and graduates with disabilities: The transition from university to work. Exceptionality Education Canada, *15*(2), 5-26.

Istituto Nazionale di Statistica. (2022). *Rapporto annuale. La situazione del Paese*, 262-263. https://www.istat.it/storage/rapporto-annuale/2022/Capitolo_4.pdf.

Kyndt, E., Donche, V., Trigwell, K., & Lindblom-Ylänne, S. (Eds.). (2017). *Higher Education Transitions. Theory and Research*. New York: Routledge.

Lascioli, A., Pasqualotto, L., & Traina, I. (2022). L'orientamento al lavoro dei giovani con disabilità: approfondimenti sulla situazione italiana e irlandese. *RicercAzione*, *14*(2), 145-159.

Legge n. 17/99, Integrazione e modifica della legge-quadro 5 febbraio 1992, n. 104, per l'assistenza, l'integrazione sociale e i diritti delle persone handicappate. 28 gennaio. https://www.gazzettaufficiale.it/eli/id/1999/02/02/099G0057/sg.

Legge n. 68/99, Norme per il diritto al lavoro dei disabili. 12 marzo. https://www.gazzettaufficiale.it/eli/gu/1999/03/23/68/so/57/sg/pdf.

Marchisio, C.M., & Curto, N. (2019). *Diritto al lavoro e disabilità. Progettare pratiche efficaci*. Roma: Carocci Faber.

Ministero del Lavoro e delle Politiche sociali. (2022). *Linee guida in materia di collocamento mirato delle persone con disabilità*. D.M. n. 43. https://www.lavoro.gov.it/documenti-e-norme/normative/pagine/decreto-ministeriale-n.-43-dell11-marzo-2022.

Santi, M., & Di Masi, D. (2018). (Eds.). *Indeep university. Un progetto di ricerca partecipata per un'Università inclusiva*. Padova: Padova University Press.

Taddei, A., & Alesi, B. (2024). La difficile transizione dalla scuola al lavoro per le donne con disabilità. Una questione di democrazia. *Italian Journal of Special Education for Inclusion*, *12*(1), 107-114.

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Enhancing Entrepreneurial Activity through Advanced Entrepreneurship Courses

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Abstract
This study examines the role of an advanced entrepreneurship course in addressing the critical research gap in the intention-to-behavior transition within higher entrepreneurship education. Leveraging the university's robust entrepreneurship ecosystem, the course targeted students with prototypes and entrepreneurial aspirations. Four teams, comprising 14 students, engaged in an ethnographic setting featuring cross-faculty coaching and personalized mentorship. Findings highlight significant variability in participants' entrepreneurial backgrounds and intentions, with team dynamics and critical project evaluation emerging as key determinants of entrepreneurial behavior. The course effectively bridges foundational entrepreneurship education and incubation programs, facilitating the progression to advanced startup development. Challenges such as varying entrepreneurial readiness, hesitance to pivot, and credit recognition underscore the need for tailored, iterative course designs that accommodate diverse student needs. This approach enhances the pipeline from academic projects to ventures and advances university-driven innovation.

Keywords: *Advanced entrepreneurship education, entrepreneurial mindset, university startups, startup incubation, entrepreneurial readiness.*

1. Introduction

Universities play a critical role in fostering innovation and entrepreneurship, serving as incubators for startup founders through Entrepreneurship Education (EE) (e.g., Audretsch, 2014; Yu, Zheng, & He, 2024). EE equips students with the knowledge and skills needed for venture creation (Zhong et al., 2022), offering programs ranging from introductory courses to advanced initiatives to transitioning academic projects into viable businesses (Neck & Greene, 2011). These programs often leverage institutional ecosystems, including incubators,

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accelerators, and entrepreneurship centers, to support students with the necessary resources and networks for startup success (Wright et al., 2017).

While EE effectively fosters entrepreneurial intent by enhancing creativity, innovation, and foundational business skills (Piperopoulos & Dimov, 2015), there remains a significant gap between intention and action. Many students with high entrepreneurial intentions fail to transition into founding a startup (e.g., Souitaris et al., 2007). This gap highlights the need for advanced, experiential learning opportunities that address real-world entrepreneurial challenges (Lackéus, 2015). Generalized curricula, limited exposure to practical problem-solving, and insufficient integration of iterative and team-based learning further hinder this transition (Kuratko, 2005; Fayolle & Gailly, 2015). In EE the Lean Startup framework (e.g., Blank & Eckhardt, 2024; Ries, 2011) is one of the most prevalent concepts to teach opportunity validation, iterative development, and self-directed learning. Given the success of the Lean Startup framework, we align with scholars such as Leatherbee and Katila (2020), who highlight its context-specific nature. However, a deeper understanding is needed despite existing insights into its effectiveness, boundary conditions, and practicality.

This study addresses the research gap concerning the intention-to-behavior transition within higher education-based EE, as Nabi et al. (2017) identified. Specifically, it investigates why some recipients of EE with high entrepreneurial intentions establish startups while others do not. It also explores the role of advanced EE in facilitating this transition by focusing on a pilot program for final-year bachelor students. Our students all had entrepreneurial intentions and had already finished a beginners' EE program. Further, we focus on teaching the most relevant aspects of the Lean Startup framework only if there is a clear demand for the skills to avoid information overload for students. The objectives of this study are twofold. First, we assess whether a specific advanced course could bridge and enhance the pipeline from EE to incubation programs. Second, we identify the specific needs of students with entrepreneurial intent.

Conducted in an ethnographic setting with cross-faculty coaching and personalized mentorship, this paper outlines the course design, methodology, and findings. We interviewed 14 participants and thereby enhanced the course design for the consecutive year. Eventually, we contribute to the debate on the intention-to-behavior transition (e.g., Souitaris et al., 2007) and offer recommendations for educators aiming to optimize advanced EE.

2. Theoretical Background

EE has emerged as a critical tool for fostering innovation and bridging the gap between entrepreneurial intentions and startup behavior. Universities worldwide integrate EE into their curricula, offering students the skills, knowledge, and resources necessary to transform ideas into ventures. The research underscores the importance of moving beyond traditional, lecture-based models to experiential, project-based approaches, pursuing the Lean Startup framework,

which emphasizes iterative development, customer validation, and agile adaptation (e.g., Ries, 2011; Leatherbee & Katila, 2020).

Theoretically, Ajzen's (1991) Theory of Planned Behavior unfolds high explanatory power in EE for the causal chain between attitudes, perceived behavioral control, and subjective norms as key drivers of entrepreneurial decision-making. While EE enhances entrepreneurial intentions and self-efficacy (Nabi et al., 2017; Nowiński et al., 2017), a persistent gap exists between the intention to become an entrepreneur and the actual founding of a startup. Souitaris et al. (2007) found that inspiration derived from entrepreneurship programs significantly raises entrepreneurial intentions but does not always translate into immediate behavior, particularly due to time lags and barriers such as insufficient interdisciplinary collaboration and limited institutional support (e.g., Blenker et al., 2011; Kuratko, 2005).

University ecosystems, comprising mentorship programs and incubation initiatives, play a vital role in supporting this transition. Wright et al. (2017) emphasize the integration of these resources into curricula to create a seamless pipeline from ideation to venture creation. Advanced courses, situated between foundational education and incubation programs, are particularly effective in fostering this transition. They allow students to refine ideas, validate markets, and develop prototypes. Effectuation principles, which encourage leveraging existing resources and embracing uncertainty, have proven valuable in such settings (Neck et al., 2014). However, the effectiveness of advanced EE depends heavily on course design. Fayolle and Gailly (2015) stress the need for a balance between structured guidance and self-directed learning. Programs that emphasize iterative learning, real-world problem-solving, and interdisciplinary collaboration are better equipped to address the intention-behavior gap and enhance university-driven innovation. These findings suggest a need for more targeted interventions that prioritize actionable outcomes over theoretical knowledge.

3. Research Method

To explore the potential of advanced EE in fostering startup creation and entrepreneurial skills, we designed and implemented a pilot course targeting bachelor students in their final year. The advanced entrepreneurship course was structured as an ethnographic study, providing students with a hands-on, self-directed learning experience. The curriculum was anchored in the Lean Startup framework, emphasizing iterative development, market validation, and reflective learning. Participants attended weekly coaching sessions led by three professors from different faculties, ensuring interdisciplinary perspectives. Lectures were offered on demand to support specific team needs, and students were encouraged to proactively request resources and guidance. The course was advertised to over 250 students across various entrepreneurship courses within the university. We were able to provide credits (ECTS) to some faculties only. Ultimately, 14 students formed four teams, with most participants being self-selected based on

their entrepreneurial interests and ongoing projects. While the course was open to all students, only students eligible for credits joined. All participants were male, and no interdisciplinary teams were formed, as most participants recruited team members from their faculties.

EE is a key pillar of our university, the institution is renowned for its entrepreneurship center, which supports students through various programs, including non-credit courses that guide participants from ideation to startup creation, and a highly regarded incubation program for nascent ventures (Etzkowitz & Zhou, 2017). Additionally, the university offers numerous intra-faculty and inter-faculty entrepreneurship courses tailored to undergraduate students. Many students engage in project-based assignments during their studies, particularly in technical disciplines, which often serve as a springboard for entrepreneurial ideas (Rasmussen & Sørheim, 2006). To gain insights into the effectiveness of the course and the needs of students with entrepreneurial intent, we build on the following data collection approach:

- **Interviews**: Semi-structured interviews were conducted with each participant at the end of the course. These interviews explored their experiences, challenges, and perceptions of their entrepreneurial development.
- **Self-Reflection Reports**: Teams documented their personal and venture-related progress in weekly reflection
- **Observation:** The teams underwent weekly coaching and kept close contact with professors with multiple touchpoints

The data was analyzed qualitatively to identify themes related to entrepreneurial skill development, team dynamics, and the effectiveness of the course structure. Interview transcripts and self-reflection reports were coded to extract insights into participants' needs, challenges, and intentions.

4. Results

4.1. Participant Characteristics

The course attracted students with diverse entrepreneurial backgrounds, ranging from those with no prior experience to individuals who already started their first ventures prior to the course. Despite the course's open nature, all participants were male, and teams lacked interdisciplinary composition, as students primarily recruited peers from their faculties. None of the team participated with the same group of team members as in their initial EE course. Team building was conducted without the intervention of the teachers. This homogeneity in team formation highlights a potential barrier to fostering cross-disciplinary innovation in university when there are few interdisciplinary courses as in our case. Additionally, many participants expressed uncertainty about their future entrepreneurial pathways, often deliberating between pursuing a

startup, advancing their academic studies, or entering the job market (see Team-specific Findings in Table 1).

4.2. Motivations and Intentions

Students' motivations were often tied to their experiences with project-based assignments during their studies, particularly in technical disciplines. These assignments provided an initial spark of entrepreneurial interest, as students recognized the potential for further development of their projects. However, entrepreneurial intentions were not static; they fluctuated throughout the course as participants encountered market feedback, team dynamics and difficulties, and personal reflections on the feasibility of their projects. For some, these experiences reinforced their entrepreneurial drive, while for others, they prompted reconsideration of their career paths after considering the risk and associated workload. Most teams derived the problem for their activity from their close private environment, as they lacked in-depth industry experience.

4.3. Skill Development

Participants demonstrated notable growth in entrepreneurial skills, particularly in areas such as presentation, prototyping, marketing, and application of entrepreneurial frameworks like the Lean Startup methodology. Interestingly, skills introduced in earlier entrepreneurship courses often became clearer and were more effectively applied when revisited in this advanced setting, especially after the need was experienced by the team. This finding underscores the value of reinforcing foundational concepts through iterative learning experiences.

4.4. Challenges

The study also revealed several challenges. Students were generally hesitant to pivot their projects in response to market feedback, as it causes uncertainty. As the course was graded, high flexibility was not included in the grading scheme from the very beginning. A greater emphasis on flexibility and adaptability in grading is essential. We experienced a passive engagement with on-demand lectures further highlighted the necessity for a more agile and problem-oriented coaching approach. Moreover, students were not engaging actively enough with their customer segment.

Table 1: Team-Specific Findings

Team	Project Description	Strengths	Challenges
1	AI-driven application for midwife documentation	Real-world problem identified; solid progress in prototype design; significant improvement in presentation skills; validated concept through target group interviews.	The initial prototype lacked modern design; needed external design expertise; limited ambition in project framing; and had low self-efficacy.
2	Ticketing system for clubs with age verification features	Experienced members brought entrepreneurial backgrounds, iterative prototype design and good initial concept. Realistic risk assessment.	Lack of team cohesion; mixed entrepreneurial intentions; insufficient field experiments; team hesitant about project relevance.
3	Platform for trading unused parking spaces	Strong entrepreneurial drive; high-quality pitch deck and interviews from the outset; utilized university resources effectively; quickly ran first experimental POC.	Slower learning curve after initial motivational surge; disappointment due to slow project progression; high expectations to the university and ecosystem.
4	Service to purchase cars with low residual value	Practical market experience; strong hands-on approach; significant improvement in presentation and entrepreneurial skills.	Limited entrepreneurial mindset; trader mentality dominated over startup mindset; insufficient digital and business expertise.

5. Conclusions, Limitations, and Future Work

5.1. Implications

The findings of this study underscore the potential of advanced entrepreneurship courses to support turning slight entrepreneurial intention into action. (e.g., Souitaris et al., 2007). However, more realistic efforts or risk assessment can reduce entrepreneurial activity in complex founding endeavors. Slightly naive and very enthusiastic founding endeavors should not be the objective of venture development in universities.

Advanced entrepreneurship courses can serve as a bridge by fostering entrepreneurial skills, validating business concepts, and improving self-efficacy. Especially the exchange between teams who progress in problem-based learning approaches helped to provide a clear picture of

risks and opportunities related to the venture. This study contributes to the intention-behavior debate by highlighting challenges occurring during the transition of students from the ideation phase into actionable startup activities. Nabi et al. (2017) emphasize the need for learning experiences, and our findings align with this, demonstrating that structured, hands-on courses foster teamwork, and iterative problem-solving skills—factors critical for translating intentions into behavior.

For these courses to maximize their impact and further contribute to the intention-behavior transition, universities should implement the following strategies: First, allocate academic credits to advanced courses, while leaving a high level of freedom to act and pivot for the teams. Providing academic credit for advanced entrepreneurship courses can attract teams that are too early to decide to act. Teams normally restructure after the first EE courses, normally one driver attracts other students from their faculty. Advanced courses must support this action. Team pivots have been shown to occur before opportunity pivots. Second, it is essential to offer structured guidance for relevant entrepreneurial learning and testing, omitting irrelevant educational deliverables. While self-directed learning fosters autonomy and an entrepreneurial mindset, it must be complemented with guidance to ensure students stay focused and achieve meaningful progress. Student teams often progress at varying speeds and stages of maturity with their start-up ideas, resulting in diverse needs regarding the content and support provided. To address this, regular feedback sessions, tailored mentorship, and milestone-based evaluations can offer the necessary scaffolding without compromising the experiential nature of these courses.

However, beyond offering guidance, it is crucial to communicate the unique opportunity that advanced entrepreneurship courses represent for students. These programs serve as a launchpad for real-world impact and professional growth. By participating, students gain valuable skills, explore their entrepreneurial potential, and engage in a low-risk environment where failure is a steppingstone, not a setback. Framing these courses as a rare chance to experiment, learn, and possibly transform their career trajectory can motivate students to fully embrace the experience. By aligning course structures with both the intention-behavior literature and this empowering perspective, universities can enhance their role as catalysts for startup formation and personal development.

5.2. Limitations

This study is limited by its small sample size and the homogeneity of participants, as all were male, primarily from computer science and business departments, and the teams were not interdisciplinary. These factors restrict the generalizability of the findings to broader student populations.

5.3. Future Work

Future research should expand on these findings by exploring the impact of interdisciplinary team formation and including a more diverse participant pool. Longitudinal studies could assess the long-term entrepreneurial outcomes of participants and their ventures. Further, comparative analyses of different teaching approaches, such as structured curricula versus self-directed learning, could provide deeper insights into optimizing advanced EE. Further, more longitudinal in-depth research could tackle the emotional journey and self-perception as well as the team dynamics as determinants of entrepreneurial activity.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Audretsch, D. B. (2014). From the entrepreneurial university to the university for the entrepreneurial society. *The Journal of Technology Transfer, 39*(3), 313–321. https://doi.org/10.1007/s10961-012-9288-1

Blank, S., & Eckhardt, J. T. (2024). The lean startup as an actionable theory of entrepreneurship. *Journal of Management*, *50*(8), 3012-3034.

Blenker, P., Korsgaard, S., Neergaard, H., & Thrane, C. (2011). The questions we care about: Paradigms and progression in entrepreneurship education. *Industry and Higher Education, 25*(6), 417–427. https://doi.org/10.5367/ihe.2011.0065

Etzkowitz, H., & Zhou, C. (2017). *The triple helix: University-industry-government innovation and entrepreneurship.*Routledge. https://doi.org/10.4324/9781315620183

Fayolle, A., & Gailly, B. (2015). The impact of entrepreneurship education on entrepreneurial attitudes and intention: Hysteresis and persistence. *Journal of Small Business Management, 53*(1), 75–93. https://doi.org/10.1111/jsbm.12065

Kuratko, D. F. (2005). The emergence of entrepreneurship education: Development, trends, and challenges. *Entrepreneurship Theory and Practice, 29*(5), 577–598. https://doi.org/10.1111/j.1540-6520.2005.00099.x

Lackéus, M. (2015). Entrepreneurship in education: What, why, when, how.

Leatherbee, M., & Katila, R. (2020). The lean startup method: Early-stage teams and hypothesis-based probing of business ideas. *Strategic Entrepreneurship Journal*, *14*(4), 570-593.

Nabi, G., Liñán, F., Fayolle, A., Krueger, N., & Walmsley, A. (2017). The impact of entrepreneurship education in higher education: A systematic review and research agenda. *Academy of management learning & education*, *16*(2), 277-299.

Neck, H. M., Greene, P. G., & Brush, C. G. (2014). *Teaching entrepreneurship: A practice-based approach.* Edward Elgar Publishing.

Neck, H. M., & Greene, P. G. (2011). Entrepreneurship education: Known worlds and new frontiers. *Journal of Small Business Management, 49*(1), 55–70. https://doi.org/10.1111/j.1540-627X.2010.00314.x

Nowiński, W., Haddoud, M. Y., Lančarič, D., Egerová, D., & Czeglédi, C. (2017). The impact of entrepreneurship education, entrepreneurial self-efficacy, and gender on entrepreneurial intentions of university students in Visegrad countries. *Studies in Higher Education, 44*(4), 759–774. https://doi.org/10.1080/03075079.2017.1365359

Piperopoulos, P., & Dimov, D. (2015). Burst bubbles or build steam? Entrepreneurship education, entrepreneurial self-efficacy, and entrepreneurial intentions. *Journal of small business management*, *53*(4), 970-985.

Rasmussen, E., & Sørheim, R. (2006). Action-based entrepreneurship education. *Technovation, 26*(2), 185–194. https://doi.org/10.1016/j.technovation.2005.06.012

Ries, E. (2011). *The Lean Startup: How today's entrepreneurs use continuous innovation to create radically successful businesses.* Crown Business.

Souitaris, V., Zerbinati, S., & Al-Laham, A. 2007. Do entrepreneurship programmes raise entrepreneurial intention of science and engineering students? The effect of learning, inspiration and resources. *Journal of Business Venturing, 22*(4): 566–591.

Wright, M., Siegel, D. S., & Mustar, P. (2017). An emerging ecosystem for student start-ups. *Journal of Technology Transfer, 42*(4), 923-934. http://doi.org/10.1007/s10961-017-9558-z

Yu, X., Zheng, S., & He, Y. (2024). The role of university ecosystems in fostering innovation and entrepreneurship. *Journal of Entrepreneurship and Innovation Studies, 30*(1), 12-34.

Zhong, Y., Wang, X., & Li, J. (2022). Integrating entrepreneurship education in universities: A systematic review. *Higher Education Quarterly, 76*(4), 672-691.

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Designpreneurship: A Research-Driven Framework for Cultivating Creative Entrepreneurs in Higher Education

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Abstract

The creative industries are undergoing a paradigm shift as traditional freelancing gives way to scalable entrepreneurial models prioritizing innovation, sustainability, and digital monetization. This evolution demands a reconfiguration of how design and arts graduates are prepared for emergent careers in a rapidly changing economy.

This paper introduces Designpreneurship, a research-informed framework that integrates Systems Thinking (ST), Value Creation (VC), and Business Model Innovation (BMI) to align creative education with entrepreneurial competencies. At its core is the 3P Business Model—Platform, Product, Packaging—designed to help graduates transition from time-based service work to scalable, resilient business ecosystems. Through qualitative interviews, ethnographic observations, and real-world case studies, the framework is shown to enhance employability, creative autonomy, and long-term career viability.

The paper critiques the limitations of freelancing, highlights the impact of digital transformation on creative labor, and proposes actionable curricular strategies to embed entrepreneurial thinking in higher education.

Keywords: *Designpreneurship; employability; creative entrepreneurship; design education; business model innovation; higher education.*

1. Introduction

The creative industries contribute over $2.25 trillion to the global economy and employ nearly 30 million people worldwide (UNESCO, 2022). Yet, these sectors are undergoing radical disruption. Automation, platform-based labor, and the volatility of the gig economy have rendered traditional freelancing models increasingly unsustainable. Reports from McKinsey (2021) and Brunner (2023) emphasize that more than 60% of creative freelancers experience chronic income instability and limited career scalability.

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Despite these realities, many creative graduates are still educated for a world of short-term client work rather than long-term, scalable enterprise. Existing curricula often prioritize technical proficiency and service-based freelancing over entrepreneurial strategy, leaving graduates unprepared for the complex dynamics of the modern creative economy (Bridgstock, 2011; Jenkins, 2024).

This paper introduces Designpreneurship, a research-driven framework that responds to this challenge by integrating Systems Thinking (ST), Value Creation (VC), and Business Model Innovation (BMI) into creative education. At the heart of this approach is the 3P Business Model—Platform, Product, Packaging—originally conceptualized through action research and first introduced at the 65th ATypI Conference (Falla, 2024). The model provides creatives with a structured pathway to build scalable businesses that transcend time-bound freelance labor.

The study investigates the following research questions:

1. How can the 3P Model enhance the income resilience and employability of creative graduates?
2. What are the theoretical foundations and applications of the 3P Model in higher education?
3. How can higher education embed Designpreneurship principles to prepare graduates for a rapidly evolving digital economy?

2. The Case for Designpreneurship in Higher Education

2.1. The Problem: Limitations of the Freelance Model

Freelancing continues to be presented as the default pathway for creative graduates, offering flexibility and autonomy. However, this model is increasingly unsustainable due to volatile income, low scalability, pricing pressure, and professional burnout. According to McKinsey (2021), over 60% of freelancers report inconsistent income, and newer studies (Brunner, 2023) emphasize the psychological toll of this precarity, especially on early-career creatives.

Despite these well-documented issues, higher education programs in design, arts, and media often still prioritize client-based service delivery over models that teach how to build, own, and grow intellectual property. As Bridgstock (2011) argues, curricula that focus narrowly on employability without entrepreneurship risk graduating creatives into "perpetual precarity."

This lack of entrepreneurial preparation is further supported by longitudinal studies such as *Creative Graduates, Creative Futures* (Ball, Pollard, et al, 2010), which highlighted a systemic gap between higher education outcomes and the complex realities of creative employment.

Moreover, this outdated approach ignores the transformative potential of digital tools, platforms, and business model innovation, which have fundamentally redefined creative labor. Freelancing is not inherently flawed—but without entrepreneurial frameworks, it offers limited pathways for upward mobility, sustainability, or impact.

2.2. The Solution: Entrepreneurial Frameworks

Designpreneurship reframes creative graduates as value creators, not just service providers and integrates three theoretical pillars—Systems Thinking (Meadows, 2008), Value Creation (Caves, 2002), and Business Model Innovation (Teece, 2010)—to frame creative practice, while Kolb's Experiential Learning Theory (2014) informs how these concepts are applied in curricular design.

This paper proposes the 3P Business Model—Platform, Product, and Packaging—as an educational tool that guides students to build digital platforms that grow audiences and enable monetization. Develop products that convert creative expertise into scalable assets, and design packaging strategies that systematize and automate service delivery.

This model addresses employability and creative identity simultaneously, helping students navigate economic uncertainty, embrace interdisciplinary opportunity, and contribute meaningfully to societal transformation.

By embedding these frameworks into curricula, higher education can evolve from preparing freelancers to cultivating creative entrepreneurs, equipped to thrive in both emerging and disrupted industries.

3. The 3P Business Model for Creative Professionals

3.1. The Framework

The **3P Model—Platform, Product, Packaging**—offers a practical, research-informed framework for transitioning from unstable freelance practices to scalable creative enterprises. Developed through a synthesis of empirical research, practice-based experimentation, and pedagogical inquiry, the 3P Model is central to the *Designpreneurship* paradigm. It equips creative professionals to:

1. **Establish digital platforms** (e.g., social media, content hubs) that build visibility, audience engagement, and monetization potential.
2. **Develop scalable products**, such as digital tools, templates, courses, and intellectual property, that transform creative knowledge into assets.

3. **Package services and expertise** into replicable, value-rich offerings that enable automation, licensing, and broader market access.

Each element of the model maps directly to key theoretical pillars:

- **Platform ↔ Systems Thinking** (Meadows, 2008): Platforms are seen as dynamic ecosystems, where feedback loops, audience engagement, and content creation reinforce one another. Creatives learn to understand the interdependencies between visibility, trust, and monetization.
- **Product ↔ Value Creation (**Caves, 2002): The development of digital assets reflects the shift from one-off artistic output to problem-solving tools that meet user needs, thus aligning artistic integrity with market relevance.
- **Packaging ↔ Business Model Innovation and Entrepreneurial Theory** (Teece, 2010; Foss & Saebi, 2016; Shane & Venkataraman, 2000): Service offerings are systematized into scalable, modular solutions—e.g., pricing packages, service kits, or automated delivery—that mirror entrepreneurial logics of opportunity recognition, resource efficiency, and scalability.

These components are mutually reinforcing, producing what Anderson (2006) describes as a "long-tail effect." Packaging strategies often draw on modular logic and value proposition design principles articulated by Osterwalder & Pigneur (2010), enabling creatives to deliver replicable, user-focused solutions.

3.2. A Vision for Design Education

The evolution of design education must move beyond technical excellence to include strategic entrepreneurship and resilient career planning. The 3P Model facilitates this shift by embedding theoretical insights into iterative, real-world learning activities.

Experiential Learning (Kolb, 2014) underpins this pedagogical shift: students prototype digital platforms, develop MVPs (minimum viable products), and test service packaging strategies in real-time environments. These iterative loops foster self-efficacy and help students build businesses around their creative identities.

Findings from interviews and ethnographic observations show a strong correlation between this model and improved student confidence, clarity in career direction, and income diversification.

Key strategies for educational integration include:

- **Embedding Entrepreneurial Frameworks:** Course modules that map directly onto the 3P Model allow students to practice building real businesses before graduation.

- **Promoting Lifelong Learning:** By linking business development to growth mindsets, students are encouraged to adapt continuously as markets, technologies, and creative opportunities evolve.
- **Encouraging Values-Driven Practice:** Students are guided to align entrepreneurial activities with personal and societal values—e.g., sustainability, accessibility, and cultural identity—reinforcing a sense of purpose alongside profitability.

This model positions educators not just as skill-trainers, but as career ecosystem designers, helping graduates to thrive in a post-freelance economy.

4. Graduate Case Studies: The 3P Model in Action

To explore the practical application of the 3P Business Model, three illustrative case studies of recent graduates are presented. Each graduate aligned their career development with one component of the framework—**Platform**, **Product**, or **Packaging**—resulting in measurable improvements in career sustainability and autonomy. These cases were selected from a broader qualitative dataset comprising interviews, student portfolios, and ethnographic observations.

1. Platform Model: Alejandra.Travels

Alejandra, a digital nomad, leveraged Instagram to build a dedicated audience of over 900,000 followers within 18 months on her Alejandra.Travels (2025) account. Her content strategy—developed as part of an HDR project—focused on visual storytelling, audience-building, and value-aligned partnerships.

She successfully converted her platform into revenue through collaborations with BMW, Velez Artisan, and travel and visa organisations, achieving a shift from sporadic client work to a consistent monthly income averaging $8,000 USD. She credits structured feedback loops in her coursework—aligned with Systems Thinking principles—as foundational to her growth.

2. Product Model: Aurelie Maron

Originally operating as a freelance lettering artist, Maron (2025) transitioned to creating and selling digital products, including Procreate brush sets for the Apple iPad, template bundles, and self-paced online courses. Within one year, she generated over $100,000 AUD in passive income—nearly triple her prior annual earnings from one-on-one client work.

Her product strategy was developed through a “Digital Product Development” module in her final undergraduate trimester, rooted in Value Creation theory and informed by iterative testing with her target audience. Educators structured assignments around MVP development and platform analytics, enabling rapid feedback and refinement.

Packaging Model: 3. Packaging Model: Liane Barker

Barker (2025), a traditionally trained sign painter, faced burnout from the physical demands and time constraints of bespoke commissions. In response, she packaged her 30-years of expertise into a modular online course series, each focusing on a specific aspect of signwriting—ranging from brush technique and layout composition to materials handling and pricing strategy.

These micro-courses are strategically designed to stack into a full signwriting qualification, enabling learners to build skills progressively while Barker creates a recurring revenue model. At the time of writing, she has successfully launched three modules, each generating steady enrollment through her email list and creative community partnerships.

Together, these case studies demonstrate how the 3P Business Model can be successfully applied across varied creative disciplines to address income instability, scale individual practice, and foster entrepreneurial confidence. Although each graduate's trajectory was distinct, they all engaged in structured educational interventions that supported the translation of creative identity into sustainable enterprise. These examples illustrate that when supported by intentional curriculum design, students are not only able to respond to industry shifts but can actively shape their own professional futures.

5. Integration into Curricula: Theory in Practice

Embedding the 3P Model—**Platform, Product, Packaging**—into design education marks a shift from technical training to cultivating entrepreneurial adaptability. Each element is underpinned by a foundational theory that shapes both pedagogy and student outcomes:

- **Platform** aligns with Systems Thinking (Meadows, 2008), encouraging students to see their practice as part of interconnected digital ecosystems. Courses focus on building online presence, understanding feedback loops, and engaging audiences through iterative branding and content strategies.
- **Product** reflects Value Creation theory (Caves, 2002), guiding learners to design offerings—such as templates or online courses—that address specific user needs. Assignments challenge students to translate creative skills into market-relevant tools and digital assets.
- **Packaging**, grounded in Business Model Innovation and Entrepreneurial Theory (Teece, 2010; Foss & Saebi, 2016), trains students to streamline services into scalable, modular offerings. Practical applications include pricing models, automation, and delivery systems designed to reduce labor intensity and expand market reach.

Experiential Learning (Kolb, 2014) serves as the pedagogical foundation, emphasizing iterative testing, reflective practice, and real-world application. Students engage in activities like MVP

launches and audience testing, building confidence and fluency in entrepreneurial thinking. As Popeanu (2024) argues, embedding business education into creative disciplines is essential for equipping students with transferable entrepreneurial capabilities that extend beyond individual projects to support long-term adaptability.

6. Limitations and Future Research

While the Designpreneurship framework offers strong potential to enhance graduate employability, several limitations must be acknowledged. Its reliance on digital tools may disadvantage students lacking access or digital fluency, underscoring the need for inclusive, low-tech alternatives. The model's current focus on design disciplines limits its tested applicability to other creative fields such as music, performance, or writing.

Additionally, the study's qualitative nature restricts generalizability. Ongoing quantitative research—such as graduate surveys and outcome tracking—aims to strengthen empirical validation. Broader implementation will also require institutional readiness, including curricular reform, faculty training, and interdisciplinary collaboration.

Future research should explore cross-sector relevance and scalable adaptations to ensure the framework's accessibility, flexibility, and long-term educational impact.

7. Conclusion

Designpreneurship offers a research-driven framework for transitioning from precarious freelancing to entrepreneurial careers. Integrating Systems Thinking, Value Creation, and the 3P Model addresses the limitations of higher education and equips graduates for more sustainable employability. Embedding this framework into design curricula empowers students to navigate the evolving creative economy with resilience and adaptability.

By grounding its principles in qualitative research and real-world case studies, this paper demonstrates how *Designpreneurship* enhances student outcomes. The findings presented here underscore the responsibility of educators and institutions to adopt entrepreneurial strategies tailored to the unique needs of creative graduates.

By embedding a *Designpreneurship* mindset and the 3P Framework into design curricula, higher education can play a pivotal role in shaping the future of creative work, empowering graduates to build meaningful, impactful careers that extend beyond the limitations of traditional freelancing.

References

Alejandra.Travels. (2025). *Alejandra.Travels' Instagram profile*. Retrieved from https://www.instagram.com/alejandra.travels (Accessed: January 22, 2025).

Anderson, C. (2006). *The Long Tail: Why the Future of Business is Selling Less of More*. Hyperion.

Ball, L., Pollard, E., & Stanley, N. (2010). *Creative Graduates, Creative Futures*. Creative Graduates Creative Futures Higher Education Partnership and the Institute for Employment Studies. https://static.a-n.co.uk/wp-content/uploads/2016/12/Creative-graduates-creative-futures.pdf

Barker, L. (2025). *Liane Barker's Instagram profile*. Retrieved from https://www.instagram.com/barker_signs (Accessed: January 22, 2025).

Bridgstock, R. (2011). Skills for creative industries graduate success. *Education + Training*, 53(1), 9–26. https://doi.org/10.1108/00400911111102333

Brunner, Z. (2023). *Exploring Solutions to Reduce Unemployment via Creative Freelancing in South Africa: Lessons from the UK*. (Master's Thesis). Birkbeck, University of London. https://www.researchgate.net/publication/375091126

Caves, R. E. (2002). *Creative Industries: Contracts Between Art and Commerce*. Harvard University Press.

Falla, D. (2024). *Ten Years of Typism: A Community Built on Craftsmanship and Entrepreneurship*. In: 65th International Conference (ATypI). Brisbane, 16-20 April 2024. https://www.youtube.com/watch?v=g3x1GUqEjW0

Foss, N. J., & Saebi, T. (2016). Fifteen Years of Research on Business Model Innovation: How Far Have We Come, and Where Should We Go? *Journal of Management*, 43(1), 200–227. https://doi.org/10.1177/0149206316675927

Jenkins, J. (2024). *Creative Discipline Education Shaping Entrepreneurial Outcomes in the Creative Industries: A Gender Perspective* (PhD Thesis). Birmingham City University. https://www.open-access.bcu.ac.uk/15839/

Kolb, D. A. (2014). *Experiential Learning: Experience as the Source of Learning and Development* (2nd ed.). Pearson Education.

Maron, A. (2025). *Aurelie Maron's Instagram profile*. Retrieved from https://www.instagram.com/aureliemaron (Accessed: January 22, 2025).

McKinsey & Company. (2021). *The Future of Work after COVID-19*. Retrieved from https://www.mckinsey.com (Accessed: January 22, 2025).

Meadows, D. H. (2008). *Thinking in Systems: A Primer*. Chelsea Green Publishing.

Osterwalder, A., & Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers.* Wiley.

Popeanu, A. (2024). The Importance of Business Education in Creative Industries. In *Creativity and Learning: Navigating Transformative Perspectives for Complex and Contemporary Environments* (pp. 239–263). Palgrave Macmillan. https://doi.org/10.1007/978-3-031-73393-2_10

Shane, S., & Venkataraman, S. (2000). The promise of entrepreneurship as a field of research. *Academy of Management Review*, 25(1), 217–226. https://doi.org/10.5465/amr.2000.2791611

Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, 43(2–3), 172–194. ttps://doi.org/10.1016/j.lrp.2009.07.003

UNESCO. (2022). *Re-Shaping Policies for Creativity: Addressing Culture as a Global Public Good*. UNESCO Publishing. https://unesdoc.unesco.org/ark:/48223/pf0000380474?posInSet=1&queryId=e025675c-ce35-42ae-8276-7144c93d2e65

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Project *Colibrí*: University Leadership in the Design and Implementation of Social Entrepreneurship Education Initiatives

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Abstract

This study explores the role of universities in addressing migration-related challenges through social entrepreneurship education. Project Colibrí (Hummingbird), developed at the UABC-Yunus Center, engaged university students in the design and implementation of targeted initiatives for migrant communities in Tijuana, Mexico. Employing an action research approach, the project fostered financial literacy, sustainable entrepreneurship, and branding skills among vulnerable groups, including women, LGBTQ+ migrants, and children. Key findings highlight the effectiveness of co-creation methodologies, such as Design Thinking and the Business Model Canvas, in empowering participants to develop innovative and sustainable business solutions. The results demonstrate that interdisciplinary collaboration between academia and civil society enhances economic integration opportunities for migrant populations. This work underscores the potential of university-led social entrepreneurship education in advancing sustainable development, economic inclusion, and social innovation in border regions.

Keywords: *Students; university; migration; social innovation; action research*

1. Introduction

Social entrepreneurship education equips individuals with the knowledge, skills, and mindset necessary to create sustainable, value-drive enterprises that address social issues. By empowering migrant populations with the capabilities, universities can foster the development of innovative solutions to the unique challenges faced by the communities, ultimately contributing to their socio-economic integration and overall well-being (Chundu*, et al.,* 2022; Ahmad*, et al.,* 2020). This type of training transcends traditional business education by placing the social mission at the core of entrepreneurial action and promoting community engagement as a pathway toward more inclusive development.

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Understanding the distinctive nature of social entrepreneurship is essential to fully grasp its transformative potential. Unlike conventional business models that focus on profit maximization, social entrepreneurship prioritizes the generation of measurable social impact. For social entrepreneurs, unmet needs, underserved populations, and even the absence of market structures represent meaningful opportunities for intervention (Austin, *et al.,* 2006). Through the innovative combination and mobilization of resources, these individuals lead initiatives aimed at driving systemic change. Although economic value creation remains important for ensuring financial sustainability, it is subordinated to the overarching social mission. Moreover, the ability to form and leverage networks (referred to as structural capital) is critical, as these relationships enable the co-creation of viable solutions, extend the reach of social action, and foster long-term resilience in vulnerable communities (Mair & Martí, 2006).

This document presents an educational practice in which university students collaboratively designed, managed, and implemented a project titled *Colibrí* (Hummingbird) in co-creation with their mentor. The initiative focused on teaching social entrepreneurship to populations experiencing mobility-related challenges, aiming to foster economic empowerment and sustainable entrepreneurial development within this vulnerable group.

Social entrepreneurship is the strategic path of creating multiple value incontexts of vulnerability. From an economics empowerment perspective, it is a mechanism for job creation, skills vigor, and access to financial inclusion mechanisms. It alsoprovides social equity bypromotingaccess and community participation. This is a resilience-building approachthat is about sustaining livelihoods in order to build capacity to adapt to uncertainty or crisis. It also helps restore lost dignity and self worth, allowing people to become active agents and leaders in transformation. Thirdly, social entrepreneurship contributes to sustainable development through market-based, scalable solutions with a long-term impact focus (Adams, n.d.; Nerugo, *et al.,* 2019; Zhang, *et al*., 2022).

2. UABC-Yunus Center: A Hub for Social Innovation

The UABC-Yunus Center is a hub for social innovation located within the Faculty of Economics and International Relations at the Autonomous University of Baja California (UABC). It is based in Tijuana, Baja California, Mexico—a border city characterized by dynamic transnational interactions and significant migratory flows.

The center was established in 1999 as part of the Research, Assistance, and Teaching Program for Micro and Small Enterprises (PIADMYPE), a social service initiative designed to engage university students in community-based economic development by providing direct support to micro and small businesses. Since its inception, students involved in this program have offered technical assistance and mentorship to Type 2 social businesses—those born out of necessity

and serving as the primary source of income for families in vulnerable contexts—according to the classification proposed by Nobel Peace Prize laureate Muhammad Yunus (2006).

Over time, the center has expanded its scope to encompass a wider array of student-led initiatives, action-research projects, and educational programs aimed at promoting social entrepreneurship and financial education among marginalized populations.

The article *Backpack Bootstrapping: Social Entrepreneurship Education Through Experiential Learning* explores how experiential learning can transform the teaching of social entrepreneurship by placing students in real-world roles in collaboration with social organizations. Through three pedagogical approaches: action research, service learning, and traditional social venture creation: the study found that out-of-classroom experiences foster greater maturity, critical reflection, and authentic engagement with social issues. The concept of "backpack bootstrapping" refers to how bearing a tangible, albeit manageable, weight accelerates entrepreneurial skill development. Despite its exploratory nature, the study underscores the importance of integrating practical engagement with reflective learning to prepare agents of change (Thomsen, *et al*., 2019).

Similarly, *Action Research in Social Entrepreneurship: A Framework for Involvement* introduces a methodological framework grounded in action research to navigate the complexity of social entrepreneurship projects. Using the Mushuk Muyu case in Ecuador, it illustrates how the Action Research Cycle (ARC): comprising problem identification, thematic analysis, strategic planning, implementation, and reflection, can sustain participatory, context-sensitive, and adaptive processes. This approach fosters local ownership and collective value creation, enabling meaningful learning and sustainable transformation in communities (Tasker, *et al.,* 2010).

2.1. Project Colibrí: Addressing Migration at the Border

In 2024, as part of its commitment to tackling pressing social challenges, the UABC-Yunus Center launched Project *Colibrí,* an initiative co-created by four students completing their professional internships at the center, in collaboration with the coordinator of the Yunus Community axis. The project focused on migration issues at the border, aiming to understand and support migrant populations through research, community engagement, and strategic partnerships. The first phase of Project *Colibrí* involved an in-depth documentary analysis of migration dynamics in Tijuana. Based on this research, specific subgroups affected by migration through an intersectional lens were identified, including children, job seekers, LGBTQ+ migrants, and women.

Following this analysis, the team conducted a mapping of civil society organizations and institutions already providing on-the-ground support to these migrant populations. Each student then assumed a leadership role within a designated subgroup, leading to the establishment of

collaborative partnerships with organizations such as Border Youth, Borderline Crisis, Centro 32, *Casa Arcoiris*, and *Al Norte Sin Límites.*

2.2. Implementation and Community Impact

After establishing these partnerships, Project Colibrí developed and implemented various targeted initiatives:

Financial Education for Migrant Children (Border Youth): As part of the *Tijuanita Mi Ciudad* event, an interactive stand was created, featuring educational games and storytelling activities focused on financial literacy. This initiative was designed specifically for children in mobility contexts, equipping them with basic financial skills through engaging and age-appropriate methodologies (Figure 1).



Figure 1. Financial education for migrant children

Environmental Awareness and Sustainable Entrepreneurship (Borderline Crisis): A workshop titled "Guardians of the Environment" was developed as a mini-rally, aimed at fostering entrepreneurial thinking and sustainability awareness among children living in a shelter for migrant populations. Through interactive activities, participants explored environmental challenges and generated sustainable business ideas within their communities (Figure 2).



Figure 2. Mini-rally

Social Entrepreneurship and Branding for Women (Centro 32): A specialized workshop on social entrepreneurship was conducted for a group of six women, utilizing Design Thinking methodology to help them develop innovative business ideas. Additionally, a doctoral student in Social Business facilitated a branding workshop, sharing insights on brand development, value proposition design, and market positioning through a practical case study (Figure 3).



Figure 3. Centro 32

Sustainable Entrepreneurship for LGBTQ+ Migrants (Casa Arcoiris): A two-day training program was delivered to two LGBTQ+ migrants, focusing on sustainable entrepreneurship. The workshop provided strategic business development tools, encouraging participants to conceptualize social enterprises with both economic and environmental impact (Figure 4).



Figure 4. Casa Arcoiris

Social Entrepreneurship Training for Migrant Women in the Textile Industry (Al Norte Sin Límites): A three-session training program was conducted for five migrant women from Colombia, Guatemala, Venezuela, and Haiti, all of whom were employed in a textile factory. The program incorporated Design Thinking, Business Model Canvas, and Pitching Techniques to equip participants with practical entrepreneurial skills and a structured framework for developing sustainable business models.

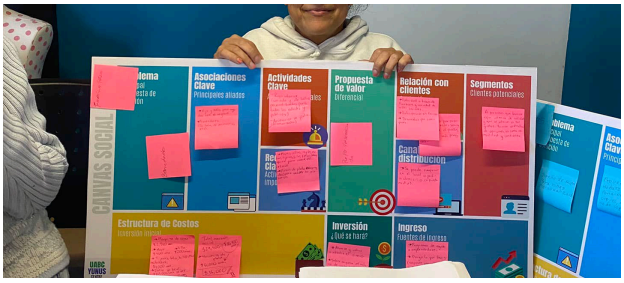


Figure 5. Al norte sin límites

2.3. Collective Participation in the Fourth Inter-University Meeting of Change Agents

As a culminating activity, all five partner institutions participated in the Fourth Inter-University Meeting of Change Agents, where they showcased and sold their products at dedicated stands. This event provided an opportunity to highlight the impact of the initiatives, strengthen networks among social enterprises, and foster collaboration between academia and the broader social innovation ecosystem.



Agents of Change – Maday Stitches: We are an artisanal and sustainable brand that transforms textile remnants into unique, eco-friendly designs, promoting conscious fashion and the reduction of textile waste.

Figure 6. Collective participation

3. Conclusion

Through *Project Colibrí* and its broader initiatives, the UABC-Yunus Center continues to demonstrate its commitment to bridging academic knowledge with real-world social impact. By fostering entrepreneurial education, sustainability, and economic empowerment, the center remains dedicated to supporting vulnerable communities, promoting social innovation, and equipping students with the skills needed to drive meaningful change in the border region and

beyond.Rooted in this vision, the Yunus Social Innovation Laboratory was created as an evolution of Project Colibrí. It has moved beyond providing workshops that encourage entrepreneurship to become a space for the co-creation of community-based social enterprises. In this environment, participants not only gain knowledge but also design and implement projects collaboratively with the university. This educational model has been strengthened by the Impaktante philosophy of the UABC-Yunus Center. This philosophy defines *Impaktantes* as individuals who commit to transforming their realities through action, empathy, and creativity.

The nine-week training program is currently being implemented in two key contexts. In a rehabilitation and reintegration center for men, participants are developing a Type 1 social business (Yunus, 2010) focused on the production of vegan bags. Meanwhile, at the Tijuana Juvenile Detention Center, adolescents are co-designing a Type 1 social enterprise for the creation of handcrafted lamps. Throughout this process, participants work to strengthen their self-esteem, build entrepreneurial skills, and develop their capacity to collaborate for the common good. The emphasis is not only on learning technical competencies, but also on rebuilding a sense of purpose and belonging.

University students play a crucial role in this initiative. Coming from diverse academic backgrounds, they participate as workshop facilitators, content designers, field assistants, and organizers of solidarity fundraising campaigns. This experiential learning model redefines the role of the university. Rather than functioning solely as a source of knowledge transmission, the university becomes a proactive agent of social transformation with a visible and sustained presence in the community.

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Ethical Note

All adult participants gave verbal consent to participate and to allow photography under the explicit condition that their faces would not be shown. For minors, consent was obtained from legal guardians or institutional supervisors. In all cases, images were selected to protect participants' identity and dignity, in alignment with ethical standards for working with vulnerable populations.

References

Adams, L. (2019). *5 examples of social entrepreneurship in developing countries*. The Borgen Project. https://borgenproject.org/social-entrepreneurship-in-developing-countries/

Ahmad, S., Arslan, S., Shuja, A. (2020). Investigating the drivers and future paradigms for social entrepreneurship in developing countries: empirical study of Pakistan. *Global Rehional Review*, V(IV), 21-32. Doi 10.31703/grr.2020(V-IV).03

Austin, J., Stevenson, H. & Wei, J. (2006). Social and commercial entrepreneurship: same, different, or both?. Entrepreneurship: Theory and Pratice Journal, 30 (1): 1-22. DOI: 10.5700/rausp1055

Chundu, M., Masara, E., Muncheri, T. (2022). Contribution of social entrepreneurship to sustainable community development in Zimbabwe. A case of Virtuous women trust operating in Harare. *Journal of human resource and sustainability studies,* 10 (3), 380-402. Doi 10.4236/jhrss.2022.103023

Mair, J. & Martí, I. (2006). Social entrepreneurship research: A source of explanation, prediction, and delight. *Journal of World Business* 41: 36–44. doi:10.1016/j.jwb.2005.09.002

Nezurugo, M., Demoulin, L. & Pawar, A. (2020). *Social entrepreneurs and COVID: Stories from the frontline*. World Economic Forum. https://www.weforum.org/stories/2020/09/social-entrepreneurs-and-covid-19-stories-from-the-frontline/

Tasker, M., Westberg, L., & Seymour, R. (2010). Action Research in Social Entrepreneurship: A Framework for Involvement. *International Journal of Action Research*, 6(2-3), 223-255. DOI 10.1688/1861-9916_IJAR_2010_02-03_Tasker

Thomsen, B., Muurlink, O. & Best, T. (2019): Backpack Bootstrapping: Social Entrepreneurship Education Through Experiential Learning, Journal of Social Entrepreneurship, DOI: 10.1080/19420676.2019.1689155

Yunus, M. (2010). *Building social business: The new kind of capitalism that serves humanity's most pressing needs*. PublicAffairs.

Zhang X, Sun Y, Gao Y and Dong Y (2022) Paths out of poverty: Social entrepreneurship and sustainable development. Front. Psychol. 13:1062669. doi: 10.3389/fpsyg.2022.1062669

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Critical Self-Reflection as the Key to Employability: Findings from an Exploratory Study

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Abstract

In an era of rapid technological change and evolving labor market demands, the ability to critically self-reflect is essential for employability. This study investigates the gap between university students' self-perceived competencies and their actual performance, emphasizing the role of critical self-reflection in fostering employability. Conducted among 37 undergraduate students at two European universities, this exploratory research compares students' self-assessments with instructor evaluations. Findings reveal that 89% of students inaccurately assessed their competencies, with a majority underestimating their abilities. These discrepancies highlight the challenges students face in self-evaluation and the need for Higher Education teachers to support the development of students' self-awareness and growth mindset. The findings contribute to the discourse on employability and call for further research into critical self-reflection as a fundamental component of graduate employability.

Keywords: *Employability; CareerEDGE Model; critical self-reflection; self-awareness; growth mindset; project management; entrepreneurship.*

1. Introduction

Today's world is evolving rapidly, mainly driven and shaped by macrotrends such as technological change, geoeconomic fragmentation, economic uncertainty, demographic shifts and the green transition. These impact the global labor market by 2030 by transforming both jobs and required skills (WEF, 2025; OECD, 2021). Crucial skills, such as AI and big data, analytical thinking, creative thinking, resilience, flexibility, agility, and technological literacy are projected to be even more relevant. Alongside these, human-centric skills, such as leadership and social influence, curiosity and lifelong learning, systems thinking, talent management, motivation and self-awareness will play an important role by 2030 (WEF, 2025; OECD, 2021). Today's university students are estimated to have more than 12 jobs and need to learn a new

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skill set every 5 years in their lifetime (WEF, 2025). Adjusting successfully to the evolving job requirements depends on their future ability to develop new skills. Future employees need to engage in continuous learning, upskilling and reskilling programs, and take their own self-development initiatives (Crowre & Adivar, 2024; OECD, 2021). Therefore, Higher Education Institutions (HEIs) need to prepare their students to be self-directed learners and agents of their own personal development. This involves self-awareness through critical self-reflection to be able to assess their actual abilities, knowledge and competences, identify their real skills gap, and set targets and directions for improvement.

A large body of research has been conducted on employability competence development, lifelong learning and professional development (e.g., Dacre Pool & Sewell, 2007; Hillage & Pollard, 1998; Harvey & Knight, 2005; Römgens et al., 2019), however little attention has been paid to the fundamental role of critical self-reflection in graduate employability (e.g., Moon, 2004). Hence this paper aims 1) to reveal students' self-perception gap between their perceived competence and actual performance; 2) to argue for the crucial importance of university teachers' role in preparing students for critical self-reflection and self-perception as a key to employability; 3) to put forward strategies and recommendations for HE teachers on how to include critical self-reflection into their teaching practice.

2. Employability and Critical Self-Reflection

The transformative changes in the labor markets have a crucial impact on the required skill sets, thus these changing and evolving skill demands will lead to a mismatch in employees' skill sets. To build a workforce equipped for the future, it is essential to focus on upskilling and reskilling across all stages of learning, from early childhood to higher education, as well as lifelong and professional development (McCrowre & Adivar, 2024). To be capable of adapting to new demands within a current job and role, employees need to learn new skills or improve their existing knowledge and skills. This process is referred to as upskilling (Brinegar & Masino, 2021). Reskilling, on the other hand, focuses on learning completely novel knowledge and skills to empower employees to shift their jobs (Brinegar & Masino, 2021). Bridging this skill gap by applying both upskilling and reskilling approaches, is crucial to ensure employability (McCrowre & Adivar, 2024).

Employability is conceptualized as a two-faceted notion: one focusing on getting and maintaining a job, and the other emphasizing the development of individual attributes (Hillage & Pollard, 1998; Harvey & Knight, 2005). Focusing on the "ability" aspect of employ*ability*, it includes the development of a range of attributes to become a critical lifelong learner (Harvey & Knight, 2005). Scholars (e.g., Römgens et al., 2019) distinguish between graduate employability and employability in workplace learning, thus several models for graduate employability (e.g., Dacre Pool & Sewell, 2007) and employability in workplace learning (e.g.,

Akkermans et al., 2013) have been put forward in the literature. The most comprehensive model of graduate employability is the CareerEDGE model published by Dacre Pool and Sewell (2007). It is a framework designed to identify the key attributes that help graduates build a holistic and competitive set of qualities that enhance their employability and workplace readiness. The model suggests that students should be given the opportunity to learn and gain experiences in career development, degree subject knowledge with connected skills, generic skills, emotional intelligence and take their work and life experiences into consideration. The reflection and evaluation of these learning and life experiences foster the students' development of self-efficacy, self-esteem and self-confidence, all of which are pivotal to employability (Dacre Pool & Sewell, 2007).

The catalyst role of reflection in the development of employability competences should not be underestimated (e.g., Heymann et al., 2022; Miller & Konstantinou, 2022). Introducing various forms of reflective practices into the HE curriculum enables students to actively engage with their learning process, assess and be aware of current abilities, knowledge and competences, so that they can take actions to improve their employability competences (Heymann et al., 2022). Becoming familiar with reflective processes, graduates will be able to employ these practices during their future career development, exercise self-reflection and take their own self-development initiatives as autonomous lifelong learners. However, individuals' self-perceptions might mismatch their actual abilities, knowledge and competences, thus providing an unrealistic view of themselves hindering their prospects for employability (Lisa et al., 2019; Miller & Konstantinou, 2022). Self-bias and the Dunning-Kruggel Effect reveal these deficits in individuals' self-evaluation (Dunning, 2011). Students tend to find self-reflection challenging and they often do not engage in a more elaborate form of realistic reflection, called critical self-reflection. Critical self-reflection requires higher-order thinking skills to question one's own assumptions, assessment and evaluation (Mezirow, 2006). Hence, critical self-reflection is the key to set clear and realistic goals for self and skills development and foster employability competences in both HE and workplace contexts.

3. Methods

Our research aimed to explore whether a gap can be identified between university students' pre-course self-perception of abilities, knowledge, competences and their actual performance during the course. Therefore, this study seeks to answer the following research questions (RQs):

1. How accurately do university students perceive and assess their own abilities, knowledge and competences related to their study subject compared to instructor feedback and evaluation?
2. How can teachers support the students' development of critical self-reflection regarding their abilities, knowledge and competencies?

This exploratory study was carried out at two European universities among 2nd-year BA students (N=37) in the autumn/winter semester of the AY 2024/25. It involved two distinct cohorts, business and education students, to ensure a diverse sample in terms of nationality, culture, and academic and disciplinary background, enriching the data's range of perspectives. The cohort in Hungary (n_1=25) was pursuing studies in the English-medium instruction program majoring in business administration and attending a practical seminar on Entrepreneurship. The participants at the Hungarian university were between 18-24 years of age and comprised 12 female and 13 male students. Their nationalities varied: eleven students were Hungarian, eight students were from former Russian states, five students from Asia and one from Africa. The cohort in Germany (n_2=12) enrolled the German speaking BA program of educational sciences and attended a seminar on Project Management. The group consisted of German students and represented a significant gender imbalance, ten female and two male students, which represents the overall gender distribution of the education program.

Students' initial self-perception was collected using two competence self-assessment questionnaires. In the group in Hungary, a validated survey in English was used designed by the EICAA project (https://www.eicaa.eu/) to assess entrepreneurship competences. In the German cohort, the questionnaire used to measure project management competencies was adapted and translated to German from Wellingtone Ltd. (https://wellingtone.co.uk). Both questionnaires contained items describing various sub-competences organized into constructs. On average 3-8 items were assigned to each construct. Students had to self-assess their level of competence for each item on a 5-point scale. Students were then evaluated on selected sub-competences by the professor based on mid-term assignments and in-class activities during the course. To answer RQ1, averages of students' self-assessment scores were then compared to teacher evaluation scores to reveal potential gaps between perceived and actual competence levels. In response to RQ2, the reflective practice approach (Gibbs, 1988) was used and teachers' individual reflections on teaching methods and strategies contributing to students' critical self-reflection were compiled to put forward recommendations.

4. Results and Discussion

Participants' perceptions of their own abilities, knowledge and competences were compared to teachers' evaluations to reveal any of the following gaps: 1) self-overestimation when participants rating themselves higher than the instructor scores, 2) self-underestimation, when participants rating themselves lower than the instructor scores. If a participant's self-assessment score matched the teacher's assessment score, then it is assumed that the participant could accurately assess their abilities, knowledge and competences.

Table 1. Self-perception gaps

	Cohort in Hungary (n_1=25)	**Cohort in Germany (n_2=12)**	**Overall (N=37)**
Self-overestimation	6	6	12
Self-underestimation	17	4	21
Accurate self-perception	2	2	4

A total of 89% of the participants misperceived their abilities, with 32% of students overestimating their performance and 57% underestimating it (Table 1). Only 11% provided self-assessments that accurately aligned with the evaluations of their instructors. Self-underestimation was more frequent in the cohort at the Hungarian university, while participants in Germany tended to overestimate themselves. The high number of participants assessing themselves more critically than their teachers did suggests a tendency toward under-confidence or excessive self-criticism. Conversely, some students have higher self-esteem and self-confidence in their own abilities which results in a false self-evaluation. Only four participants provided a self-assessment that matched the teacher's evaluation. This represents just 10,8% of the total sample, indicating that most students may struggle to accurately gauge their own performance.

Analyzing the gender distribution of the sample, eight female and four male participants overestimated their capabilities, while twelve female and nine male students were more critical of themselves than their teachers. The gender distribution of the four participants accurately assessing themselves was even; it consisted of two male students in sample 1 and two female in sample 2. As regards the participants' work experience, most students (n=26) did not have any work experience at all, only eight students had less than two years and three students between two to five years of work experience. Participants with more work experience tend to overrate themselves in this sample. Students' self-evaluation with no or little work experience varied. Similarly, no patterns could be identified in case of nationalities and cultures, probably due to the limited number of the sample. However, demographic attributes should be investigated further to reveal any possible correlations among such attributes and individuals' self-perception patterns.

Several factors may contribute to these patterns of self-assessment. One potential explanation could be the early-semester effect, as students may still be in the process of developing a clear understanding of academic expectations and grading criteria. At the beginning of their academic journeys, they may struggle to assess their own performance accurately (Zimmerman, 2002). Additionally, students may lack prior experience in self-evaluation, making it difficult for them to align their self-perceptions with external assessments (Nieminen & Boud, 2025). Psychological factors such as the interplay between confidence and competence (Cohen & Katz, 2024), as well as self-doubt and impostor syndrome, could also contribute to these

misperceptions. Research on the Dunning-Kruger effect suggests that individuals with lower expertise may overestimate their abilities due to a lack of awareness of their own limitations, which may explain why some students overrate their performance (Dunning, 2011). Conversely, self-underestimation may be associated with self-doubt or impostor syndrome, wherein students undervalue their abilities despite strong academic performance. Furthermore, artificial intelligence (AI) may reinforce and perpetuate self-biases through AI-driven recommendation systems, particularly in social media environments. Personalized recommendations, confirmation bias reinforcement, and algorithmic biases can all contribute to distorted self-perceptions (Goyal, 2025). Additionally, life and work experience and cultural background differences may further influence these self-assessment patterns, potentially shaping students' tendencies toward overestimation or underestimation (Becker et al., 2014). These factors collectively highlight the complexity of self-evaluation processes in academic settings.

5. Recommendations and Conclusion

The CareerEDGE Employability Development Profile, which is a self-report diagnostic tool based on the model to encourage students to consider their employability strengths and plan actions for any improvements, could be an initial step to foster self-reflection. Additionally, teachers should systematically integrate designated time slots and spaces for reflection within their lessons, for students' critical self-reflection as well as for individual teacher-student reflection. This practice familiarizes students with the concept, underscores its pivotal role in the learning process across all disciplines, and raises awareness of cognitive biases, personal assumptions, and belief systems. Furthermore, it would be essential to provide guidance on strategies to overcome these biases. Encouraging students to engage in peer collaboration, peer-reflection, and teacher-guided reflection can help them identify discrepancies between self-perception and external evaluations. One commonly recommended tool for fostering self-reflection is learning journals, which can effectively document individual learning progress and serve as a basis for ongoing or retrospective critical reflection. Regular engagement in individual and collaborative reflection sessions, alongside teacher-led reflective practices, could foster new routines among students, ultimately embedding critical self-reflection as an academic habit.

Since learning as well as critical self-reflection is highly dependent on students' self-awareness and mindsets, fostering both is essential (e.g., Dweck, 2017). Self-awareness creates the foundation for recognizing the need for self-reflection, a growth mindset fuels the motivation to engage in and act on self-reflective insights. A practical strategy to facilitate self-awareness and mindset exploration in students is reflective self-talk, a process in which individuals consciously examine and verbalize their beliefs, attitudes, and responses to learning challenges (e.g., Gainsburg & Kross, 2020). By fostering critical self-reflection, educators equip students with lifelong learning skills and enhance their employability in a rapidly evolving job market. Despite limiting factors, such as small sample size, students' limited introduction to critical self-

reflection, assessment bias, and the explorative nature of the study, this research provided valuable insights. Our preliminary findings call for further research into critical self-reflection. A qualitative inquiry with interviews would help a deeper understanding of students' self-perception and reveal the factors influencing self-awareness and self-reflection. Further investigation is needed on how to foster students' self-awareness and growth mindset. Testing of formulated hypotheses in a consequent large-scale quantitative study is yet to be conducted.

References

Akkermans, J., Brenninkmeijer, V., Huibers, M., & Blonk, R. W. B. (2013). Competencies for the contemporary career: Development and preliminary validation of the career competencies questionnaire. *Journal of Career Development, 40*(3), 245–267. https://doi.org/10.1177/0894845312467501

Becker, M., Vignoles, V. L., & Owe, E. (2014). Cultural bases for self-evaluation: Seeing oneself positively in different cultural contexts. *Personality and Social Bulletin*. https://doi.org/10.1177/0146167214522836

Brinegar, C., & Masino, H. S. (2021). Adapting to the new normal: Upskilling and reskilling. *Training Industrie Magazine.* https://www.nxtbook.com/nxtbooks/trainingindustry/tiq_20210506/index.php#/p/4

Cohen, R., & Katz, I. (2024). Students' academic competence beliefs as an antecedent of perceived teachers' autonomy support and motivation: A longitudinal model. *Current Psychology, 43*(45), 34601–34612. https://doi.org/10.1007/s12144-024-06900-x

Dacre Pool, L., & Sewell, P. (2007). The key to employability: Developing a practical model of graduate employability. *Education+ Training*, *49*(4), 277–289. https://doi.org/10.1108/00400910710754435/full/html

Dunning, D. (2011). Chapter five - The Dunning–Kruger effect: On being ignorant of one's own ignorance. *Advances in Experimental Social Psychology, 44*, 247–296. https://doi.org/10.1016/B978-0-12-385522-0.00005-6

Dweck, C. (2017). *Mindset - updated edition: Changing the way you think to fulfil your potential*. Constable & Robinson.

Gainsburg, I., & Kross, E. (2020). Distanced self-talk changes how people conceptualize the self. *Journal of Experimental Social Psychology, 88*, 103969. https://doi.org/10.1016/j.jesp.2020.103969

Gibbs, G. (1988). *Learning by Doing: A guide to teaching and learning methods*. Further Education Unit. Oxford Polytechnic.

Goyal, A. (2025). AI as a cognitive partner: A systematic review of the influence of AI on metacognition and self-reflection in critical thinking. *International Journal of Innovative Science and Research Technology*. https://eprint.ijisrt.org/id/eprint/159Harvey, L., & Knight, P. (2005). Briefings on employability 5. Helping Departments. http://www.employability.ed.ac.uk/documents/Staff/HEABriefings/HEA-Briefing5-Helping_depts_develop_employability.pdf

Heymann, P., Bastiaens, E., Jansen, A., van Rosmalen, P., & Beausaert, S. (2022). A conceptual model of students' reflective practice for the development of employability competences, supported by an online learning platform, *Education + Training, 64*(3), 380–397. https://doi.org/10.1108/ET-05-2021-0161

Hillage, J., & Pollard, E. (1998). *Employability: developing a framework for policy analysis.* UK Department for Education and Employment.

Lisa, E., Hennelova, K. & Newman, D. (2019). Comparison between employers' and students' expectations in respect of employability skills of university graduates. *International Journal of Work-Integrated Learning, 20*(1), 71–82.

McCrowre, R., & Adivar, B. (2024). Exploring underlying factors for variations in digital upskilling. *Industry and Higher Education, 38*(6), 515–533. https://doi.org/10.1177/09504222241249078

Mezirow, J. (2006). An overview of transformative learning. In P. Sutherland & J. Crowther (Eds.), *Lifelong learning: Concepts and contexts* (pp. 24-38). Routledge.

Miller, E., & Konstantinou, I. (2022). Using reflective, authentic assessments to embed employability skills in higher education. *Journal of Work-Applied Management, 14*(1), 4–17. https://doi.org/10.1108/JWAM-02-2021-0014

Moon, J.A. (2004). *Reflection and employability*. LTSN. https://www.advance-he.ac.uk/knowledge-hub/reflection-and-employability

Nieminen, J. H., & Boud, D. (2025). Placing authenticity at the heart of student self-assessment: An integrative review. *Teaching in Higher Education, 30*(3), 640–662. https://doi.org/10.1080/13562517.2024.2367669

OECD. (2021). *OECD Skills Outlook 2021 – Learning for Life.* OECD Publishing. https://doi.org/10.1787/0ae365b4-enRömgens, I., Scoupe, R., & Beausaert, S. (2019). Unraveling the concept of employability, bringing together research on employability in higher education and the workplace. *Studies in Higher Education, 45*(12), 2588–2603. https://doi.org/10.1080/03075079.2019.1623770

World Economic Forum (WEF). (2025). *Future of Jobs Report 2025*. World Economic Forum. https://www.weforum.org/reports/the-future-of-jobs-report-2025/

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory Into Practice, 41*(2), 64–70. https://doi.org/10.1207/s15430421tip4102_2

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The impact of careless responding on employability research

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Abstract

Careless Responding (CR) compromises data quality in psychological and educational contexts. In this study we examine the impact of CR on research involving a key construct in Higher Education: personal employability. Particularly we assess how this impact depends on the strategy used to address CR by comparing four strategies: 1) using the total sample without taking any action, 2) eliminating careless respondents, 3) introducing CR as a control variable, 4) introducing CR as a moderating variable. Using a sample of 360 university graduates, results show that removing careless respondents reduces statistical power and some hypothesized employability effects become non-significant. In contrast, incorporating CR as a moderating variable was highly informative and yielded the best goodness-of-fit. These findings highlight the importance of considering CR behaviours and suggest that introducing CR as a moderator is an effective approach to maintaining data quality, statistical power and representativeness in employability research.

Keywords: *careless responding; data quality; employability; young graduates.*

1. Introduction

Personal employability is a critical construct in Higher Education, enhancing students' chances of securing quality jobs (González-Romá et al., 2018) and improving satisfaction (Vanhercke et al., 2016). Typically measured via questionnaires, employability research is vulnerable to Careless Responding (CR), a major source of bias that compromises data quality and validity. This study examines the indirect effects of employability on life satisfaction through core self-evaluations while investigating how different strategies for managing CR impact tested relationships and model fit. Four approaches are compared: 1) using the full sample without addressing CR, 2) excluding careless respondents, 3) incorporating CR as a control variable,

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and 4) treating CR as a moderating variable. Findings will shed light on mechanisms linking employability and satisfaction while offering practical recommendations to address CR and safeguard validity in employability research.

1.1. Addressing and managing Careless Responding

Careless responding (CR) occurs when participants fail to thoroughly read or focus on items' content, producing unreliable data that misrepresents their true construct levels (Ward & Meade, 2022). Among various CR detection methods (see Edwards, 2019, Ward & Mead, 2022), this study focuses on Instructed Response Items (IRIs), a widely recommended approach (e.g., Berinsky et al., 2021; Maniaci & Rogge, 2014; Meade & Craig, 2012). IRIs instruct participants to select a specific response (e.g., "5. Completely agree"), with failure to comply indicating careless responding. This approach stands out for its simplicity, transparency, and strong metric properties (Kam & Chan, 2018).

Despite concerns about CR's negative impact on research validity (Kim & Oh, 2022; Maniaci & Rogge, 2014), there is no consensus on how best to address it. While excluding careless respondents is common (e.g., Maniaci & Rogge, 2014; Meade & Craig, 2012), this reduces sample size, lowers statistical power, and risks losing representativeness by excluding unique participants (e.g., Goldammer et al., 2020; Ward & Meade, 2022). Alternatives include treating CR as a control (Goldammer et al., 2020) or moderating variable (Edwards, 2019). However, no published research has compared the effects of these strategies. This study fills the gap by examining the most effective methods for managing CR, focusing on employability research.

1.2. From employability to well-being: A mediated model through core-self evaluations

In this study we focus on personal employability. It is defined as "a form of work-specific active adaptability that enables workers to identify and realize career opportunities" (Fugate et al. (2004; p. 16). It is a multidimensional construct that encompasses four personal factors: a) career identity, which reflects one's sense of self and aspirations within a career, serving as a motivational driver; b) personal adaptability, or the ability to respond to environmental demands and explore opportunities; c) human capital, including attributes such as education, work experience, and skills; and d) social capital, the advantages gained through social networks that provide access to information and opportunities.

In the employability literature, a central hypothesis is that employability enhances satisfaction and well-being. It fosters a sense of control over one's employment situation, positively influencing outcomes like job satisfaction and life satisfaction (De Cuyper et al., 2011). Additionally, job insecurity has been identified as a mediating mechanism linking employability and well-being indicators such as engagement and life satisfaction (De Cuyper et al., 2008). In

this study, we propose core self-evaluations (individual's subconscious, fundamental evaluations about themselves) as the mediator between employability and life satisfaction.

1.3. Hypotheses

Our research model is depicted on the left panel of Figure 1. All relations are expected to be positive. Regarding the best way of managing CR, we hypothesize that using the full sample without addressing CR will be the least effective option. The limited research on this topic prevents us from making a specific hypothesis about which of the other strategies (excluding careless respondents, including CR as a control variable, introducing CR as a moderator), is most effective.

2. Method

2.1. Participants and procedure

This study was part of a larger investigation on graduates' overqualification in Spain. To test our hypotheses, we utilized a sample of undergraduate and master's students that were about to complete their studies. Participants were first contacted approximately one month before graduation (T1), and were informed they would be invited to complete two additional questionnaires: nine months post-graduation (T2) and four months after T2 (T3). The final sample consisted of 360 participants who completed the online questionnaire at all three time points. In terms of educational level, 61.1% had earned a bachelor's degree, while 38.9% had completed a master's degree. Most participants came from Social Sciences (53.6%) and Health (23.6%). The average age was 25.6 years (SD = 6.3), and 71.7% were female. Careless respondents were those who made one or more errors on the three IRIs included in the questionnaire. At T1, 8.3% of participants were identified as careless respondents, increasing to 14.4% at T2, and 14.7% at T3.

2.2. Measures

Careless responding was measured by means of three IRIs that were embedded within different scales of the questionnaire, each specifying the response to be selected. For instance, in a scale ranging from 1 ("Never") to 6 ("Always"), an IRI example would read: "To control the quality of survey responses, now select the option 'never'". We computed the total number of errors (responses different from the ones specified in the IRIs) across the three IRIs (from 0 to 3).

Employability was measured at T1 including the four factors proposed by Fugate et al. *Career identity* was measured with González-Romá et al.'s (2018) 4-item scale (e.g., "I identify with the line or area of work that I have chosen"), rated on a 6-point Likert scale (1. Strongly Disagree, 6. Strongly Agree). *Personal Adaptability* was measured with a 3-item scale

developed for this study (e.g., "I am able to adapt to the changing circumstances of my environment"). Items were rated on a 5-point scale (1. Not at all, 5. A lot). *Human Capital* was measured with a 6-item scale based on Hernández-March et al.'s (2009) generic competences: oral and written communication, problem solving, time and resource management, teamwork, continuous learning, and taking responsibility. Items were rated on a 5-point Likert scale (1. Low degree, 5. High degree). *Social Capital* was measured by means of a 4-item scale based on González-Romá et al. (2018) (e.g., "I have a network of professional contacts that will help me find job opportunities"). Items were rated on a 6-point Likert scale (1. Strongly Disagree, 6. Strongly Agree). Confirmatory factor analysis supported the expected four-factor solution (χ^2 =250, df = 113, p < .001; RMSEA = 0.06; SRMR = 0.05; CFI = 0.94; TLI = .93) with factor loadings ranging between .41 and .91 (p<.001). Cronbach's alphas ranged between .72 and .85.

Core-self evaluations (CSE) were measured at T2. To measure CSE, we used the Core Self-Evaluations Scale developed by Judge et al. (2003). The scale consists of 12 items (e.g., "I am confident I will get the success I deserve in life") that are responded to on a 6-point Likert scale (1. Strongly Disagree, 6. Strongly Agree). Cronbach's alpha value was .85.

Life satisfaction was assessed at T3 by the five-item Satisfaction with Life Scale (Diener et al., 1985) (e.g., "In most ways my life is close to my ideal."). Cronbach's alpha was .88.

2.3. Analysis

We tested the proposed mediation model by means of Structural equation modeling (SEM). We first tested the model on both the total sample (M1) and the clean sample (M2) (after excluding careless respondents). Additionally, two models were tested using the full sample while accounting for "careless responding" in two ways: as a control variable influencing the relevant substantive variables (M3), and as a moderator of all proposed substantive relationships (M4). The goodness-of-fit of the four models was compared. Differences of no more than .015 in RMSEA values (ΔRMSEA; Chen, 2007) and no more than 0.01 in CFI and TLI values (ΔCFI and ΔTLI; Cheung & Rensvold, 2002; Widaman, 1985) were considered indicative of negligible practical differences. Analyses were conducted using SPSS 28 and Mplus version 8.8.

3. Results

3.1. Goodness-of-fit of the models

Table 1 shows the goodness-of-fit comparison across the alternative models tested. The best fitting model was the one that introduced CR as a moderator (M4). M4 showed relevant differences compared to models M1 (ΔRMSEA = .047, ΔCFI = .025, ΔTLI = .057), M2 (ΔRMSEA = .051, ΔCFI = .027, ΔTLI = .062), and M3 (ΔRMSEA = .036, ΔCFI = .038, ΔTLI = .077). Conversely, the model with CR as a control variable (M3) exhibited the poorest fit,

showing relevant differences with both M1 (ΔCFI = .013, ΔTLI = .020), and M2 (ΔCFI = .011, ΔTLI = .015). The differences between M1 (full sample) and M2 (sample without careless respondents) were negligible in terms of fit (ΔRMSEA = .004, ΔCFI = .002, ΔTLI = .005).

Table 1. Goodness-of-fit of the alternative models tested.

Model	χ^2	df	RMSEA	CFI	TLI	SRMS
M1: Full sample (N=360)	11.01*	4	0.070	0.967	0.925	0.040
M2: Eliminating CR (N=248)	9.42	4	0.074	0.965	0.920	0.041
M3: CR as control variable (N=360)	36.30**	16	0.059	0.954	0.905	0.041
M4: CR as moderating variable (N=360)	13.03	11	0.023	0.992	0.982	0.029

Note: CR = careless responding. *p<.05; **p<.01.

3.2. Relationships between the variables

Figures 1 and 2 illustrated that the regression coefficients across the tested models were largely consistent. All hypothesized relationships were statistically significant, except for M2 (the model excluding careless respondents), where one of the tested relationships and the corresponding indirect effect were not statistically significant. Specifically, while all four employability factors showed positive and statistically significant relationships with CSE, the relationship between social capital and CSE in M2 was not statistically significant (β=.13, p=.055). Similarly, indirect effects of the employability factors on life satisfaction through CSE were significant (as the 95% bias-corrected (BC) bootstrap confidence interval (CI) excluded zero), with values ranging from .08 to .25, except for the indirect effect of social capital on life satisfaction in M2, which was not significant (IE = .07; BC bootstrap 95% CI = [-.001, .15]).

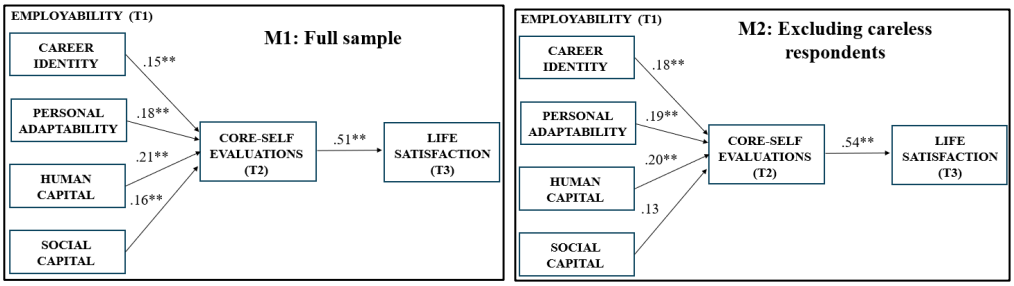


Figure 1. Standardized regression coefficients for M1 and M2.

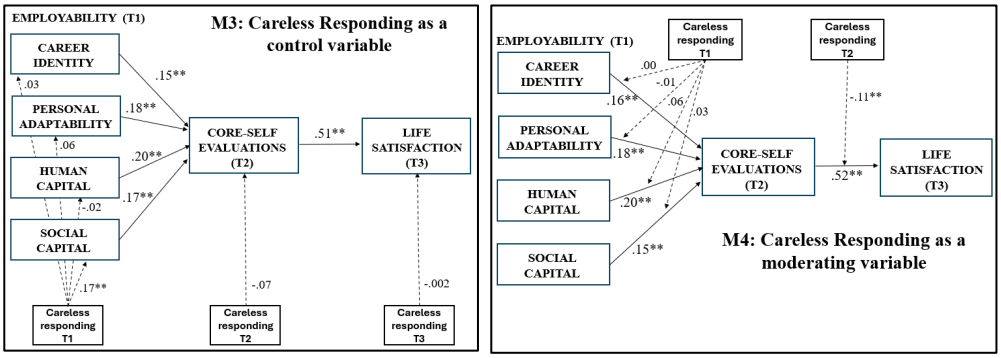


Figure 2. Standardized regression coefficients for M3 and M4.

Interestingly, in M4 one of the moderating effects of CR was statistically significant. This significant interaction term indicates that the effect of CSE on life satisfaction differs across groups of respondents defined by the number of errors in the IRIs. To further examine the interaction effect, we used Process macro for SPSS (Hayes, 2013) to compute simple slopes for the four levels of the moderator: careful (0 errors) and careless respondents (1, 2, or 3 errors). We also plotted the corresponding regression lines (see Figure 3). The results showed that the slope estimating the relationship between CSE and life satisfaction was positive and statistically significant for careful respondents (b=0.84, p<.001) and for careless respondents with 1 error (b=0.51, p<.001). However, the relationship was not statistically significant for careless participants with 2 errors (b=0.17, p=.51) and 3 errors (b=-0.16, p=.69).

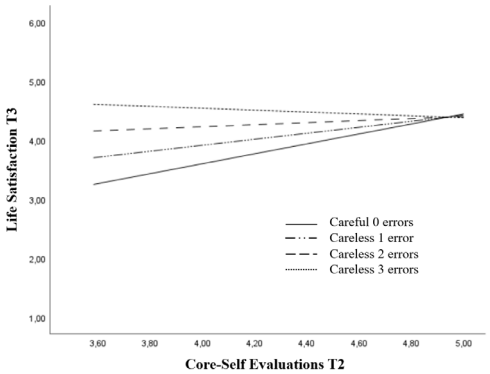


Figure 3. Relationship between CSE and life satisfaction as a function of careless responding.

4. Discussion

The results reveal that all factors in Fugate et al.'s personal employability model contribute to enhancing well-being (life satisfaction) through the increase of CSE. However, this indirect

effect was not supported when careless respondents were excluded from the sample, as the relationship between social capital and CSE became statistically nonsignificant. These findings highlight the impact of different strategies for managing CR on employability research outcomes. Specifically, the results suggest that in studies with relatively small sample sizes (360 in this study), excluding careless respondent reduces statistical power, potentially obscuring significant relationships. Additionally, using CR as a control variable appears to be the less advisable option, as it yielded the poorest model fit. On the other hand, incorporating CR as a moderating variable proved to be the most effective strategy, offering the best model fit while preserving statistical power by retaining the full sample. Analysis of the moderating effect of CR showed that the relationship between CSE and life satisfaction was stronger for careful respondents, becoming nonsignificant for groups with higher errors in the IRIs.

Several limitations of our study should be acknowledged. Contextual factors such as sample size, the proportion of careless respondent, and the length of the questionnaire remained constant, which restricts the generalizability of our findings to different conditions. Future simulation studies are needed to explore how these and other contextual variables may influence the impact of CR on psychological research outcomes.

Despite these limitations, our findings have valuable theoretical and practical implications. By comparing various CR management strategies, we recommend against excluding careless respondents. Instead, we emphasize the importance of accounting for CR behaviors during data analysis. Introducing CR as a moderating variable emerges as an effective strategy for preserving data quality and representativeness in employability research.

References

Berinsky, A. J., Margolis, M. F., Sances, M. W., & Warshaw, C. (2021). Using screeners to measure respondent attention on self-administered surveys: Which items and how many? *Political Science Research and Methods*, 9(2), 430-437. doi:10.1017/psrm.2019.53

Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural Equation Modeling*, 14, 464-504. https://doi.org/10.1080/10705510701301834.

Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modeling*, 9(2), 233-255. https://doi.org/10.1207/s15328007sem0902_5.

De Cuyper, N., Bernhard-Oettel, C., Berntson, E., De Witte, H., & Alarco, B. (2008). Employability and employees' well-being: Mediation by job insecurity. Applied Psychology: An International Review, 57(3), 488–509. https://doi.org/10.1111/j.1464-0597.2008.00332.x.

De Cuyper, N., Van der Heijden, B. I. J. M., & De Witte, H. (2011). Associations between perceived employability, employee well-being, and its contribution to organizational success: a matter of psychological contracts? The International Journal of Human Resource Management, 22(7), 1486–1503. https://doi.org/10.1080/09585192.2011.561962.

Diener, E. D., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of Personality Assessment*, 49, 71–75. https://doi.org/10.1207/s15327752jpa4901_13.

Edwards, J. R. (2019). Response invalidity in empirical research: Causes, detection, and remedies. *Journal of Operations Management*, 65(1), 62-76. https://doi.org/10.1016/j.jom.2018.12.002.

Fugate, M., Kinicki, A. J., & Ashforth, B. E. (2004). Employability: A psycho-social construct, its dimensions, and applications. *Journal of Vocational Behavior*, 65(1), 14–38. https://doi.org/10.1016/j.jvb.2003.10.005.

Goldammer, P., Annen, H., Stöckli, P. L., & Jonas, K. (2020). Careless responding in questionnaire measures: Detection, impact, and remedies. The Leadership Quarterly, 31(4), Article 101384. https://doi.org/10.1016/j.leaqua.2020.101384.

González-Romá, V., Gamboa, J. P., & Peiro, J. M. (2018). University graduates' employability, employment status, and job quality. *Journal of Career Development*, 45(2), 132-149. https://doi.org/10.1177/0894845316671607.

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York, NY: Guilford Press. https://doi.org/10.1111/jedm.12050.

Hernández-March, J., Martín del Peso, M., & Leguey, S. (2009). Graduates' skills and higher education: The employers' perspective. *Tertiary Education and Management*, 15(1), 1-16. https://doi.org/10.1080/13583880802699978.

Judge, T. A., Erez, A., Bono, J. E., & Thoresen, C. J. (2003). The Core Self-Evaluations Scale: Development of a measure. Personnel Psychology, 56(2), 303–331. https://doi.org/10.1111/j.1744-6570.2003.tb00152.x.

Kam, C. C. S., & Chan, G. H.-h. (2018). Examination of the validity of instructed response items in identifying careless respondents. Personality and Individual Differences, 129, 83–87. https://doi.org/10.1016/j.paid.2018.03.022.

Kim, N., & Oh, J. (2022). Learning from mistakes: Impact of careless responses on counseling research using amazon's mechanical turk. Measurement and Evaluation in Counseling and Development. Advance online publication. doi: 10.1080/07481756.2022.2073895.

Maniaci, M. R., & Rogge, R. D. (2014). Caring about carelessness: Participant inattention and its effects on research. Journal of Research in Personality, 48, 61–83. https://doi.org/10.1016/j.jrp.2013.09.008.

Meade, A. W., & Craig, S. B. (2012). Identifying careless responses in survey data. Psychological Methods, 17(3), 437–455. https://doi.org/10.1037/a0028085.

Vanhercke, D., De Cuyper, N., & De Witte, H. (2016). Perceived employability and well-being: An overview. *Psihologia Resurselor Umane*, 14(1), 8-18.

Ward, M. K., & Meade, A. W. (2022). Dealing with careless responding in survey data: Prevention, identification, and recommended best practices. *Annual Review of Psychology*, 74(1), 577-596. https://doi.org/10.1146/annurev-psych-040422-045007.

Widaman, K. F. (1985). Hierarchically nested covariance structure models for multitrait-multimethod data. *Applied Psychological Measurement*, 9(1), 1-26. https://doi.org/10.1177/014662168500900101.

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Revisiting the Graduate Capital Scale: A Cross-Cultural Examination for China's Undergraduate Vocational Graduates' Employability

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Abstract

This study examines the employability of undergraduate vocational graduates in China through the lens of Tomlinson's Graduate Capital Model (2017). Amidst shifting economic conditions and rising youth employment challenges, higher vocational education has gained prominence as a potential means to facilitate the education-to-work transition. This research adapts and validates the Graduate Capital Scale for China's undergraduate vocational education, employing a content validation process with expert panels. Findings indicate the necessity of contextual adjustments to employability frameworks, reinforcing the model's applicability beyond Western contexts. The validated instrument provides a foundation for self-assessment and career development among vocational graduates. By integrating cultural and economic specificities, this study offers insights into employability measures in diverse educational settings, informing policy and institutional strategies to enhance graduates' labour market readiness.

Keywords: *Employability; Self-assessment; Graduate Capital; Undergraduate Vocational Education.*

1. Introduction

Vocational education and training (VET) is regarded as one trigger of social and economic development, and in turn, the social and economic changes contribute to the development of vocational education (Lee et. al., 2020; Pilz & Regel, 2021; Tucker, 2019). The global shift toward knowledge-based economies, together with rapid technological advancement, has changed the nature of work (Pham & Jackson, 2020). It is widely recognized that traditional academic pathways alone may not sufficiently prepare graduates to navigate transformed labour

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markets (Brown & Souto-Otero, 2020; Tomlinson, 2013). The massification of higher education has led to concerns about an uneven supply-demand relationship between graduates and employment opportunities (Brown, 2022). Associated youth employment challenges may constrain economic growth, opportunities for social mobility, and hinder alleviation efforts (Mok & Neubauer, 2016; World Bank, 2015) and bring individuals scarring effects and growing anxiety about career prospects (International Labour Organisation, 2024).

In response, a growing number of nations are shifting the focus of higher education away from traditional academic orientations towards higher forms of vocational education (UNESCO, 2022; World Bank, 2023a). This trend also includes China, the focus of this research, which has experienced an economic slowdown (World Bank, 2023b), and is at risk of a middle-income trap (Kharas & Kohli, 2011). There is tension between millions of vacancies for highly skilled talents alongside a record-high unemployment rate of bachelor's graduates (Fu, 2023; Ma, 2024; Nulimaimaiti, 2023). In recent years, the government has pursued a new reform agenda focused on higher vocational education, enabling higher vocational institutions to confer academic degrees (The State Council, 2019). Although the number of students in undergraduate vocational education has increased rapidly (see Figure 1), it remains unclear how students perceive their education and graduate employability in their education-to-work.

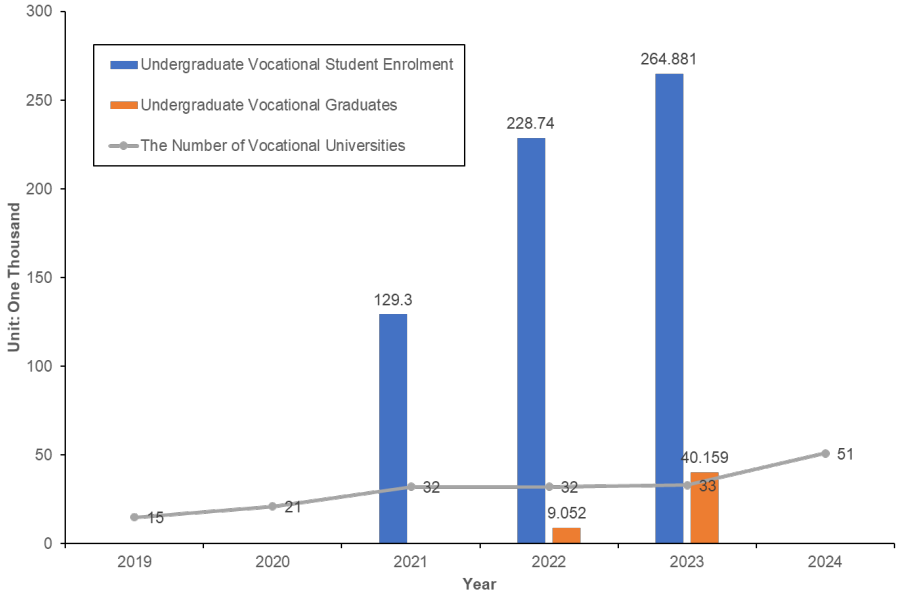


Figure 1. Undergraduate Vocational Education in Mainland China. Source: "2019, 2020, 2021, 2022 Number of Higher Education Institutions, by the Ministry of Education of the People's Republic of China, 2019, 2020, 2021, 2022 (http://en.moe.gov.cn/documents/statistics/2022/national/)". In the public domain.

2. Theoretical Framework

An expanding literature has discussed on graduate employability (Broadley et al., 2023; Huu Nghia et al., 2020, 2022; Ng, 2022; Tran et al., 2022). Pham and Jackson (2020, p. 45) pointed out that recent research revealed that possessing technical knowledge and skills was crucial for graduates to achieve favourable employment outcomes. However, it is not the only determinant for graduates' success in the job market. Therefore, it is crucial for the graduate employability agenda to embrace a broader and more comprehensive perspective that goes beyond simply acquiring employability skills in order to effectively address the evolving requirements of the global labour market. Many scholars have agreed that employability is not only the possession of a set of skills that are required or needed by employers but also a combination of different capitals or resources (Clarke, 2008; Tomlinson, 2017).

More recently, Yorke and Knight (2006, p. 8) defined employability as "a set of achievements, skills, understandings and personal attributes that make graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community, and the economy." That is based on their USEM account of employability (2004), which is probably one of the well-known and respected models in this field. USEM stands for understanding, skills, efficacy beliefs, and metacognition. This model forms a large body of research-based scholarly work. However, it failed to clarify the concept of employability to individuals who are not experts in the industry, e.g., students and their parents.

2.1. Tomlinson's Graduate Capital

The framework is Tomlinson's (2017) Graduate Capital Model that seeks to measure the employability of graduates. Tomlinson (2017) developed Bourdieu's theory of capital (1986) to conceptualize the Graduate Capital Model in five interconnected dimensions, i.e., Human, Social, Cultural, Identity, and Psychological Capital to depict graduate employability. The Graduate Capital Scale (Tomlinson et al., 2021), grounded in this model, consists of 45 items distributed across these five dimensions. Initially validated among students from universities in the United Kingdom, the applicability to China's undergraduate vocational education remains under-researched. This study aims to adapt and validate the Graduate Capital Scale for undergraduate vocational education in China. The validated scale will be incorporated into a practical toolkit for China's undergraduate vocational students and graduates to self-assess their employability and identify their employability deficiencies for development.

3. Methods

A content validation process was conducted by using an expert panel review to contextualize the Graduate Capital Scale for China's undergraduate vocational education. The expert panel

included higher education institutional career guidance directors, faculty and department heads, HR managers from employers having recruited undergraduate vocational graduates, and researchers specialized in graduate employability. Experts were selected through purposive sampling based on their familiarity with China's undergraduate vocational education. The invited experts evaluated each item within the Scale by categorizing it as "Essential", "Useful but not essential", or "Not necessary" in an online survey. The Content Validity Ratio (CVR) was calculated by using Lawshe's (1975) formula, and only items meeting the minimum CVR threshold were retained (Kyriazos & Stalikas, 2018). To refine and finalize the questionnaire, follow-up interviews were conducted with three expert panellists.

Lawshe (1975, p. 566) had devised the following formula for the content validity ratio (CVR):

$$\mathrm{CVR} = \frac{\mathrm{n_e} - (\frac{\mathrm{N}}{2})}{\frac{\mathrm{N}}{2}}$$

in which the n_e is the number of panellists indicating 'essential' and N is the total number of panellists.

4. Results

A total of 47 valid responses were received for evaluating the translated and adjusted Graduate Capital Scale items. Scores were counted only if the item was rated as "Essential" by experts. After calculating CVR value based on Lawshe's formula (1975, p. 566), 39 items exceeded the minimum CVR threshold of 0.29 for 47 panellists (Lawshe, 1975, p. 568) and were retained in the final questionnaire. 6 items were excluded, including the item "I have an effective online career profile, LinkedIn, 51 Job, Boss Zhipin, etc." under human capital, and the item "I have distinctive achievements and interests which make me stand out from others." under cultural capital, together with 2 items under social capital and psychological capital respectively. All 9 original items under identity capital were retained. Structured interviews with 3 panellists reviewed and supported the adapted Scale. They also suggested supplementing the questionnaire with some background and socioeconomic status questions to finalize it. Overall, the final version of the questionnaire is available for further quantitative validation of the Graduate Capital Model among China's undergraduate vocational students and graduates.

The findings confirm the need for culturally specific adjustments in employability and reinforce the applicability of Tomlinson's Graduate Capital Model beyond Western contexts.

5. Limitation, Discussion, and Significance

The expert panel review contextually adapted and validated the Graduate Capital Scale in the context of undergraduate vocational education in China. The invited experts, covering a wide range of resources, directly from higher educational institutions, who know graduates well and guide their transition from education to work, as well as employers working closely with graduates, however, limited to some industries in some regions in China because of the employed purposive convenience sampling. The adapted and translated Scale is expected to be large-scale validated with final-year students and graduates to achieve the validity and reliability of the research on the employability of undergraduate vocational graduates through the lens of the Graduate Capital Model. That could also be supplemented by the perceived employability of undergraduate vocational graduates from employers' perspectives.

This study adds contextual relevance of the Graduate Capital Scale in a non-Western context, offering insights into the adaptability of employability measures across diverse educational settings. By developing a validated instrument to assess graduate employability in China's undergraduate vocational education. It provides a solid foundation for future evidence-based interventions aimed at enhancing professional development and career readiness, guiding reforms in undergraduate vocational curriculum design, and introducing employers' engagement in developing and assuring graduate employment readiness, which is rare in China's educational system.

This research can be duplicated in other emerging countries or economies, which are confronted with a similar paradox as China to develop a toolkit for their higher vocational graduate to facilitate their navigation in graduate labour markets.

References

Bourdieu, P. (1986). The forms of capital. In J. G. Richardson (Ed.), *Handbook of theory and research for the sociology of education* (pp. 241–259). Greenwood Press.

Broadley, T., Cai, Y., Firth, M., Hunt, E., & Neugebauer, J. (2023). *The SAGE handbook of graduate employability*. Sage Publications.

Brown, P. (2022). Higher education, credentialism, and social mobility. In J. E. Côté, & S. Pickard (Eds.), *Routledge handbook of the sociology of higher education* (2nd ed., pp. 351–362). Routledge.

Brown, P., & Souto-Otero, M. (2020). The end of the credential society? An analysis of the relationship between education and the labour market using big data. *Journal of Education Policy, 35*(1), 95-118. https://doi.org/10.1080/02680939.2018.1549752

Clarke, M. (2008). Understanding and managing employability in changing career context. *Journal of European Industrial Training, 32*(4), 258-284. DOI 10.1108/03090590810871379

European Commission (EU). (2015). *Modernisation of Higher Education in Europe: Access, Retention and Employability 2014*. European Commission.

Fu, C. (2023, August 23). China suspends report on youth unemployment, which was at a record high. *The New York Times*. https://www.nytimes.com/2023/08/15/business/china-youth-unemployment.html

Huu Nghia, T. L., Pham, T., Tomlinson, M., Medica, K. & Thompson, C. D. (Eds.). (2020) *Developing and utilizing employability capitals: Graduates' strategies across labour markets*. Routledge.

International Labour Organisation (ILO). (2024). *Global employment trends for youth 2024: Decent work, brighter futures*. https://doi.org/10.54394/FGPM3913

Jackson, D. (2020). The changing nature of graduate roles and the value of the degree. *Journal of Higher Education Policy and Management, 43*(2), 182-197. https://doi.org/10.1080/1360080X.2020.1777634

Kharas, H., & Kohli, H. (2011). What is the middle-income trap, why do countries fall into it, and how can it be avoided? *Global Journal of Emerging Market Economies, 3*(3), 281-289. https://doi.org/10.1177/097491011100300302

Kyriazos, T. A., & Stalikas, A. (2018). Applied psychometrics: The steps of scale development and standardization process. *Psychology, 9*(11), 2531-2560. https://doi.org/10.4236/psych.2018.911145

Lawshe, C. H. (1975). A quantitative approach to content validity. *Personnel Psychology, 28*(4), 563–575. https://doi.org/10.1111/j.1744-6570.1975.tb01393.x

Lee, H. S., Har, W. M., & Lee, S. Y. (2020). Impacts of Lower and Upper Secondary Vocational Education on Economic Growth. Journal of Technical Education and Training, 12(1), 71-81.

Ma, S. (2024, March 9). China jobs: push to raise incomes, social standing of indispensable skilled workers at 'two sessions' amid hi-tech drive. *South China Morning Post*. https://www.scmp.com/economy/economic-indicators/article/3254675/china-jobs-push-raise-incomes-social-standing-indispensable-skilled-workers-two-sessions-amid-hi

Mok, K., & Neubauer, D. (2016). Higher education governance in crisis: A critical reflection on the massification of higher education, graduate employment and social mobility. *Journal of Education and Work, 29*(1), 1-12. https://doi.org/10.1080/13639080.2015.1049023

Ng, B. (2022). Current status of higher education research in work readiness and job employability. In B. Ng (Ed.), *Higher education and job employability*. Springer. https://doi.org/10.1007/978-3-031-05716-8

Nulimaimaiti, M. (2023, December 7). China's college graduates to hit record high 11.79 million in 2024, adding to job market pressure. *South China Morning Post*. https://www.scmp.com/economy/economic-indicators/article/3243244/china-jobs-how-much-employment-pressure-worlds-second-largest-economy-facing?module=perpetual_scroll_1_RM&pgtype=article

Pilz, M. & Regel, J. (2021). Vocational Education and Training in India: Prospects and Challenges from an Outside Perspective. *Margin The Journal of Applied Economic Research, 15*(1), 101-121. DOI:10.1177/0973801020976606

Pham, T., & Jackson, D. (2020). Employability and determinants of employment outcomes. In T. L. Huu Nghia, T. Pham, M. Tomlinson, K. Medica, & C. Thompson (Eds.), *Developing and utilizing employability capitals* (1st ed., pp. 237-255). Routledge.

The State Council. (2019). *State Council encourages vocational education reform* [Policy brief]. The State Council of the People's Republic of China.

Tran, L. T., Ngo, N. T. H., Nguyen, H. T. M., & Thanh Le, T. T. (2022). *Employability in context: Labour markets needs, skills gaps and graduate employability development in regional Vietnam*. Palgrave Macmillan. https://doi.org/10.1007/978-3-031-04144-0

Tomlinson, M. (2013). *Education, work and identity: Themes and perspectives*. Bloomsburry Academic.

Tomlinson, M. (2017). Forms of graduate capital and their relationship to graduate employability. *Education + Training, 59*(4), 338-352. http://www.emeraldinsight.com/0040-0912.htm

Tomlinson, M., Port, A., Maguire, N., Zabelski, A. E., Butnaru, A., Charles, M., & Kirby, S. (2021). Developing graduate employability for a challenging labor market: the validation of the graduate capital scale. *Journal of Applied Research in Higher Education, 14*(3), 1198-1209. DOI: 10.1108/JARHE-04-2021-0151

Tucker, M. S. (2019). Introduction: The vocational education and training system you need depends on the kind of economy you want. In M. S. Trucker (Ed.), *Vocational education and training for a global economy* (pp. 1-7). Harvard Education Press.

UNESCO. (2022). *Transforming technical and vocational education and training for successful and just transitions: UNESCO strategy 2022-2029*. https://unevoc.unesco.org/pub/unesco_strategy_for_tvet_2022-2029.pdf

World Bank. (2015, October 13). *Addressing the youth employment crisis needs urgent global action* [Press release]. https://www.worldbank.org/en/news/press-release/2015/10/13/addressing-the-youth-employment-crisis-needs-urgent-global-action

World Bank. (2023a, July 12). *Improve technical and vocational education and training (TVET) to meet skills and labour mismatch* [Press release]. https://www.worldbank.org/en/news/press-release/2023/07/12/improve-technical-vocational-education-training-tvet-meet-skills-labour-mismatch

World Bank. (2023b, December 14). *Sustained policy support and deeper structural reforms to revive China's growth momentum – World Bank Report* [Press release]. https://www.worldbank.org/en/news/press-release/2023/12/14/sustained-policy-support-and-deeper-structural-reforms-to-revive-china-s-growth-momentum-world-bank-report

Yorke, M., & Knight, P. (2006). *Embedding employability into the curriculum (Learning and Employability Series 1)*. The Higher Education Academy. https://www.qualityresearchinternational.com/esecttools/esectpubs/yorkeknightembedding.pdf

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Does Developing a Study Guide Impact Test Performance? A Comparison Between Unguided and Guided Development of Scientific Writing

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Abstract

The present study asked whether voluntarily developing a study guide for the final exam would be positively related to performance on the exam. It also asked whether the mode of study guide development (instructor-guided or unguided) would differentiate the performance of students who completed this task. In the study, the development of a study guide was one of the many curriculum-related activities that students could carry out in a course taught through instructor-guided inquiry-based learning. Because it was not a compulsory activity, 81% of the students completed it. Among these students, no differences were observed in the final grades of the instructor-guided and unguided conditions. However, across all participants, completing the study guide was linked to higher class participation and class grades. These findings suggest that participation in co-curricular activities is a reflection of engagement and desirable performance outcomes.

Keywords: *Inquiry-based learning; study-guide development; co-curricular activities*

1. Introduction

In academic courses, inquiry-based learning is an instructional strategy in which students adopt the practices of professional scientists to acquire the knowledge and skills expected of them. Typical of inquiry-based learning is the fact that students often carry out self-directed learning activities under the guidance of the instructor. Not surprisingly, there has been considerable debate about the degree to which learners should be provided more or less scaffolding (i.e., supportive guidance from the instructor) to perform class-related activities (Tawfik et al., 2020). Scaffolding is conceptualized as "any form of assistance offered before and/or during the inquiry

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learning process that aims to simplify, provide a view on, elicit, supplant, or prescribe the scientific reasoning skills involved" (Lazonder & Harmsen, 2016, p. 687). On one side, some studies have reported the benefits of instructor-led teaching, which can be advantageous to novices faced with the tasks of acquiring new and often complex knowledge and skills (Alfieri et al. 2011; Lazonder & Harmsen, 2016). On the other side, other studies have reported the benefits of broadening student-directed learning. It has been argued that the latter gives learners the necessary sense of agency to understand what they know and do not know, develop learning goals, and assess the resources needed to complete the task at hand (Tawfik et al., 2020). Benefits include performance gains arising from the sense of agency that learners experience. Interestingly, inconsistencies in the findings of the extant literature generally involve activities that are part of the curriculum of a course and are thus compulsory. Consequently, one may ask whether academic performance can be impacted by voluntary co-curricular activities with differing levels of instructor involvement. Co-curricular activities are pursuits that entail learning opportunities (i.e., events or tasks) that are related to the curriculum and whose purpose is to enhance its quality and improve learning (Camerato et al., 2019).

Besides the degree of instructor guidance, student engagement is another key issue in the literature on inquiry-based learning. Engagement, which is the effort students direct to course activities, is under their control (Waked et al., 2024). Across disciplines, educators agree that students' engagement is key to successful learning (e.g., Freeman et al., 2014). In co-curricular activities, engagement, conceptualized as a disposition, can impact the decision as to whether to undertake or not such activities (Kuperminc et al., 2013; Olewnik et al., 2023). According to self-determination theory (Ryan & Deci, 2017), the types of motivation propelling the undertaking of co-curricular activities may be a combination of 'identified regulation', and 'introjected regulation'. 'Identified regulation' refers to involvement in a given endeavor because of its relevance to achieving personal goals. 'Introjected regulation' justifies involvement in that endeavor to avoid negative emotions (e.g., "I would be worried if I did not do it"). Because co-curricular activities merely complement the curriculum and generally do not give course credit, they are less likely to be motivated by 'external regulation', which links involvement in a given endeavor to rewards and punishments (e.g., "I would get a bad grade if I did not do it"). Whether the undertaking of particular co-curricular activities can be more broadly related to course engagement and attainment is an open question.

In the present field study, a course devoted to scientific writing taught through guided inquiry-based learning pedagogy was selected. In this context, a co-curricular activity that students could interpret as potentially beneficial to their performance (i.e., the development of a study guide for the final exam), was targeted for experimental manipulation. There were two conditions, instructor-guided and unguided, under which the activity could be performed. The following research questions were asked, each linked to a hypothesis to be tested:

Q1 Do students who complete a voluntary co-curricular activity towards the end of the semester, such as developing a study guide for the final exam, yield higher performance not only in the exam but also in the course? If carrying out this activity is an indicator of a student's effort in the course (i.e., engagement), undertaking this activity would be linked to not only higher final exam grades but also higher course grades (H1).

Q2 Among the students who complete this voluntary co-curricular activity, do instructor-guided and unguided study-guide development yield different perceptions of readiness for the final exam? Do they also yield different performance outcomes? Here, guidance is defined as explicit information regarding the items that the study guide needs to contain. It is a form of scaffolding that tells learners what to do (i.e., develop definitions and examples for each concept covered in this course), providing designated means to carry out the task (i.e., a list of concepts). Based on self-determination theory (Ryan & Deci, 2017), the unguided condition could be described as offering a greater sense of agency. If the satisfaction of students' needs for autonomy and competence are linked to engagement and desirable learning outcomes, the unguided condition should yield evidence of higher final exam performance (H2).

2. Method

2.1. Participants

The participants were 235 undergraduate students enrolled in a compulsory course on scientific writing taught in English through guided inquiry-based learning pedagogy (Lazonder & Harmsen, 2016). They were first-year students (age range: 18-30) who could be classified as Arabic-English bilingual speakers. Proficiency in their second language (English) had been assessed before enrollment as being comparable to that of modest or competent English users (as per IELTS criteria).

2.2. Materials and Procedure

Toward the end of the semester, students in each of the 8 sections of the course were asked about their habits for preparing for the final exam. Most students cited reviewing their class notes as their main strategy. None mentioned a study guide. Following this informal inquiry, a co-curricular activity was proposed, which required students to develop personalized study guides to prepare for the final exam. As an instance of summative assessment, the final exam consisted of simplified abstracts of empirical studies, which students had to analyze based on the methodological concepts acquired and practiced during the semester.

The 8 sections of the course were randomly assigned to either an instructor-guided condition or an unguided condition, all involving the development of student-customized study guides for the final exam. In the instructor-guided condition, the instructor gave students a list of key terms

(i.e., concepts to be tested in the final exam). Their task was to generate a definition of each term and an example. In the unguided condition, the students themselves had to identify the key terms to be tested in the final exam. For each key term, a definition and an example were to be produced. Thus, the two conditions differed in one important way. In the unguided condition, students had to determine which relevant concepts would be included in the comprehensive exam at the end of the semester. In the instructor-guided condition, this information was provided by the instructor. The variable instructor was not confounded with conditions. Namely, random assignment was carried out by ensuring that both conditions were assigned to each of the two instructors selected for the study.

During two class meetings, students were allowed to work either individually or as a group. Most students chose to work individually. They were given approximately a week to complete this task. Irrespective of whether students completed the co-curricular activity with others or alone, each student was to submit the completed work individually through Blackboard.

The development of a personalized study guide was one of the many co-curriculum-related activities that students could carry out during the semester to better understand the class materials. Thus, it was not graded but simply marked as done or not done. At the end of the semester, attendance rates were used to compute an engagement score for each student. The number of classes offered was divided by those attended to compute the engagement score, which was then translated into a percentage (scale range: 0-100) for statistical analyses.

Students who agreed to develop a study guide were asked to estimate their final exam preparation after they submitted the study guide. For convenience, they estimated their readiness on a scale from 0 (not at all prepared) to 10 (completely prepared). Their estimates were then translated into percentages to ensure comparison with the grades students obtained in the course.

At the end of the semester, final exam grades, course (i.e., overall) grades (scale range: 0-100), and engagement scores were collected and linked to the condition to which they belonged. Then, all identifying information was deleted. The study was approved by the Deanship of Research of the hosting institution as complying with the guidelines for educational research of the Office for Human Research Protections of the U.S. Department of Health and Human Services.

3. Results

3.1 Did Completing a Study Guide Impact Grades?

Non-parametric, Mann–Whitney *U* tests were conducted on each performance variable to determine whether there were significant differences between students who did not complete the study guide and those who did. The descriptive statistics of the participants are displayed in Table 1. In the table, the asterisk refers to a significant difference between the two groups of students. Final exam grades did not differ between groups [$U = 4965.50$, *ns*], albeit a trend in

the direction of higher grades for those who completed the study guide emerged. However, the students who completed the study guide exhibited higher engagement [$U = 6895.00$, $p < .001$, with mean rank for completed = 131.91 and mean rank for not completed = 57.61]. They also obtained higher course grades [$U = 6665.50$, $p < .001$, with mean rank for completed = 62.01 and mean rank for not completed = 130.90]. H1 was partially supported.

Table 1. Descriptive statistics (mean and standard error of the mean) of key variables for students who completed (n = 191) or did not complete (n = 44) the study guide

Variable	Did Not Complete		Completed	
	Mean	***SEM***	***Mean***	***SEM***
Readiness for Final Exam			62.10	1.35
Final exam Grade	51.75	3.32	59.02	1.47
Engagement Score *	59.00	3.97	85.73	1.10
Course Grade *	63.59	2.72	79.21	0.69

Note: * = Significant differences

3.2 Did Completing a Personalized Study Guide Impact Grades?

Non-parametric, Mann–Whitney *U* tests were conducted on estimates of readiness, final exam grades, and course grades to determine whether there were significant differences between students in the instructor-guided and unguided conditions. The descriptive statistics of the participants are displayed in Table 2. Estimates of readiness, final exam grades, and course grades did not differ between groups [$U \leq 5034.00$, *ns*]. Students in the unguided-study guide condition, however, obtained higher engagement scores [$U = 5599.00$, $p = .006$, with mean rank for guided = 85.06 and mean rank for unguided = 106.82]. H2 was not supported. The results of the comparisons between conditions, however, supported one of the main tenets of self-determination theory (Ryan & Deci, 2017). Namely, the greater satisfaction of students' needs for autonomy and competence, which was offered by the unguided condition, was linked to greater course engagement. How could an activity carried out towards the end of the semester yield greater course engagement? The study guide assignment was given approximately three weeks before the end of the semester. When the number of class meetings that students attended in these three weeks was separated from those of the previous weeks, students in the unguided condition had better attendance than those in the instructor-guided condition. During the previous weeks, no attendance differences were detected.

Table 2. Descriptive statistics (mean and standard error of the mean) of key variables for students who completed (n = 191) the study guide

Variable	Instructor-Guided Cond.		Unguided Cond.	
	Mean	SEM	Mean	SEM
Readiness for Final Exam	61.09	1.64	63.10	2.15
Final exam Grade	59.22	2.22	58.82	1.94
Engagement Score *	81.91	1.77	89.51	1.21
Course Grade	79.50	0.89	78.92	1.04

Note: * = Significant differences

4. Discussion

The results of the present study can be summarized into two points: First, in a course taught through inquiry-based learning instruction, students who completed the study guide exhibited higher course engagement and obtained higher class grades. A reasonable account for these differences is that students' effort devoted to class activities, as measured by course engagement, was the underlying variable. Ultimately, it led to higher performance in the course. The null finding concerning final exam grades might be traced to the fact that the development of a study guide simply served as a reiteration of concepts already understood by students. Reiteration could be carried out through other means (e.g., review of class notes). Thus, developing a study guide could do little to improve performance above and beyond the impact of other means of reiteration. Nevertheless, a non-significant trend in the direction of higher final grades for those who completed the study guide emerged.

Second, among the students who completed the study guide, there were no significant differences in performance between unguided and instructor-guided conditions. There was a significant difference between conditions for course engagement, favoring higher engagement in the unguided inquiry-learning instruction. Attendance records, which were used as coarse indices of course engagement, indicated better attendance in the last three weeks of students assigned to the unguided condition. Thus, the latter could be assumed to have propelled increased class attendance.

In the comments made by students who estimated their readiness for the final exam, the experience of developing a customized study guide was frequently judged as giving students concrete insight into their readiness. Interestingly, in the instructor-guided condition, most comments were about the study guide as a tool to better remember concepts. Instead, in the unguided condition, most comments were about the increased confidence that students experienced in their readiness for the final exam. Readiness, however, was not about memory. It was about students' critical thinking skills in dealing with the likely contents of the final exam.

Of course, the motivating effect of the sense of agency arising from developing independently of the instructor a customized study guide needs to be further examined. Another limitation of the present study is the self-selection that arose from the study-guide activity being presented to students as one of the many co-curricular options. If the development of a study guide were treated as a compulsory and graded activity, self-selection would have been prevented in the sections randomly assigned to unguided and instructor-guided conditions. Larger samples would have also been available for testing.

In the extant literature, the tasks (assignments and tests) that are used to differentiate conditions are usually not optional co-curricular activities. Generally, all activities subjected to instructional manipulation and upon which performance was measured are compulsory. For instance, in a research-oriented course taught through inquiry-learning instruction, Waked et al. (2024) reported that greater instructor involvement (akin to the instructor-guided condition of the present study) yielded better problem-solving and knowledge-acquisition outcomes. Instead, in a business course, Tawfik et al. (2020) found that less instructor involvement yielded higher conceptual knowledge and causal reasoning when measured through a compulsory assignment. Furthermore, in a psychology undergraduate course, Pilotti et al. (2024) found that a student-directed learning approach (akin to the unguided condition) yielded greater assignment performance than a partially student-directed learning approach (akin to the instructor-guided condition). No prior differences in self-efficacy (i.e., confidence in one's abilities) between the two groups were recorded. In studies involving compulsory activities, what seems to matter is the perceived difficulty of the tasks that students are asked to perform. Greater scaffolding may be needed if the task is novel and perceived as being above the current resources that students possess. Developing a study guide towards the end of the semester is unlikely to be judged as a task that can overwhelm the resources students possess. Thus, the compulsory versus optional nature of the activities subjected to different degrees of instructor involvement may not matter much if the task is perceived as doable. Further research needs to be conducted on co-curricular activities that are perceived by students as challenging.

Lastly, in the literature covering learning, a key distinction is made between learning-oriented and grade-oriented students (Eison, et al., 1986; Pilotti et al., 2022; Pollio & Beck, 2000). In the context of an academic course, the former can be defined as learners whose activities are driven by the desire to acquire desirable knowledge and skills. The latter can be described as learners who view course activities as necessary burdens that can impact their course grades as well as their grade point average (GPA). Both attitudes may also coexist in individual students (Pollio & Beck, 2000). Thus, the degree to which students emphasize learning over grades, grades over learning, or neither may be used as a measure of individual differences within a particular course or across courses. In the present study, the activity of completing a study guide was not graded and thus was not a component of students' course grades. Whether a grade or learning orientation differentially motivated students to complete the activity was examined in debriefing

sessions serving as focus groups. Both attitudes appeared to coexist in the students. No group differences were detected between students who completed or did not complete the study guide. Similarly, no group differences were uncovered between students who completed the study guide under unguided or guided conditions. Further assessment of the learning and grade orientation constructs may uncover differences that the debriefing sessions might have been unable to probe.

References

Alfieri, L., Brooks, P. J., Aldrich, N. J., & Tenenbaum, H. R. (2011). Does discovery-based instruction enhance learning? *Journal of Educational Psychology*, *103*, 1-18. https://doi.org/10.1037/a0021017

Camerato, K., Clift, A., Golden, M. N., Gramajo Vivas, J., Rogers, P., & Strelecki, A. (2019). What does "high-impact" mean in extracurricular experiences? *The Journal of Campus Activities Practice and Scholarship, 1*(1), 60-67. https://doi.org/10.52499/2019008

Eison, J. A., Pollio, H. R., & Milton, O. (1986). Educational and personal characteristics of four different types of learning-and grade-oriented students. *Contemporary Educational Psychology*, *11*(1), 54-67. https://doi.org/10.1016/0361-476X(86)90012-3

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings for the National Academy of Sciences of the United States of America*, *111*, 8410-8415. https://doi.org/10.1073/pnas.1319030111

Kuperminc, G. P., Smith, E. P., & Henrich, C. C. (2013). Introduction to the special issue on social and motivational processes in after-school settings: Bridging gaps between theory, research, and practice. *Journal of Early Adolescence, 33*(1), 5-16. https://doi.org/10.1177/0272431612469055

Lazonder, A., & Harmsen, R. (2016). Meta-analysis of inquiry-based learning: Effects of guidance. *Review of Educational Research, 87*(4), 681-718. http://doi.org/10.3102/0034654315627366

Pilotti, M., Abdelsalam, H. M., & Waked, A. (2024). Does inquiry-based learning instruction work for introductory psychology? *Teaching of Psychology*. Advance online publication. https://doi.org/10.1177/00986283241287495

Pilotti, M., Al Kuhayli, H., & Libdeh, N. A. (2022). Grade orientation, decision-making habits, and academic performance. *The International Journal of Learning in Higher Education*, *29*(2), 125-140. https://doi.org/10.18848/2327-7955/CGP/v29i02/125-140

Pollio, H. R., & Beck, H. P. (2000). When the tail wags the dog: Perceptions of learning and grade orientation in, and by, contemporary college students and faculty. *The Journal of Higher Education*, *71*(1), 84-102. https://doi.org/10.1080/00221546.2000.11780817

Olewnik, A., Chang, Y. & Su, M. (2023). Co-curricular engagement among engineering undergrads: do they have the time and motivation? *International Journal of STEM Education, 10*, 27. https://doi.org/10.1186/s40594-023-00410-1

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness.* The Guilford Press. https://doi.org/10.1521/978.14625/28806

Tawfik, A. A., Hung, W., & Giabbanelli, P. J. (2020). Comparing how different inquiry-based approaches impact learning outcomes. *Interdisciplinary Journal of Problem-based Learning*, *14*(1), 1-17. https://doi.org/10.14434/ijpbl.v14i1.28624

Waked, A., Pilotti, M. & Abdelsalam, H.M. (2024). Differences that matter: Inquiry-based learning approach to research writing instruction. *Scientific Reports, 14*, 27941. https://doi.org/10.1038/s41598-024-78962-7

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Moving towards a Comprehensive Instructor Performance Appraisal Model for Intensive English Programs

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Abstract

In higher education institutions, various performance appraisal models (PAM) are proposed worldwide for evaluating academic performance. However, these models often prove unsuitable for implementation in Intensive English Programs (IEP) at universities. Therefore, this study aimed to develop an instructor PAM that aligns with accreditation requirements, focuses on instructor autonomy with the end goal of ensuring, maintaining and enhancing educational quality. The study involved 134 English language instructors from the IEP of a state university in Türkiye. Data were collected through semi-structured interviews, focus groups, and a survey. Based on the findings of the needs analysis, an Instructor PAM was designed and developed. After instructors received training on the implementation process, they fulfilled the model's requirements during a semester. The model was subsequently evaluated through semi-structured interviews, and areas for revision were discovered. The revised model will undergo implementation for an additional term to finalize its structure.

Keywords: *Instructor performance appraisal; higher education; accreditation; professional development; teacher autonomy*

1. Introduction

A variety of performance appraisal models (PAM) are utilized in higher education institutions (HEI) across the world, aiming to encourage academic productivity by evaluating activities including projects, research studies, publications, designs, exhibitions, patents, citations, proceedings, and awards (Aktan & Gencel, 2010; Hussey & Smith, 2010). Many higher education institutions in Türkiye assess the performance of their academics based on their involvement in these types of academic contributions (Turhan & Erol, 2017). However, such approaches or models of performance appraisal are not well-suited to the Intensive English Programs (IEP) of HEIs offering English medium instruction (EMI) (e.g., Eren & Hamurcu,

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2019). This discrepancy arises because IEPs have distinct employment criteria that prioritize teaching experience while typically excluding academic work such as projects, research patterns, publications, or citations. This situation leads to challenges not only in monitoring the performance of foreign language instructors but also in encouraging better performance. Additionally, the lack of such performance-monitoring systems leads the IEP programs to fail to account for quality assurance processes for faculty - an important criterion to be granted or to maintain accreditation (Ataman & Adıgüzel, 2020). Moreover, state universities face a particular challenge because of their contextual and financial conditions (Başbuğ & Ünsal, 2012), making PAMs suited to their affordances a dire need. Even though there have been different PAMs developed in different countries and by different institutions to meet the needs of different groups, it is a tough task to create a common set of procedures to guide instructor appraisal work across different contexts. We believe such a model can become conceivable with professional development (PD) at its core, through careful attention to teacher autonomy to ensure positive outcomes for both instructors and institutions (Dikilitaş & Mumford, 2019; Kennedy, 2014; Yorulmaz & Çolak, 2023).

2. Theoretical Background

PAMs tailored to an institution's culture, objectives, and structure hold significant potential for enhancing educational quality. Accreditation in higher education is recent phenomenon gaining growing recognition internationally (Duarte & Vardasca, 2023; Makhoul, 2019). IEPs seek accreditation to enhance teaching quality and certify the effectiveness of educational processes have emphasized the need for these systems (Ataman & Adıgüzel, 2020) on the way of ensuring and maintaining educational quality while promoting excellence through specific standards (Aktan & Gencel, 2010; Hussey & Smith, 2010). While developing these systems, teacher autonomy, allowing teachers to achieve meaningful growth in their professional learning (Kennedy, 2014), also needs to be considered. Teacher autonomy encompasses making decisions in administrative duties, curricula, teaching methods, and practices. It also promotes social and academic development within classrooms and schools (Gwaltney, 2012); thus, PAMs should support teacher autonomy and pave the way for PD. However, studies addressing this issue in Türkiye have been found scarce (Yorulmaz & Çolak, 2023). Few IEPs in Türkiye have attempted to establish their own PAM and even fewer reported their results. Üstünlüoğlu (2009) examined the implementation and outcomes of a new PAM in a private university's IEP, finding that although instructors initially reacted negatively, they later viewed it positively, even likening it to a remedy. PAMs play a critical role in ensuring PD (Tarhan et al., 2019), therefore, their multifaceted nature needs thorough examination. To address this, Savaş (2021) designed a survey and offered a model to assist development of PAMs for the IEPs in Türkiye. The study proposed a development-oriented PAM to guide the future research and practice with its essential components focusing on teaching, student gains, PD, and institutional duties. Building

on this work, we tried to provide a more comprehensive view of instructors' overall performance, including institutional duties, while highlighting teacher autonomy. We adopted Kennedy's (2005, 2014) model, which categorizes professional development activities based on their support for autonomy. Keeping these two frameworks as guides in mind, we aimed to answer the following research questions:

1. What are the key components of the designed and developed language instructor PAM based on needs analysis and extensive literature research?
2. How did instructors engage with the proposed PAM, and what were their experiences? What revisions did they suggest for further refinement?

3. Method

Research design: A concurrent mixed methods design, incorporating the collection and analysis of both qualitative and quantitative data synchronously was employed in this research.

Context of the study: This study was carried out in the IEP of one of the top-tier state universities in Türkiye. IEPs offer a one-year intensive English language education at EMI universities. To apply for an instructor position in IEPs, individuals must have a bachelor's and a master's degree in the English language-related fields defined by the Council of Higher Education (CoHE). Additionally, state universities may require higher education teaching experience. Besides, candidates must meet minimum score requirements from the exams as defined by the CoHE.

Participants: A total of 134 survey and interview participants who work as English language instructors working in the IEP of a top-tier state university in Türkiye participated in the needs analysis, implementation, and evaluation stages of the study. The participants were selected through clustered sampling.

*Instruments***:** In the needs analysis stage of the study, one focus group was held with five participants and semi-structured interviews were conducted with 14 participants, using two commonly accepted theoretical frameworks, Present Situation Analysis (Robinson, 1991) and Target Situation Analysis (Chambers, 1980). Additionally, 101 participants responded to "In-service Teacher Evaluation Survey" by Savaş, (2021), providing data about their experiences and opinions about performance appraisal practices. In the evaluation stage, 15 post-semi-structured interviews were carried out to evaluate the effectiveness of the PAM following one semester of implementation period.

Procedures: Prior to the research, all participants were provided a consent form and informed about the steps of the research. In the needs analysis stage, the questionnaire (Savaş, 2021), a focus group and individual semi-structured interviews were carried out in the Spring Term of the 2023-2024 Academic Year. To obtain the quantitative data, the questionnaire was sent to all

instructors through an online survey platform and 101 of them responded. Semi-structured interviews took 30-45 minutes, and the focus group lasted for 1.5 hours. Following the analysis of qualitative and quantitative data from needs analysis, a language instructor PAM was designed and developed. Upon developing the model, the piloting stage of the model was initiated. Firstly, the instructors received training that introduced the model and its steps Following the training, instructors chose and implemented activities from different categories and filled in the required forms to indicate activity completion in the Fall Term of 2024-2025 Academic Year. At the end of the term, they uploaded the related documents into their online personal folders, which were later subject to the scrutiny of the researchers for their suitability. To investigate the application process and revise the model, 14 semi-structured interviews were performed. Revisions will be made in line with the outcomes of these interviews and the revised form of the instructor PAM will be introduced to instructors at the beginning of the Spring Term of the 2024-2025 Academic Year. As this is an ongoing project, this paper only presents the results of the needs analysis and the piloting stage of the study. Throughout the Spring Term of the 2024-2025 Academic Year, instructors will continue to carry out the requirements of the model and their performance will be assessed at the end of the term. Later, awards will be determined in line with input from the instructors. The final form of the model will be shaped in line with data collected by the completion of the implementation process. Figure 1 shows the research process.

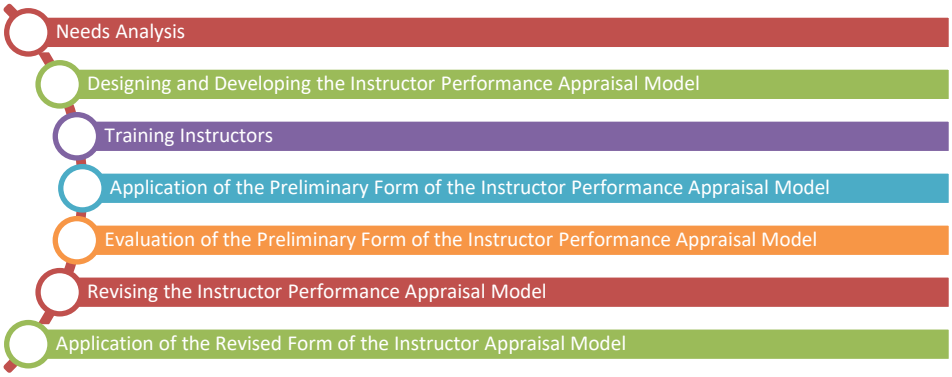


Figure 1. Steps of the research

Data Analysis: For the needs analysis phase, the survey data was processed using SPSS version 26 for descriptive statistics. For the qualitative analysis of the semi-structured interviews and the focus group, thematic analysis was carried out in line with Braun and Clarke (2006). The data were transcribed verbatim, and the documents were examined using MAXQDA to identify recurring codes. To evaluate the preliminary form of the PAM, content analysis was conducted on the data of semi-structured interviews to discover strengths, weaknesses, and suggested improvements on the model.

4. Results

4.1. Design and Development

Needs analysis results revealed that instructors expected a professional development-focused approach to the PAM and believed that the PAM is likely to foster collegial support, boost motivation for PD, and improve both teaching quality and student performance. In this regard, clear guidelines, a compelling rationale, and evidence of its alignment with the principles of teacher autonomy and quality assurance standards should be provided to them during the implementation.

Based on the results of the needs analysis and a detailed investigation of the literature, the purpose statement of the autonomy-based instructor PAM was formulated. In this process, the models of Savaş (2021) and Kennedy (2005) provided guiding lenses as needs analysis results played a more pivotal role to determine the essential features of the initial model. The language instructor PAM consisted of two main categories namely Core Elements and Autonomy-based Continuous Professional Development (CPD) Elements. While the Core Elements solely focused on institutional tasks as described by the institution, autonomy-based CPD elements included CPD tasks under three categories based on their capacity to promote teacher autonomy. These categories are Category 1- Transmissive Activities, Category 2- Transitional Activities, and Category 3- Transformative Activities. Additionally, student evaluations of teaching staff, which are conducted in the context regularly as part of accreditation processes, are added as an additional component. This final component is a supportive element and will only be used if there is a situation requiring a tie-breaker.

The CPD component of the model is designed to have an important impact on determining the higher performers. This component has three categories that bring in increasingly more credentials for their implementers:

Category 1- Transmissive activities position teachers as passive recipients, primarily focusing on equipping them with the necessary skills for various implementations or practices. These activities often involve unsystematic reflections and place minimal emphasis on utilizing their capacity for autonomy. Participation in training sessions offered by external bodies such as attending online or face-to-face workshops and webinars, participation in conferences as a listener, and participation in in-house CPD events are activities listed under this category.

Category 2- Transitional activities, situated between transmission and transformation, are primarily collaborative in nature. Compared to transmissive and transformative approaches, these activities involve a moderate level of professional autonomy. While they do not lead to immediate changes in teaching and learning practices within the classroom, they promote reflective practice. The activities encompass peer observation, teacher exchange, peer coaching, mentoring new instructors, co-teaching, reading groups, community of practice, video recorded lessons, and reflective teaching journals.

Category 3- Transformative activities, representing the highest level of PD, aim to cultivate the highest capacity for professional autonomy. These activities are inquiry-oriented, requiring a critical approach to practice, sustained effort, and meaningful changes in teaching practices. Teachers must adopt a proactive and deliberate approach to CPD, as this category emphasizes a teacher-centered focus. Action research, pedagogical experimentation, workshop delivery, lesson study, presenting a research study at a conference, peer observation, and community of practice are examples of the listed activities.

To guide instructors in the implementation process of the model, detailed explanations, criteria, guidelines, and documents were prepared for each activity under each category. Instructors were distributed these documents, along with how to follow the implementation steps. Additionally, a frequently asked questions document was shared with instructors.

4.2. Implementation and Evaluation

For the implementation stage, out of 134 actively employed instructors during the Fall Term of the 2024–2025 Academic Year, 95 participated in at least one activity across three categories. Nine instructors selecte Turkey d activities exclusively from Category 1, while six chose activities solely from Category 3. The majority, 92 instructors, completed activities within Category 2. Additionally, nine instructors engaged in two different activities across two categories, whereas two instructors completed two distinct activities within the same category. In Category 1, eight instructors participated in training sessions conducted by external organizations. Within Category 2, 60 instructors opted for peer observation, 17 engaged in peer collaboration, and eight maintained reflective teaching journals. Only seven instructors participated in teacher exchange programs. In Category 3, two instructors mentored newly hired colleagues, and another two engaged in pedagogical experimentation. Presenting research at a conference and conducting an extended version of peer observation were also reported by one instructor each.

Following the completion of the first semester of implementation process, 14 semi-structured interviews were conducted to evaluate the effectiveness of the developed model and identify areas for further improvement. The results indicated three main themes, namely i) core achievements, ii) areas for improvement, and iii) suggestions for further development. Regarding the core achievements, instructors noted the model was strong in terms of: a) promotion of instructor autonomy, b) enhancing motivation and engagement, c) supportive documentation processes, d) diverse structured CPD activities, and e) well-structured system. As for instructor autonomy, the participants pointed out that the model provided “freedom of choice” in terms of their professional learning, which enabled them to decide on the activity for their own professional growth while reporting that this opportunity increased their motivation for involving in professional development. The documentation and categorization of the activities were also highlighted as for their clear guidance to the participants. Finally, the

participants found the current version of the model "well-structured" in terms of its detailed components and guidance for CPD.

Pertaining to areas for improvement, instructors emphasized several points, which were a) challenges in integrating CPD activities, b) negative perceptions of inquiry-based activities, and c) insufficiency of communication in the appraisal process. The instructors stated they had difficulty in fitting the CPD activities in their busy teaching and other duties. They believed the inquiry-based activities were suitable only for those who have experience in research. They also referred to inadequate clarity and communication between the instructors and the implementers about the process of the new appraisal system as another shortcoming that needed recognition.

For suggestions for further development, a) enhanced ongoing guidance, b) greater focus on students and teaching, and c) shift from semesterly to yearly requirements were identified as subthemes. These findings demonstrated that the steps in the appraisal system needed more clarification in the process of implementation. Additionally, they suggested further inclusion of student- and teaching-focused components which would provide better opportunities for non-academically motivated staff. A final suggestion was to provide more time for the instructors to work on their CPD activities rather than setting deadlines per semester.

5. Conclusion

This study designed and developed a language instructor PAM for use in IEPs, integrating accreditation requirements with teacher autonomy. The model was piloted over the course of one term, during which its strengths, weaknesses, and areas for revision were thoroughly assessed. The results of this study revealed insight into the nature of improvements. Accordingly, providing more guidance, delivering trainings on implementation of third category CPD activities, and opening further communication channels between model implementers and practitioners come to the fore as key revisions. The piloting process will continue over the Spring Term of the same academic year before the model is finalized. The final version is expected to make a significant contribution to the literature and provide valuable insights for IEPs. Should the model be completed as planned, it has the potential to create an added value for the IEPs as it addresses the needs of all stakeholders, takes the contextual affordances into account, keeps teacher autonomy at its core, and responds to the requirements of accreditation bodies. In addition, the model will set an example for IEPs in other international universities where accreditation of English language education is becoming more and more widespread.

References

Aktan, C. C., & Gencel, U. (2010). Yükseköğretimde akreditasyon. *Değişim Çağında Yükseköğretim, 2*(2), 137-146.

Ataman, O. & Adıgüzel, A. (2020). Akreditasyon Sürecini Tamamlayan Yabancı Diller Yüksekokulu Öğretim Elemanlarının Sürece İlişkin Görüşlerinin Belirlenmesi. *Journal of Higher Education, 10*(3), 279–290. https://doi.org/10.2399/yod.19.515834.

Başbuğ, G., & Ünsal, P. (2012). Kurulacak bir performans değerlendirme sistemi hakkında akademik personelin görüşleri. *Studies in Psychology, 29*, 1-24.

Chambers, F. (1980). A re-evaluation of Needs Analysis, *ESP Journal, 1*(1), 25–33.

Dikilitaş, K., & Mumford, S. E. (2019). Teacher autonomy development through reading teacher research: agency, motivation and identity. *Innovation in Language Learning and Teaching, 13*(3), 253-266.

Duarte, N., & Vardasca, R. (2023). Literature review of accreditation systems in higher education. *Education Sciences, 13*(6), 582.

Eren, T. & Hamurcu, M. (2019). Akademik teşvik tabanlı yeni bir performans değerlendirme önerisi ve uygulama. *Üniversite Araştırmaları Dergisi, 2*(2), 82-100. https://doi.org/10.32329/uad.596163.

Gwaltney, K. D. (2012). *Teacher autonomy in the United States: Establishing a standard definition, validation of a nationally representative construct and an investigation of policy affected teacher groups* (Unpublished doctoral dissertation). University of Missouri, Columbia.

Hussey, T., & Smith, P. (2010). Transitions in Higher Education. *Innovations in Education and Teaching International, 47*, 155-164. http://dx.doi.org/10.1080/14703291003718893

Kennedy, A. (2005). Models of continuing professional development: A framework for analysis. *Journal of In-service Education, 31*(2), 235-250.

Kennedy, A. (2014). Understanding continuing professional development: The need for theory to impact on policy and practice. *Professional Development in Education, 40*(5), 688-697.

Makhoul, S. A. (2019). Higher education accreditation, quality assurance and their impact to teaching and learning enhancement. *Journal of Economic and Administrative Sciences, 35*(4), 235-250.

Robinson, P. (1991). *ESP today: A practitioner's guide*. Prentice Hall.

Savaş, H. (2021). *In-service teacher evaluation and assessment at English preparatory programs of the universities in Turkey: An exploratory mixed methods study* (Unpublished doctoral dissertation). Bahçeşehir University, Turkey.

Tarhan, H., Karaman, A. C., Kemppinen, L., & Aerila, J. A. (2019). Understanding teacher evaluation in Finland: A professional development framework. *Australian Journal of Teacher Education, 44*(4), 33-50.

Turhan, M., & Erol, Y. C. (2017). Araştırma Görevlilerinin Eylem Kimlikleme Biçimleri. *Turkish Journal of Educational Studies, 4*(3), 105-121.

Üstünlüoğlu, E. (2009). Is appraisal system a threat for teachers*? Procedia-Social and Behavioral Sciences, 1*(1), 118-123.

Yorulmaz, Y. İ. & Çolak, İ. (2023). Exploring teacher autonomy through teachers' perspectives: A qualitative case study. *Research on Education and Psychology, 7*(2), 537-556. https://doi.org/10.54535/rep.1360698

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Incorporating AI-Administered Personalized Feedback in an Inquiry-Based Learning EFL Writing Class

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Abstract

In an academic writing class using inquiry-based learning, ChatGPT-3.5 was used to provide personalized feedback to 95 female undergraduate native speakers of Arabic. Throughout the semester, students completed four essays by engaging in two weeks of student-led, in-class essay writing workshops, followed by entering their work into ChatGPT-3.5 with the prompt "correct my grammar." Students were to complete reflections on the types of errors found and how to use this information to improve future writing. Students either submitted the required reflection or incorrectly provided an AI-generated response. Completing reflections were significantly related to higher essay-writing grades in the handwritten final exam. This relationship was also found with grammar sub-scores within the total essay grade. No relationships were found with class attendance alone. Results suggest that AI-generated feedback can assist EFL learners in improving their writing in an inquiry-based learning course, but only if they choose to engage in related critical-thinking exercises.

Keywords: *EFL; Grammar Instruction; AI Teaching Tools; Writing Instruction; Inquiry-Based Learning, SRL, Personalized Feedback*

1. Introduction

Since Microsoft's 2022 release of Chat Generative Pre-Trained Transformer (ChatGPT), the experience of writing courses has evolved for students and teachers alike. Generative AI programs use Large Language Model (LLM) Functionality and are trained on vast amounts of both human and AI-generated writing to accomplish a wide variety of tasks. Among these tasks are translation, text summarization, and generation of conversation and written output intended to imitate human-like responses to prompts (Microsoft, 2025). Said output is known to be generally accurate, informative, and both lexically and semantically coherent in a wide variety of genres (Lo, 2023; Waked et al., 2024a). For instructors of writing courses, the aim of which is to improve students' composition abilities, this particular feature of LLM Functionality can

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serve as a tool to develop novel educational activities that may increase students' course engagement.

Writing is a complex task requiring active learning that is both cognitively and linguistically demanding. Even in one's native language, writing entails engagement in a cycle of drafting, reflection, and rewriting after learning from one's errors. For English as a Foreign Language (EFL) learners, difficulties in navigating the writing process are further exacerbated when learning to write in the structured format of a university-level essay. Depending upon their level of English-language proficiency, EFL writers are challenged at every level of essay composition. Many EFL writers struggle to effectively outline the main ideas of their essays, leading to poor overall compositional structure. Limitations in vocabulary may also hinder the ability of EFL writers to construct sentences and paragraphs that effectively convey their ideas. Many students report feeling overwhelmed by the magnitude of the essay-writing task (Bisriyah, 2022). Indeed, Cheng (2024) showed that writing anxiety may manifest in avoidant behavior, wherein EFL learners procrastinate or attempt to avoid English-language writing tasks altogether. While writing, EFL learners face difficulties organizing the arguments they wish to express, including the construction of a strong thesis statement to guide their composition (Ananda et al., 2024). Writing as an EFL learner may also require overcoming negative language interference, in which lexical or syntactic rules from one's first language are incorrectly implemented in English-language writing (Waked et al, 2024b).

The process of learning to both write and refine a composition often takes place in a classroom environment in which instructors strive to provide real-time feedback. Instructor feedback is intended to assist students in the reflection portion of the active-learning writing cycle. While feedback is often managed by course instructors, peer review is also often implemented. Students report feelings of empowerment in the collaborative learning experience of both giving and receiving peer feedback (Miao et al., 2026). With minimal guidance and regular encouragement, ELF students may be able to engage in self-regulated learning (SRL). SRL theory proposes that lifelong learning comes from allowing learners to move at their own pace, reflect upon their own writing, and use this reflection to actively engage in revising their work. SRL requires students to approach academic tasks through the lens of critical thinking (Uyen, 2022). Educational activities using text-generative LLM Functionalities rely on this theory to provide timely, personal, and actionable insights into specific areas of improvement for EFL writers (Afzaal et al., 2024).

In EFL courses, students often complete short compositional responses to instructor prompts. As studies in the extant literature primarily focus on beginning to introductory level EFL education, activities incorporating LLM Functionalities often concern instruction of rudimentary aspects of the English language, such as the correct use of a singular grammatical tense. Such exercises have been described as empowering as students are allowed to engage in SRL by noting their own errors in the personalized feedback provided. Yet, given the level of

their English-language proficiency, the SRL allowed by AI-generative exercises is limited as interaction with feedback often requires instructor assistance (e.g., Baskara, 2023; Yener & Selcuk, 2024). Studies are also often limited by the number of participants, as small class sizes are often necessary to provide the focused instructor-led training that is beneficial to EFL learners at the beginning of their English-language educational journey (e.g., Harfitt, 2012).

The current study differs from those in the extant literature in two key aspects. Unlike the majority of studies assessing beginning to introductory level English-language learners, participants in this study consisted of undergraduate university students whose English-language proficiency was moderate to competent as judged by the International English Language Testing System (IELTS) prior to admission to an English-medium university. This study is additionally unique in that participants were enrolled in a course using inquiry-based learning as the method of instruction. In this educational structure, students are provided with the essential tools and information necessary to understand generalized academic concepts, but are required to engage in critical thinking and problem-solving to complete assignments with minimal guidance from the instructor. In this manner, the instructor acts primarily as a facilitator and moderator of educational activities (Pilotti et al., 2024).

In the current study, a convenience sample of 95 female EFL university students of Saudi Arabian descent completed academic essays in four genres as part of an introductory written communications class. All students were native speakers of Arabic. Following one class session of an instructor-led overview of an essay genre, two weeks of student-led writing workshops took place. At the end of this two-week period, students entered their completed work into ChatGPT-3.5 with the prompt "Correct my grammar. Highlight all changes." They were instructed to complete a reflection assignment in which they wrote one paragraph describing both the *types* of errors found (e.g., errors in capitalization, tense, or sentence structure) and how the personalized feedback regarding the types of errors identified would be used to improve future writing. Students either correctly submitted the required self-reflection or chose to incorrectly submit AI-generated output related to the reason behind the chatbot's changes. The relationship between engagement in this activity and grades in the handwritten essay portion of the course's final exam was investigated. The relationship between course attendance and grades on the essay portion of the handwritten final exam was additionally examined. These variables were further studied in relation to the grammar sub-section of the total handwritten essay grade. In this context, the following research questions were asked:

1) What is the relationship between writing a reflection on ChatGPT-generated personalized feedback of grammatical errors and the learning outcomes of both students' essay writing and English-language grammar use in an inquiry-based learning EFL writing class (as assessed by the handwritten essay portion of the course's final exam)?

2) What is the relationship between class attendance and the learning outcomes of both students' essay writing and English-language grammar use in an inquiry-based learning EFL writing class (as assessed by the handwritten essay portion of the course's final exam)?

The following hypotheses were proposed:

1) Engaging in the critical thinking required to analyze and explore the types of errors revealed through ChatGPT's personalized feedback and to write a well-structured reflection paragraph on how feedback would be used to improve future writing will be related to improved learning outcomes of both essay writing and English-language grammar use. Namely, students who correctly completed the activity would attain higher grades on both the handwritten essay portion of the final exam as well as the grammar sub-section of this essay.
2) Attendance alone does not necessarily imply engagement in critical thinking or SRL. As such, attendance will not be related to improved learning outcomes in either essay writing or grammar use. Namely, attendance will not be related to grades on either the handwritten essay portion of the final exam or the grammar sub-section of this essay.

At the core of inquiry-based learning is the establishment of critical thinking skills. Said skills have been found to be related to lifelong learning in a number of fields (e.g., Darland & Carmichael, 2012; Peters et al., 2015). In order to identify patterns in the grammatical errors as provided by ChatGPT's output, students must engage in the critical thinking SRL process of categorizing changes made by the program, determining how the information they have learned from this personalized feedback can be used, and crafting this reflection into a well-structured paragraph. As such, it is unlikely that simply attending classes without fully engaging in reflective, critical thinking exercises will lead to successful learning outcomes in an inquiry-based learning EFL writing course.

2. Methods

2.1 Participants

Participants in this study included a convenience sample of 95 Saudi Arabian female students enrolled in an introductory written communications course at an English-medium university in Saudi Arabia. Participants were native speakers of Arabic who were judged to be moderate to competent English-language users by the IELTS examination, which was administered prior to admission. Students were primarily freshmen and ranged in age from 18-22 years. As this course is the first in a required communications series, students had no prior experience with writing feedback at the university level.

2.2 Materials and Procedure

EFL students completed four essay assignments during a 16-week written communications course taught using inquiry-based learning. Although these assignments were written and submitted digitally, students were informed that the final examination for the course would be handwritten and that 60% of their final exam grade would be dependent upon writing a truncated essay (i.e., the introduction paragraph, one body paragraph, and the conclusion paragraph). As such, students were made aware that to pass the final exam, they were required to learn how to write a well-structured, grammatically correct, English-language essay independent of technological aids.

During the first month, students learned to write in the standard five-paragraph essay format (i.e., the introduction paragraph, three body paragraphs, and the conclusion paragraph). Students worked together in instructor-assigned groups to create documents defining key components of each type of paragraph, such as the thesis statement, topic sentences, supporting sentences, and concluding sentences. Students also worked in groups to define essential essay-writing concepts, such as lexical cohesion. The instructor interacted with each group throughout class sessions to ensure that students remained focused on assigned tasks. For the remainder of the semester, students completed four essay assignments using the five-paragraph essay format. Each essay was completed over a two-week period.

During the first class of each essay-writing cycle, the instructor used the first 30 minutes to introduce students to the novel genre. Students were encouraged to use this portion of the class to ask the instructor questions and to take notes. The remainder of this class was used by students to independently select the topic of their essays and begin the writing process. The remainder of the two-week period consisted of in-class, student-led writing workshops. Students worked in their assigned groups to assist one another. As the topic of each student's essay had been selected individually, groupmates could only provide feedback on queries pertaining to translation, grammar, and essay structure. As in the first portion of the course, the instructor interacted with groups in each class session to ensure that students remained engaged in the writing process. She did not directly answer students' questions, but instead responded with questions of her own relating to students' independent knowledge of the topic of their queries.

Students were explicitly directed to not use any form of AI during the writing-workshop period. These included paraphrasing programs and translation applications as well as generative AI programs. They were made aware that at the end of each writing workshop period, they would complete an exercise analyzing ChatGPT's correction of the grammatical errors in their compositions. They were also made aware that these activities would count towards their participation points, which collectively counted towards 10% of their final course grade. During the writing process, rather than relying upon technological aids, students were encouraged to use what they had learned through their problem-solving teamwork regarding general essay

structure and to rely upon one another within their assigned groups to both provide and receive the feedback necessary to restructure and refine written compositions.

During the final class of the two-week writing period, students completed an in-class exercise using the program ChatGPT-3.5. They were instructed to:

1) Enter the query, "Correct my grammar. Highlight all changes."
2) Paste a copy of their essay into the program
3) Analyze the changes and categorize general patterns (e.g., regular mistakes in capitalization, subject-verb agreement, word order, or tense)
4) Write a well-structured paragraph explaining the types of grammatical errors in their essays and how they intended to use this personalized feedback to improve their future writing

Students submitted their original essay, ChatGPT output, and their reflection as three separate documents to the online learning platform, BlackBoard. They were made aware that only the reflection portion of the assignment would be graded. They were also made aware that if a 100% match between the AI-generated document and their final assignment submission was found, they would be given a score of 0%. Thus, students were made to understand that they were to only implement grammatical changes to their original work rather than submit the AI-generated "correction" of their essay.

3. Results

Although students were aware that they would only receive participation credit based on their submitted reflection, only 35% of students (n = 33) submitted at least half of the four assignments using clearly human-generated reflections. The remaining 65% of students (n = 62) submitted only the AI-generated output without the required reflection paragraph.

Prior to conducting analyses, percentage scores were converted to rationalized arcsine units (RAU) to control for the assumption of normativity. Table 1 displays the means and standard deviations of the four variables of this study: Engagement with the ChatGPT reflection activity, class attendance, students' grades on the handwritten essay portion of their final exam, and the grammar sub-section on the handwritten essay in their final exam.

To determine the value of this exercise, a paired-sample t-test was conducted to examine whether class attendance differed from engagement with the ChatGPT reflection activity [$t(94) = 50.76$, $p \leq 0.000$]. As these two variables differed, correlational analyses were conducted to determine the relationship between exam outcomes and either course attendance or engagement with the ChatGPT personalized feedback activity. In Table 2, significant correlations are marked in bold with an asterisk.

Table 1. Means and Standard Deviations of Course and Learning Outcome Measures

	n	***Mean***	***SD***
Engagement	95	1.23	1.23
Attendance	95	89.12	17.31
Final Exam Essay Grade	95	72.08	23.62
Grammar Grade	95	79.75	31.17

**SD* = standard deviation

Table 2. Correlational Analyses Comparing Exam Outcomes with Assignment Engagement and Class Attendance

	Engagement	**Attendance**
Essay Grade	**0.46***	0.13
Grammar Grade	**0.28***	0.16

Engagement with the ChatGPT personalized feedback activity was found to be significantly correlated with improved scores on both the overall handwritten essay and the grammar sub-section of this essay in the course's final exam. No relationship between either assessment and class attendance was found. These findings provide evidence that in an inquiry-based learning EFL writing class, SRL engagement with the AI-generated personalized feedback was more likely to lead to successful course learning outcomes than simply attending class.

4. Discussion

The findings of this study indicate that for moderate to competent EFL learners enrolled in an inquiry-based learning written communication course, improved essay writing (including improved grammar) is unlikely to occur by simply attending classes. To benefit from personalized feedback through exercises involving AI-generated grammar corrections in an essay, active engagement with such activities is necessary. By writing a well-structured, reflective paragraph addressing the patterns of errors exhibited by a given text and explaining how to implement changes in future writing, students engaged in critical thinking as well as practiced articulating their ideas in a structured written format, an area of essay writing which many EFL students find challenging (Anada et al., 2024). As such, both H1 and H2 were supported.

Although students were told that each activity counted towards the 10% participation grade in the class, more than half of students elected to not actively participate in the SRL reflection activity. Inquiry-based learning requires students to be actively involved in the critical thinking process of discovering the information required to solve problems (Pilotti et al., 2024). Consequently, academic goal orientation (dispositions towards engagement with opportunities for furthering one's knowledge) may need to be considered for future implementation of SRL

activities with AI-generated feedback. Students with a learning orientation may possess sufficient intrinsic motivation to critically analyze feedback to increase their baseline knowledge. However, students with a grade orientation towards learning may not be motivated to engage in SRL activities at a level beyond what they perceive to be the bare minimum required to earn credit (Pilotti et al., 2003).

For grade-oriented students, the low percentage of each activity contributing to the total grade may not have provided sufficient motivation to correctly complete the SRL activity. To increase engagement, it may be prudent for instructors using similar SRL activities with AI-generated feedback to immediately post a grade of 0% for incorrect submissions. It may also be beneficial to regularly reiterate the importance of accumulating participation points throughout the semester for the sake of their final course grade. Allowing students to engage with AI-generated feedback may also lead grade-oriented students to submit the "corrected" ChatGPT-generated essay rather than their own work. In this study, students were warned that a 100% plagiarism match between the submitted assignment and the AI-generated essay submitted as part of the SRL engagement activity would result in a grade of 0%. For the first assignment only, students were allowed to resubmit a handwritten essay completed under instructor supervision. Following the shock of seeing a grade of 0% on the first essay assignment, very few students elected to again submit AI-generated essays.

This study contains limitations that can be explored in future research. First, 95 students participated. Greater generalizability could be found by increasing the number of participants. Second, the study examined only female students who were native speakers of Arabic. As such, results cannot be generalized to male EFL students of comparable English-language competency and similar linguistic backgrounds. Third, the present study did not examine learning orientation and did not account for students' attitudes and beliefs toward writing and feedback. Investigating said attitudes and beliefs before and after completing the four SRL activities with AI-generated personalized feedback may offer a broader insight into the potential benefits of such exercises. This research can lead to a better understanding of the benefits and costs of implementing SRL AI-based exercises in inquiry-based learning EFL written composition courses. As knowledge is a work in progress, it is believed that further studies will deepen the effectiveness of using activities involving generative AI in EFL instruction.

References

Afzaal, M., Zia, A., Nouri, J., & Fors, U. (2024). Informative feedback and explainable AI-based recommendations to support students' self-regulation. *Technology, Knowledge and Learning*, *29*(1), 331-354. https://doi.org/10.1007/s10758-023-09650-0

Ananda, C. R., Mardiah, R., & Fajaryani, N. (2024). Writing argumentative essays: Jambi EFL students' challenges and strategies. *Indonesian Journal of English Language Teaching and Applied Linguistics*, *9*(2), 339-357. https://doi.org/10.21093/ijeltal.v9i2.1722

Baskara, F. R. (2023). Integrating ChatGPT into EFL writing instruction: Benefits and challenges. *International Journal of Education and Learning*, *5*(1), 44-55. https://doi.org/10.31763/ijele.v5i1.858

Bisriyah, M. (2022). EFL university students' difficulties in the essay writing process. *Scope: Journal of English Language Teaching*, *7*(1), 66-71.

Cheng, Y. S. (2004). A measure of second language writing anxiety: Scale development and preliminary validation. *Journal of Second Language Writing*, *13*(4), 313-335.

Darland, D. C., & Carmichael, J. S. (2012). Long-term retention of knowledge and critical thinking skills in developmental biology. *Journal of Microbiology & Biology Education*, *13*(2), 125-132. https://doi.org/10.1128/jmbe.v13i2.331

Harfitt, G. J. (2012). Class size and language learning in Hong Kong: The students' perspective. *Educational Research*, *54*(3), 331-342. https://doi.org/10.1080/00131881.2012.710091

Lo, C. K. (2023). What is the impact of ChatGPT on education? A rapid review of the literature. *Education Sciences*, *13*(4), 410. https://doi.org/10.3390/educsci13040410

Miao, Y., Badger, R., & Zhen, Y. (2006, 12). A comparative study of peer and teacher feedback in a Chinese EFL writing class. *Journal of Second Language Writing, 15*(3), 179-200. https://doi.org/10.1016/j.jslw.2006.09.004

Microsoft. (2025). *Know it all: ChatGPT and its capabilities.* Soco. https://soco.com.au/know-it-all-chatgpt-and-its-key-capabilities-that-will-surprise-your-team/

Peters, R. A. (2015). Anchored learning and the development of creative, critical thinking, and life-long learning skills. *Teaching Public Administration*, *33*(3), 221-240. https://doi.org/10.1177/0144739415581077

Pilotti, M., Abdelsalam, H. M., & Waked, A. (2024). Does inquiry-based learning instruction work for introductory psychology? *Teaching of Psychology*. Advance online publication. https://doi.org/10.1177/00986283241287495

Pilotti, M. A., Waked, A., El Alaoui, K., Kort, S., & Elmoussa, O. J. (2023). The emotional state of second-language learners in a research writing course: Do academic orientation and major matter? *Behavioral Sciences*, *13*(11), 919. https://doi.org/10.3390/bs13110919

Vu Le, U., My, T. N., Hong, L. T. K., & Linh, D. H. (2024). Applying writing feedback orientation and self-regulated learning writing strategies to EFL students at Van Lang University during COVID-19. *International Journal of TESOL & Education*, *2*(5), 64-88. https://doi.org/10.54855/ijte.22255

Waked, A., Abdelsalam, H., Ashraf, M., Pilotti, M., & El Alaoui, K. (2024a). The impact of falsely detecting AI-generated text on academic assessment. In M. Shelley & O. T. Ozturk (Eds.), *Proceedings of ICRES 2024-- International Conference on Research in Education and Science* (pp. 573-586), Antalya, Turkiye. ISTES Organization.

Waked, A. N., El-Moussa, O., Pilotti, M. A., Al-Mulhem, H., El Alaoui, K., & Ahmed, R. (2024b). Cultural considerations for the second language writing anxiety inventory: Saudi Arabian female university students. *Frontiers in Education*, *9*, 1288611.

Yener, B., & Selcuk, H. (2024). AI-assisted grammar learning: Improving present perfect tense proficiency in EFL students. *The Literacy Trek*, 10(3), 339-361. https://doi.org/10.47216/literacytrek.1556837

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Flipped peer observation using COPUS for young faculty development

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Abstract

The present paper aims at contributing to improve young STEM faculty members' training, by focusing on exploring the potential of peer observation in fostering reflection on teaching practices. To this end, two young faculty members were involved as observers of the lessons of a more experienced teacher, using a specific observation protocol, that is COPUS model. The collected data from comments provided during observations, the observers' feedback on their experience in the observer's role and final interviews which focused on the role of peer observation in faculty development are holistically analyzed. The obtained results show that peer observations using COPUS, combined with well-structured feedback sessions and interviews, encourage young faculty members to deeply reflect on their past and future teaching practices and, hopefully, enhance their teaching practice.

Keywords: *Peer observations; COPUS protocol; Higher STEM education; Early-career faculty training*

1. Introduction

Faculty training plays a crucial role in creating opportunities to develop teaching skills (Gunersel & Etienne, 2014). However, as noted by Wimberg et al. (2018), research on professional development in teaching STEM courses at the university remains limited. One potential approach to faculty training is through peer observation, given its potential for fostering reflective processes. Gosling (2002) outlines three models for peer observation, the evaluative model, the developmental model, and the peer-review model, which all involve faculty members being observed while teaching by a colleague. In the first two models, the role of the observer is covered by an expert, focusing, respectively, on the identification of areas of underperformance and on fostering personal growth. The peer-review model takes a more collaborative approach meant to initiate open discussions about teaching practices. For instance,

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using the protocol of peer review developed by Dillon et al. (2019), all faculty members involved in the study emphasized the value of observation for reflecting on their own teaching. Also, Sundset and Sandvoll (2022) adopt the peer-review model in their qualitative case study aimed in a multidisciplinary faculty with STEM and business education, highlighting how peer observation enhanced the educational discourse between participants.

Considering the social learning theory (Bandura and Walters, 1977), our primary goal is to explore the potential of peer observation for young faculty members' development, through reflection on teaching practices. To this end, we adopt a slightly different approach with respect to the models discussed previously, introducing what we call a "flipped" peer observation model. Rather than an expert observing a less experienced colleague, this model involves early-career STEM faculty members (young faculty) observing the teaching practices of more experienced colleagues, using an observation protocol. In the present paper we adopt the wide definition of teachers' practice proposed by Da Ponte and Chapman (2006) as the professional tasks that teachers undertake in their instructional roles. We also include the choice of lesson format, the use and types of questioning employed by the teacher (Dougherty, 1990), the management of class discussions and the recognition of patterns of interactions (Wood, 1996).

According to a field study, among the observation protocols designed for large STEM classes, the Classroom Observation Protocol for Undergraduate STEM (COPUS), proposed by Smith et al. (2013), stands out for its widespread use, as highlighted by Anwar and Meneske (2020). In fact, thanks to the simplicity of its coding system, COPUS allows it to be reliably used by faculty members after only 1.5 hours of training, making it accessible even to those without expertise in educational research. COPUS captures classroom behaviors in two-minute intervals throughout a session and avoids requiring observers to make judgments about the quality of teaching. With its 25 distinct codes divided into two categories "What the students are doing" (13 codes) and "What the instructor is doing" (12 codes), COPUS offers a straightforward and practical approach to documenting classroom interactions. For students, examples of COPUS codes include "listening to the instructor" (**L**) and "discussing clicker questions" (**CG**). While instructor codes include "moving/guiding" (**MG**, identifying the instructor moving among students providing suggestions during the group work) and "conducting a demo" (**D/V,** identifying the instructor showing applets, videos, etc.). Despite not being a required step in the protocol, COPUS also allows observers to add comments during observations. Comments may relate directly to COPUS codes, providing explanations and additional contextual details, or may capture broader observations about classroom dynamics and teacher practices.

The present work aims at answering the following research question: how the flipped peer observation model, implemented with the COPUS protocol, can support the reflection of early-career STEM faculty members on teaching practices? The paper outlines the data collection and analysis in Section 2, presents results in Section 3, and discusses findings in Section 4.

2. Methodology

The collected data come from activities that involve all the authors with different roles: two of them (named as Observers A and B) are the participants of the study, while the other two (named as Researchers A and B) employed the analysis of the narratives produced by the participants. This distinction between the participants and the researchers implies that the present work is not a self-study (Bullough & Pinnegar, 2001). However, the participants contribute actively to the conceptualization of the problem and to the discussion of the results.

Observer A, who started her PhD on November 2024, has a very short teaching experience in higher education, namely she was in charge of a small class of the preparatory courses on Maths, edition 2024, aimed for undergraduates in Politecnico di Milano (PoliMi, https://www.polimi.it). While, Observer B has eight-year experience of teaching on different mathematical subjects, firstly still as a PhD student, then as a teaching assistant, in charge of large classes of students enrolled in preparatory courses on Maths, for the last five years.

For the present study, Observers A and B applied the COPUS protocol four times, during the fall semester 2024/25, attending Researcher A's course on Elementary Mathematics aimed for a group of Architecture undergraduates in PoliMi, with an average attendance of 100 students. The syllabus of the course covers the basics of Linear Algebra and Calculus with one variable. In general, each lesson lasts for three hours with a break of 15 minutes, after 90 minutes. During the peer observations, Observers A and B, previously trained to apply the COPUS protocol, were seated behind the class so that the data collection process was not too disruptive. In periods of observation that lasted up to 72 minutes, the two observers marked the COPUS codes corresponding to the activities occurring at that moment. They also included many comments on their COPUS coding forms. These peer observations took place at the beginning of the semester, and then at mid-November and mid-December. After the first two observations and at the end of the semester, the observers were invited to give structured feedback on their experience in that role. For that purpose, Researchers A and B prepared a set of open questions to investigate specific difficulties in applying the COPUS protocol, the perceived main differences in observing the first and the second time, the perceived differences of students'/instructor's behaviors, and the perceived difficulties of observing group work. Then, the researchers prepared the semi-structured interviews, that were held individually in mid January, and conducted by Researcher B who also later transcribed them. The interviews focused on the reasons for participating in the observations, previous teaching experiences, self-reflection on previous teaching practices with the current lens of COPUS observations, and on the role that peer observations could play in faculty development. Finally, observers were also asked to reply to a final question (FQ) about what they would change/adopt in their previous/future teaching practices.

We are going to base our findings on Observers A and B comments written in the COPUS coding forms (**data 1**), the observers' written sentences in the structured feedback after observations (**data 2**), and the observers' replies to the semi-structured interviews (**data 3**). The analysis of these data was then carried on by Researchers A and B, and went through the following steps:

1. Numbering all the statements: every comment in the COPUS forms, each written sentence of the structured feedback, and every reply in the transcript of the semi-structured interviews; then close reading all the statements, individually;
2. Discussing and defining in a holistic way the themes that emerged from the reading;
3. Reaching an agreement on the categories for classifying the data;
4. Individually, classifying the statements for each observer according to the identified categories; then discussing the previous classification, reaching an agreement, and organizing it in 2D tables for analysis.

The step 3 outcome is the identification of two types of categories: the lens used during the observation, that is COPUS or GENERAL, and the eyes with which one may observe, that is WITNESS or TEACHER. Each statement can be uniquely classified as belonging to a pair (LENS, EYES) of those types. Table 1 is an example of a result of step 4, where Researchers A and B numbered from 1 to 46 the comments of the first observation.

Table 1. Classification table of Observers' comments reported in COPUS form during the first observation. Source: by Authors.

(LENS, EYES)	**WITNESS**	**TEACHER**	
COPUS	2, 4, 7, 9, 10, 11, 12, 17, 21		*Observer A*
	1, 3, 23, 24, 25, 31, 32, 33, 34, 36, 37, 38, 39, 43, 45	29, 30, 44	*Observer B*
GENERAL	5, 6, 8, 13, 14, 15, 16, 19	18, 20, 22	*Observer A*
	26, 27, 28	35, 40, 41, 42, 46	*Observer B*

More precisely, the numbers 2, 4, 7, 10, 11, 12, 17, 21 correspond to Observer A's comments left in the COPUS form that are classified as a pair (COPUS, WITNESS), because they explicitly refer to COPUS protocol codes and serve as clarifications about what happened in class without any further pedagogical interpretation. For instance, the comment 2 reads: "Not sure about FUp code, because they are doing a recap test", revealing a doubt about a COPUS code (FUp=Follow-up) being correctly marked. Similarly, the numbers 35, 40, 41, 42, 46, correspond to Observer B's comments, and are classified as a pair (GENERAL, TEACHER) because they don't presuppose any use of COPUS protocol and provide teacher's practice insights. For example, comment 41: "A student anticipates the teacher's solution of a linear system" requires a teacher practice of recognizing patterns of interaction with students about the content. Similarly, the pair (GENERAL, WITNESS) refers to statements that do not

presuppose any use of COPUS and contain neutral observations; while the pair (COPUS, TEACHER) concerns those statements which rely on COPUS and teacher's practice insights.

3. Data Analysis

During the first COPUS observation, see Table 1, Observers A and B provided twenty comments and twenty six comments, respectively. From the total number of comments, we have eleven comments classified as TEACHER and the remaining ones, the majority of comments, classified as WITNESS. Note that Observer B, with more teaching experience, made more comments with TEACHER eyes than Observer A. The pair (COPUS, WITNESS) is what appears most often, which is understandable because the observers were applying the protocol for the first time and realized that they had questions about using specific COPUS codes. But it is interesting to remark that even during this first COPUS observation, the observers started to reflect as teachers, in particular, Observer B did that with the lens of COPUS. For example, the comment 44 by Observer B reads: "*MG*, because teacher *moves* to show how vectors behave", using COPUS code (MG=Moving/Guiding). It is interesting to compare the classification difference between this statement 44 by Observer B and statement 20 by Observer A: "The *embodied* explanation seems to engage the students back", since they are related to the same situation in class. The statement 20 is classified as (GENERAL, TEACHER) since Observer A described the effectiveness of the instructor action using the word "*embodied*" rather than a word related to COPUS codes (e.g., "*moves*").

Table 2. Classification table of data 2. Source: by Authors

(LENS, EYES)	**WITNESS**	**TEACHER**	
COPUS	1, 2, 3, 4, 5, 9	6, 7, 8	*Observer A*
	13, 14, 15, 16		*Observer B*
GENERAL	11	10, 12	*Observer A*
	17		*Observer B*

Analyzing **data 2**, we see from Table 2 that Observers A and B provided twelve statements and five statements, respectively. From the total number of statements, we have now five statements classified as TEACHER, all of them by Observer A, and the remaining ones, the majority of comments, classified as WITNESS. This unbalance does not come as a surprise, because the open questions within the structured feedback were focused on the participants' experience as observers. Nevertheless, there are statements within the pair (COPUS, WITNESS) that can point to the TEACHER category. For instance, statement 3 by Observer A, when comparing her first two COPUS observation experiences: "The second time, however, everything was more natural and clearer. By being more familiar with the codes, I was able to better *recognize behaviors* and *categorize activities* more efficiently.". In this statement, Observer A mentioned terms which

can be related to teacher's practice: class management ("*recognize behaviors*") and lesson format ("*categorize activities*").

Table 3. Classification table of data 3. Source: by Authors

(LENS, EYES)	**WITNESS**	**TEACHER**	**OTHER**	
COPUS	2, 14	3, 4, 6, 7, 9, 35, 37, 38, 39, 41	2, 8, 10	*Observer A*
	17, 24	25, 26, 27, 28, 44, 47, 48	33	*Observer B*
GENERAL	12	1, 13, 15, 36, 40, 42	5, 11	*Observer A*
		16, 18, 19, 20, 21, 22, 23, 29, 30, 31, 32, 43, 45, 46	34	*Observer B*

Table 3 reports the results of the classification applied to **data 3**, the semi-structured interviews. Observers A and B provided twenty-four and twenty-five statements, respectively, being only five of them classified as WITNESS. A further category was identified for such type of data, namely the broad academic eyes of a faculty member, here named OTHER. For example, in the pair (COPUS, OTHER), we find statement 8 by Observer A: "I think that peer observations are very important. COPUS protocol allows for complete and extensive observations.". During the semi-structured interviews, the observers reflected a lot as TEACHER using the lens of COPUS. For example, in statement 41, Observer A said on FQ: "Using lecture notes already written, like prepared slides, force students to be busy in *copying* and *not listening*… I will do only *writing* during class or give notes to students in advance." The statement is classified as COPUS since Observer A used the COPUS code "*listening*", even if she emphasized that students do not listen to, but just "*copy*" what they see. This statement also suggests a future improvement of the teaching practice, because she intends either to provide notes in advance or to *write* in real time.

The analysis also highlights how very long moments of frontal lesson are less effective for student engagement. Both observers reflect on that, proposing a different approach to avoid similar moments in their future teaching practices. Observer B with statement 48 (COPUS, TEACHER) commented: "There were long moments (marked in *every 2 minutes*) [...] when only *Lecturing/Listening* was happening; I observed how many students started little by little to become more absent… I will try to pause more often, posing questions to students, not necessarily *clicker questions*…". Similarly, with statement 42 (GENERAL, TEACHER) Observer A said: "I observed that the frontal part of the lesson on integration was hard for students, but I still don't know how to improve this. Maybe preparing something in advance to give the students before they come to class… perhaps having a MOOC on that subject.".

4. Discussion and Conclusion

This work aims at investigating the potential of flipped peer observation in faculty development, more precisely it addresses the following research question: how the flipped peer observation model, implemented with the COPUS protocol, can support the reflection of early-career STEM

faculty members ("young faculty") on teaching practices? The study resorts data collected in three different moments of an Elementary Mathematics course in fall semester 2024/25.

The analysis of **data 1** reveals that during the COPUS observation, the young faculty have reflected on teaching practices related to the lesson format, the types of tasks, and class management. However, when young faculty are asked to provide feedback on their observation, it turns out that the questions should be very explicit and specific. Indeed, the analysis of **data 2** shows that Observers A and B made comparatively less statements with TEACHER's eyes than during observation moments. Note that Observer A, less experienced young faculty, made more comments in that moment with TEACHER eyes than Observer B. Somehow, the fact that the Researchers A and B did not ask explicitly for reflections on teaching practices narrowed the feedback on pedagoygic issues when applying COPUS protocol. On the other way around, when Researchers asked explicitly for a reflection, Observers A and B behaved differently. Indeed, **data 3** analysis shows that young faculty may provide many insights as teachers, such as class management, lesson format and recognition of pattern of interactions, so that they can critically reflect on their own past teaching practices and suggest some changes for the future.

Even though we know this is a preliminary study which involved only a limited sample of observers, the results seem promising in the direction of the young faculty development. Moving back on the research question, we can conclude that flipped peer observations with COPUS, along with specific moments of well-prepared feedback and interviews by young faculty, prompt them to think more with teacher's eyes, and thus led them deeply reflect on their own teacher practices. In future, despite the issues involving many faculty members, we aim to evaluate the effectiveness of flipped peer observation by setting up a large study.

References

Anwar, S., & Meneske, M. (2020). A systematic review of observation protocols used in postsecondary STEM classrooms. *Review of Education*, 9(1), 81-120. https://doi.org/10.1002/rev3.3235

Bandura, A., & Walters, R. H. (1977). *Social learning theory* (Vol. 1, pp. 141-154). Englewood Cliffs, NJ: Prentice hall.

Bullough, R. V., & Pinnegar, S. (2014). Guidelines for quality in autobiographical forms of self-study research. Educational Researcher, 30(3), 13-21. doi: https://journals.sagepub.com/doi/10.3102/0013189X030003013

Da Ponte, J. P., & Chapman, O. (2006). Mathematics teachers' knowledge and practice. In A. Gutierrez & P. Boero (Eds.), *Handbook of research on the psychology of mathematics education. Past, present and future* (pp. 461-494). Sense Publishers.

Dillon, H., James, C, Prestholdt, T., Peterson, V., Salomone, S., & Anctil, E. (2020). Development of a formative peer observation protocol for STEM faculty reflection. *Assessment & Evaluation in Higher Education*, 45(3), 387-400. https://doi.org/10.1080/02602938.2019.1645091

Dougherty, B.J. (1990). Influences of teacher cognitive/conceptual levels on problem-solving instruction. In G. Booker, P. Cobb & T.N. Mendicuti (Eds.), *Proceedings of the 14th PME international Conference* (Vol.1, pp. 119–126). Oaxtepex, Mexico: PME.

Gosling, D. (2002). *Models of Peer Observation of Teaching.* Learning and Teaching Support Network (LTSN).

Gunersel, A. B., & Etienne, M. (2014). The impact of a faculty training program on teaching conceptions and strategies. *International Journal of Teaching and Learning in Higher Education*, 26(3), 404-413. http://www.isetl.org/ijtlhe/

Smith, M. K., Jones, F. H., Gilbert, S. L., & Wieman, C. E. (2013). The Classroom Observation Protocol for Undergraduate STEM (COPUS): A new instrument to characterize university STEM classroom practices. *CBE—Life Sciences Education*, 12(4), 618-627. https://doi.org/10.1187/cbe.13-08-0154

Sundset, M.A., & Sandvoll, R. (2022). Academic development through a collective approach - introducing peer observation of teaching in a multidisciplinary faculty. *Nordic Journal of STEM Education*, 6(1), 16-27.

Wimberg, C., Adendorff, H., Bozalek, V., Conana, H., Pallitt, N., Wolff, K, Olsson, T., & Roxå. (2018). Learning to teach STEM disciplines in higher education: a critical review of the literature. *Teaching in Higher Education*, 24, 930-947. https://doi.org/10.1080/13562517.2018.1517735

Wood, T. (1996). Teaching to create discussion as mathematical argumentation. In L. Puig & A. Gutiérrez (Eds.), *Proceedings of the 20th PME International Conference* (Vol.4, pp. 427–434). Valencia, Spain: PME.

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Giving Nature a New Voice: Translating BioRia from Portuguese to German

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Abstract

As part of the 3rd year of the Bachelor's Degree in Translation at the Department of Languages and Cultures of the University of Aveiro, a collaborative translation project was conducted during the second semester of the 2022/23 academic year with students from the Portuguese-German Translation course at the University of Mainz, Germany. This project aimed to deepen intercultural dialogue between Portuguese and German students while equipping undergraduate students from both universities with essential academic and professional skills. The project focused on BioRia, a nature conservation and biodiversity initiative in the Aveiro district. Since 2005, BioRia has transformed environmentally degraded areas into a network of walking and cycling trails, offering direct contact with nature. Given the ecological significance of the Ria de Aveiro and the lack of German-language information on the official website, the team proposed a collaboration with Estarreja's City Council to translate a tourism brochure into German. This effort aimed to enhance the visibility of the BioRia project for German-speaking audiences. This study describes and analyzes the translation project, highlighting the challenges of translating ecotourism materials and the project-based work methodology. The bilingual brochure's publication was financially supported by the Center for Languages, Literatures, and Cultures (CLLC) at the University of Aveiro and the German Academic Exchange Service (DAAD).

Keywords: *Translation Project; Ecotourism; BioRia; Portuguese-German*

1. Introduction

In the context of the 3rd year of the Bachelor's degree in Translation at the Department of Languages and Cultures of the University of Aveiro, a translation project in the field of ecotourism was carried out in collaboration with students from the Portuguese-German Translation course at the University of Mainz, Germany, during the second semester of the

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2022/23 academic year. The aim of this project was to deepen the intercultural dialogue between Portuguese and German students, as well as to best prepare the undergraduate students from both universities for the translation profession and other professions or activities that require intercultural skills.

The chosen theme for the translation project was the BioRia Nature Conservation and Biodiversity Project, located in Estarreja, within the Aveiro district. This project, initiated in 2005, focuses on rehabilitating environmentally degraded areas and has established a network of walking and cycling routes that offer direct contact with nature. Given the ecological and cultural significance of Ria de Aveiro, and the absence of German-language resources on the official BioRia website, the project team proposed collaborating with the Estarreja City Council to translate a tourist-information leaflet into German. This effort aimed to enhance the visibility and accessibility of the BioRia Project to German-speaking audiences.

The current study describes and analyzes the execution of this translation project, highlighting the specific challenges encountered within the ecotourism domain. This initiative builds upon a longstanding tradition of inter-university translation projects. Since 2007, the Department of Languages and Cultures at the University of Aveiro has engaged in bilateral collaborations with various institutions. The first such project, developed in partnership with the Department of German Studies at the University of Minho, focused on translating historical and cultural tourism materials for the Monastery of São Martinho de Tibães. Subsequently, several seminars were held in the areas of ecotourism at São Jacinto Natural Park in 2008, wine tourism in the Vinhos Verdes region of Melgaço in 2008, and monumental tourism in Vouzela in 2009. These projects included guided tours by an expert in the area and on-site translation work.

More recently, collaboration with the University of Mainz resulted in notable projects, including the translation of narrative texts in 2021 and 2022, the BioRia Project in 2023, and a 2024 initiative titled "Tell me how it was," which documented the experiences of Portuguese emigrants in Germany during the April 25th Revolution.

In this context, the present study aims to describe the translation project, highlighting translation challenges in the field of ecotourism and the project's work methodology. The project concluded with the publication of a bilingual brochure, which received financial support from the Center for Languages, Literatures, and Cultures (CLLC) at the University of Aveiro and the German Academic Exchange Service (DAAD).

2. Translation in the Field of Tourism

In the context of globalization, tourism now reaches even the most remote and lesser-known destinations worldwide. Translation plays a vital role in this process, facilitating communication between tourists and local communities, thereby contributing to intercultural understanding. As

global tourism continues to expand, there is an increasing demand for culturally sensitive translations across various types of texts. Salvatore (2009, p. 4) argues that “local cultures need to remove “their veil” and to work out how to make those patrimonies less inevitable and automatic, that is more evident and clear for the people outsider the circle”. Among common text types are informational brochures, websites, travel guides, restaurant menus, signage, and more, all essential in ensuring seamless cross-cultural interactions.

The language of tourism is "a specialized type of cross-cultural communication" (Agorni, 2012) and “belongs to a particular genre of specialised language characterised by peculiar stylistic, pragmatic and lexical features and within Translation Studies (Giampieri & Harper, 2021, p. 17). Malamatidou (2024, p. 57) observes that, despite widespread acknowledgment that “tourism texts need to be adapted through translation to address a new audience, research on how this might be achieved is generally limited and patchy”. Similarly, Agorni (2012) identifies translating tourism as an under-explored area, attributing this research gap to the challenges scholars face when defining the nature and degree of specialization of tourism language. The author notes that “it is precisely the heterogeneous nature of this community that produces the complex discursive practices characterizing this field, best exemplified by those hybrid genres such as the guidebook, brochure, and leaflet” (Agorni, 2012, p. 6). These hybrid forms combine various communicative functions, blending both informational and promotional elements, making their translation a unique challenge.

Furthermore, Agorni (2012, pp. 6-7) highlights that "the translation of tourist texts is an extremely interesting case of cross-cultural communication," Tourist texts also carry cultural markers that represent the specific historical, geographic, social, and cultural aspects of a destination, making their translation a complex task. In translating tourist texts, translators must intervene not only at the textual level but also at the cross-cultural level. For instance, in the case of a brochure translation, the assumption is that foreign tourists need more detailed information than local ones. Therefore, translators must choose from various techniques, such as glossing, adding clarifying explanations within the text, or providing additional information in footnotes. The selection and combination of these strategies should be guided by a thorough understanding of the foreign tourists’ profiles, as these will shape their expectations and informational needs (Agorni, 2012, p. 7). This nuanced approach is essential for ensuring that the translation is both culturally accurate and functionally effective in meeting the needs of its target audience.

3. Academic-Curricular Context and Training in Translation

In the context of translation education at the University of Aveiro (UA) for 3rd-year Bachelor's students, the curriculum comprises various fields, including Tourism, Literature, Technical Translation, and Public-Administrative Translation, as well as different types of texts, such as

informative, operative, and expressive texts. Practical training begins in the third year through Translation Practice courses, where students apply theoretical knowledge to hands-on translation projects, gaining essential skills for their future professional pursuits. Prior to this, during the first and second years, they are introduced to fundamental subjects such as Translation Methodologies, which provide essential concepts and theories related to translation practice. In these courses, students become familiar with not only the essential principles of translation but also concepts from Text Linguistics, such as text genres, discourse conventions, and textual structures. Additionally, subjects like Portuguese Linguistics complement their understanding of language and text functioning, preparing them for the practical challenges they will face during their Translation Practice. At the University of Mainz, Portuguese is offered as a secondary subject (Beifach) in combination with a major subject (Kernfach; such as other philologies, social sciences, history, etc.) as part of the Bachelor of Arts program. The Portuguese program covers four main areas: Linguistics, Literature, Culture, and Portuguese as a Foreign Language (with courses such as grammar, translation, oral communication, and creative writing, all aimed at enhancing writing and communication skills).

Additionally, starting in the winter semester of 2022/23, the university offers a unique qualification for education students (Lehramt/Education), providing a supplementary certification with a didactic component (Zusatzqualifikation: Zertifikat über die fachwissenschaftlichen Voraussetzungen zur Erlangung der Unterrichtserlaubnis in Portugiesisch) to train future Portuguese language teachers for the German educational system.

4. Methodology

Prior to initiating the translation project, a visit to the Natural Reserve was organized to familiarize the students with the area. Notably, only one out of 18 students had previously visited the reserve. A guided tour, led by a biologist from the Estarreja City Council, provided detailed insights into the region's unique flora and fauna. By exploring various areas within the reserve, each with its own unique characteristics, students were able to contextualize the translation project and gain a greater understanding of the site's significance. The Translation Practice classes were conducted in a computer lab to create an environment that supported research using online dictionaries, databases, websites, parallel texts, and other digital resources. At the onset of the project, students from both the University of Aveiro and the University of Mainz were invited to collaborate on a shared Google document, facilitating both real-time and asynchronous interactive collaboration.

The students were organized into mixed groups composed of members from both universities. This structure ensured that German students reviewed the translations produced by their Portuguese counterparts, offering detailed feedback and observations, often outside the context of regular class sessions. The exchange of feedback, which focused on error analysis and

suggestions for improvement, proved to be highly advantageous, as it emphasized student-centered learning.

The selection of Google Docs as the primary platform for the project facilitated a high degree of interaction and collaboration among participants. This platform allowed all group members to work concurrently on the same document, enabling immediate and efficient collaboration. Students could add comments and suggestions directly within the text, fostering continuous revision and constructive feedback. Additionally, Google Docs automatically tracked all changes made to the document, simplifying the process of monitoring progress and identifying areas requiring further attention. The platform also streamlined communication among group members, allowing for quick resolution of queries and alignment of work throughout the translation process.

The instructors, including the authors of this study, encouraged autonomy and responsibility among students throughout the collaborative learning process. While offering guidance and support as needed, the instructors allowed students to take the lead in decision-making, fostering a learning environment in which the students assumed responsibility for their own educational development. This approach effectively promoted engagement and facilitated the students' growth during the project.

5. Selection of Topic and Characteristics of the Source Text

Although the field of tourism is notably complex due to the wide range of discursive and stylistic practices across its various text types, students generally show a heightened interest in translating tourism-related texts. This interest stems from the fact that most students are already familiar with textual genres such as travel guides, brochures, and historical monument leaflets, among others. This prior knowledge contributes to their comfort and confidence when translating texts in this domain. As Agorni (2012, p. 7) notes,

> students generally demonstrate a great familiarity with this type of text, as a large majority of them has been a consumer of similar works either in a foreign or in their native language. This familiarity facilitates the management of competencies related to discursive and textual conventions.

The BioRia Project text is a descriptive and informative document that highlights the natural heritage of Estarreja and the environmental conservation efforts promoted by the Estarreja City Council. The text is organized into several key sections, each focusing on distinct aspects of the BioRia project. The General Introduction outlines the history and objectives of the project, emphasizing the rehabilitation of degraded areas and the development of pedestrian and cycling trails. The Description of the Ria de Aveiro explores its geological formation and conservation

significance, while also detailing the historical interplay between humans and nature in the region. The Baixo Vouga Lagunar section provides a detailed insight at the area's ecosystems and biodiversity, showcasing the harmonious coexistence of human activities and natural habitats. Finally, the Walking Trails section offers detailed information about each trail, including distances, durations, environmental features, and GPS coordinates, enriching the reader's understanding of the opportunities for exploration within the reserve. The source text combines factual information with an emphasis on ecological awareness and conservation, makes it an ideal candidate for translation, especially within the context of promoting tourism and environmental conservation.

6. Culture-Specific Terms or Realia: Challenges for the Translator

Suleiman and Wilson (2019, pp. 51-52) highlight that Translation Studies research focusing on "the observable level of culture" addresses culture-specific terms (also *culture-specific items*, Aixelá, 1996; *cultural words*, Newmark, 1988; or *culturemes*, Nord, 1997, among other designations), which present significant challenges for translators. One of the primary challenges encountered was the translation of landscape-specific terms. A prime example is the term *Bocage*, which refers to a particular type of agricultural landscape found in regions, with moderate climates, particularly in parts of Europe, such as the Aveiro area. Originating from French, the *Bocage* landscape is characterized by a mix of small fields, hedgerows, trees, and shrubs. This contrasts with the more uniform open field system, where large areas of land are cultivated without permanent divisions between fields. In the translation process, students consulted dictionaries, databases, and parallel texts in both languages and decided to use the term *Landschaftsgefüge* in German. Although not a direct equivalent, this term offered a more appropriate description for German readers, emphasizing the landscape's structure and harmony between human activity and nature.

Another challenge was the translation of specific species names for both fauna and flora. The source text references a diverse array of species typical of saline environments. The translation of geographic names and references presented another challenge. For example, the *Ria de Aveiro* is a unique lagoon-like water system found near Aveiro, Portugal. This term, while specific to the local landscape, needed to be retained in the translation. However, additional context was provided to explain its significance to the German-speaking audience. In this case, the name was kept in the translation, supplemented by an explanation that described it as a "lagoon-like water landscape" in the Aveiro region.

Figure 1 displays a section of the final version of the brochure, highlighting how some of these challenges were addressed and the translation choices made.

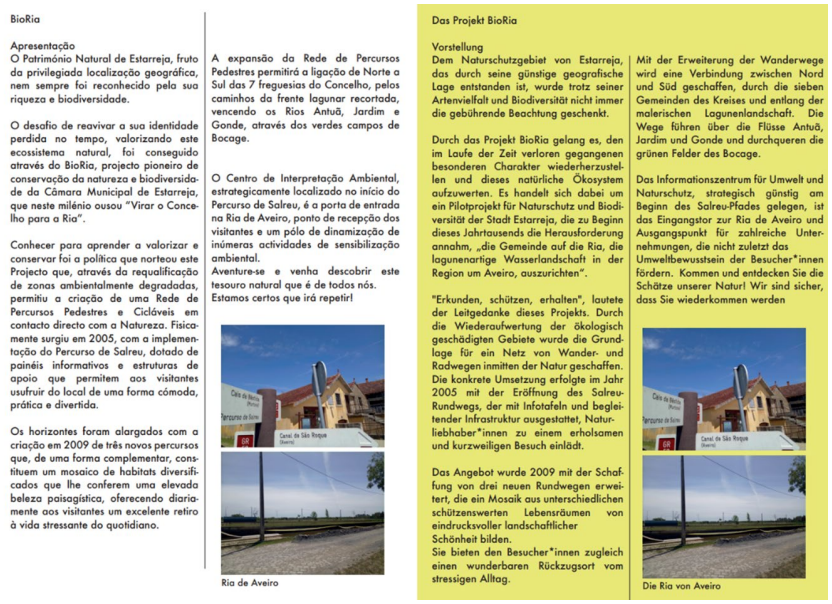


Figure 1. Final version of translated ecotourism brochure.

7. Conclusions

The translation project of the BioRia nature reserve brochure provided a valuable learning opportunity for students, encouraging them to take an active and autonomous role in the translation process. The inter-university collaboration was a key factor in the success of the project, with the exchange of knowledge and perspectives between students from the University of Aveiro and the University of Mainz enriching the educational experience.

Peer feedback, rather than relying solely on the professor's guidance, was considered a motivating and essential factor for enhancing translation skills. This exchange of opinions and suggestions contributed not only to the technical improvement of the translations but also to the development of a greater cultural sensitivity, which is crucial in translation practice. The BioRia project also provided students with an authentic translation experience, allowing them to encounter the real-world challenges of working with specialized texts and culture-specific terms. Furthermore, the project raised students' awareness of environmental issues, emphasizing the importance of ecological preservation and sustainability. This component of environmental awareness strengthened the understanding of how education can play a fundamental role in promoting sustainability and building a more conscious and responsible future. In this way, the project also served as an opportunity to reflect on the role of translation in disseminating cultural and ecological values.

References

Agorni, M. (2012). Tourism Communication: The Translator's Responsibility in the Translation of Cultural Difference PASOS. *Revista de Turismo y Patrimonio Cultural*, vol. 10, 4, 2012, 5-11.

Aixelá, J. F. (1996). Culture-Specific Items in Translation. In R. Álvarez and M.C. África Vidal (eds.), *Translation, Power, Subversion*, (pp. 52–78). Clevedon: Multilingual Matters.

Cappelli, G. (2008). The translation of tourism-related websites and localization: Problems and perspectives. In A. Baicchi (Ed.), *Voices on translation*, RILA Rassegna Italiana di Linguistica Applicata (pp. 97–115). Bulzoni Editore.

Giampieri, P., & Harper, M. (2021). *Tourism Translation: From Dictionary to Corpus.* Le Penseur.

Malamatidou, S. (2024). *Translating Tourism.* Palgrave Studies in Translating and Interpreting. https://doi.org/10.1007/978-3-031-49349-2_3

Nord, C. (1997/2018). *Translating as a Purposeful Activity: Functionalist Approaches Explained.* Routledge.

Salvatore. Going tourist. Tourism and translation of local cultures. *8th International Conference of Territorial Intelligence.* ENTI. November, 4th- 7th, Nov 2009, Salerno.

Sulaiman, M. Z. & Wilson, R. (2019). *Translation and Tourism. Strategies for Effective Cross-Cultural Promotion.* Springer.

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A beginner-friendly introduction to the "Concept" lecture series, featuring engaging PowerPoint animations

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Abstract

Lecture videos animated with PowerPoint as audio and visual stimulus cover different learning methodologies and are concurrently implemented in higher education. They are widely used by students in traditional courses and online courses. PowerPoint is a powerful production tool offering a wide range of possibilities to motivational arrangement of digital visualization. The program is widely available, easily accessible, there are multiple open access tutorials and most instructors and students have common knowledge of the program. Using the basic function animated lecture videos (not screencasts which are voice-over slides only!) can be successfully produced by guided student project groups (peer-to-peer approach) as well as instructors.

The concept of producing and implementing PowerPoint lecture videos is introduced with respect to teaching material science to first year engineering students, the special needs of these students, sustainable easy production and implementation in blended teaching scenarios.

Keywords: *lecture films, PowerPoint, making of, peer to peer, material science.*

1. Introduction

The use of lecture videos in universities has increased substantially over the last decade – in both, online and face-to-face courses. Also, the number of students studying mainly guided by online learning material in otherwise traditional courses has increased. The learning materials online students are expected to use vary greatly: (Chen and Thomas, 2020), such as: PowerPoint slides, online/interactive lectures, interactive mind-maps, course templates etc.: (Pfennig, 2023). Lecture videos cover different learning methodologies and generally comprise of screencasts (voice-over PowerPoints), captured lectures (audio or video recordings of lectures) and short animated lecture videos of relevant course material: (Pfennig, 2019).

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Most students appraise lecture videos easy to use and effective learning tools: (Kay, 2012) and place significant value on the use of videos: (Gulley, 2016). When students watch lecture videos they not only read to learn, but simultaneously see and hear words and images to understand explanations, thus enhancing retention (Robertson and Flowers, 2020); Mayer 2009). Utilizing multiple senses is beneficial to learning, primarily because students encounter learning more enjoyable and tend to retain more information for longer: (Robertson and Flowers, 2020). Advantages of using instructional videos for foreign learners in inverted classroom teaching scenarios are the improvement of learning autonomy, controlling language deficiencies, avoiding the time and psychological pressure, activation to master new knowledge, motivation and engagement in online learning, learning at own pace, enhance self-directed learning and flexibility of learning and accessing lecture videos at time and space convenience (Bui, 2021). Moreover, the content is made more accessible to students with disabilities or second language students: (Pfennig, 2023; Robertson and Flowers, 2020) conclude that lecture videos lessen requests to lecturers for content clarification and the combination of aids –e.g. PowerPoint (PPT) or lecture notes– provided along with a video give best student learning outcomes.

Most lecturers know how to produce screencasts but rate animated videos difficult and time consuming. However, the latter mostly are the only way of explaining difficult pathways in science where slides or textbooks only provide results. Hence, the purpose of this "how-to" praxis paper is to share more than 10 years of experience to create animated lecture PPT videos. It is neither a scientific research analysis or compares other methods of lecture film production.

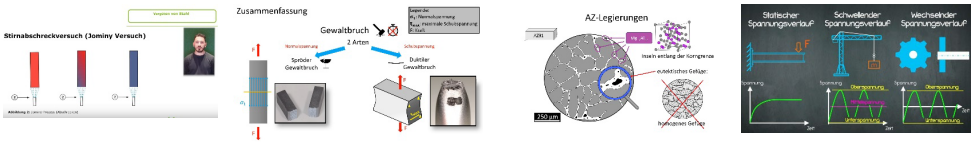
2. Setting of lecture videos using PowerPoint

Depending on pre-knowledge of video production, PowerPoint and the underlying scientific content of the future lecture video it is advantageous to produce lecture videos for content that is not subject to change over at least a medium period. However, to produce PowerPoint lecture videos you do not have to have professional skills or professional technical equipment. Alignment with course learning outcomes, clear content and a well written and understandable script are most viable to the success of lecture videos.

Despite more time and effort for an instructor to create a hand-drawn lecture video than it might take to prepare a narration-over-PowerPoint type of lecture video (screencast with partial or minimal motion) a hand-drawn lecture video results in higher levels of student engagement: (Pfennig; 2019; Pfennig, 2023; Chen and Thomas, 2020).

At HTW Berlin the production of lecture films are content of a voluntary student group semester project where most of the students have little or no film making skills. The procedure of this peer-to-peer approach was introduced by: (Pfennig, 2019) and includes 1. Writing a script/screenplay, 2. Preparation of assets, e.g. illustrations, 3. Text/Voice-over recording´, 4. PowerPoint preparation, 5. Editing and post-production, 6. Finish and delivery. Up to now there

are 71 PPT lecture films readily available on YouTube comprising of different: ppt layouts (Figure 1): https://www.youtube.com/c/Werkstofftechnik-HTWBerlin:



ppt with speaker	ppt with photos	ppt with handdrawn digital assets	ppt with symbols
https://youtu.be/h-kzx5WoY1c	*https://youtu.be/rrkoO2oV4L4*	*https://youtu.be/CzYH4qXVM_g*	*https://youtu.be/zzFY0mGB-E0*

Figure 1. PowerPoint lecture video layouts by HTW Berlin.

Based on our experience PowerPoint lecture videos are suitable for all types of films but show outstanding abilities to produce deep scientific information (Table 1). In general, the choice of the PowerPoint format has to suit 3 boundary conditions: Pfennig (2019), Pfennig (2023):

1. Learning outcome of the lecture (e.g. introduction, overview or precise instruction)
2. Technical support (e.g.: professional director and/or illustrator or artist for sketches)
3. Motivation of student group (own choice works better than instructor suggestions)

Many feedback rounds are necessary until the final version is completed. Figure 2, for example shows the development of visualizing: recrystallization in metals micro structures.

Table 1: Examples of PPT lecture films, playlist, main characteristics and required skills

Theme	URL playlist	Main characteristics	Required skills Illlustr.	Speak.	Cut.	Dir.	Phot.
Mg and Mg alloys	https://www.youtube.com/playlist?list=PLUOlZMSZYz5zL0tdqE7ZNqmB0j1kDMGcN	Digital assets		X	X		
Crystal structures	https://www.youtube.com/playlist?list=PLUOlZMSZYz5xUOfP0o3APbngJ2djip0RH	Hand-drawn assets	X	X	X		
Fracture	https://www.youtube.com/playlist?list=PLUOlZMSZYz5yLhYznb0Az_AV2IXLpvPTF	Integration of photos		X	X		
Ultrasonic testing	https://www.youtube.com/playlist?list=PLUOlZMSZYz5wLXOL12hlWOrL1MIbXfZeS	Coupling of animation and real time movie		X	X		(X)
Annealing of steels	https://www.youtube.com/playlist?list=PLUOlZMSZYz5y_UdFxKzsbkEc7h9stytNH	Smooth quick animation, hand-drawn digitized assets	X	X	X		
Haig diagram	https://www.youtube.com/playlist?list=PLUOlZMSZYz5yyGoklkDIAGnvFh-ayHLdB	Smooth quick animation, hand-drawn digitized assets	X	X	X		
Hardening of steels	https://www.youtube.com/playlist?list=PLUOlZMSZYz5z3wRCqGTbJIZ0gKLVe-uFF	Animated hand drawn assets	X	X	X		
Hardness and Charpy testing	https://www.youtube.com/playlist?list=PLUOlZMSZYz5zKAxQiSnKztPlF-pmhBn7y	Coupling of animation and real time movie		X	X		(X)
Plastic deformation	https://www.youtube.com/playlist?list=PLUOlZMSZYz5y2u0Bhw7UpY4Pa4qCp3cka	Screencast as ppt		X	X		
Recrystallization	https://www.youtube.com/playlist?list=PLUOlZMSZYz5zAaB_frRDs9PeMBnBYnCIu	Screencast as ppt		X	X		

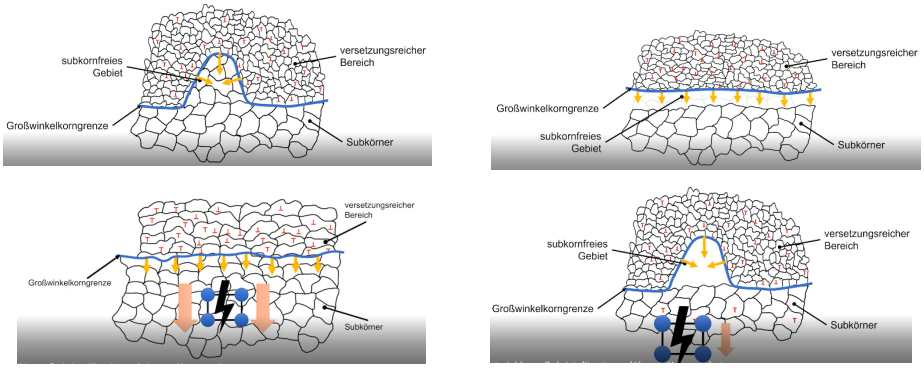


Figure 2. Development: "recrystallization": scientific correctness is inevitable when visualizing.

3. "Concept" of Power Point lecture videos

3.1. Setting of power point

PowerPoint is a versatile program suitable for creating simple animations, such as moving text or images, as well as manipulating graphics and morphing shapes effortlessly. The program allows users to group individual slides, facilitating the organization of multiple slides into scenes based on the script. A group may encompass various scenes, especially when content or animations span several slides.

Each scene can be rendered separately, streamlining post-processing and video editing. This results in individual video files that can be later compiled using editing software. However, a drawback is the substantial one-time effort required to render individual segments. While rendering the entire PowerPoint animation at once reduces this effort, the benefits become apparent during rework. Rendering in sections offers advantages, particularly when addressing imperfections in small portions of a scene. By rendering sections separately, the need to redo the entire PowerPoint animation, including unaffected segments, is avoided. This approach also facilitates the alignment of voice-over with the video, allowing for easy synchronization after each section.

3.2. Treatment and Script

Emphasizing the importance of prioritizing the script over visuals is crucial for successful lecture video production. The script plays a central role as the most pivotal, vulnerable, and flexible element in the entire production process. Post-production changes to recorded text are time-consuming and can disrupt the workflow, potentially impacting student motivation. It is recommended to meticulously craft the script to meet all criteria before acceptance. Encouraging students to see the script as a tool for delivering a podcast promotes clear and precise sentences

without heavy reliance on visuals. Language clarity, shorter sentences, and additional explanations for technical terms are advised. Lecturers should carefully proofread the script, recognizing the significance of each word, as external voice-over artists adhere strictly to the written content. The script includes content, scene setting, embedded texts, drafts of illustrations, and scene duration, aiding students in focusing on the text while providing a rough visualization of scene production. Documenting time while reading aloud helps adhere to the 5-minute limit and prioritize crucial content. As mentioned earlier, groups in Power Point can be used to structure single or multiple scenes. To assign these groups to the correct text sections easier, it is advised to implement a maximum of 2-3 sentences in a scene. This way post-production remains structured in the end.

3.3. Voice over

The text and its content establish the framework and tempo of the film: (Pfennig, 2019). Therefore, it is highly advisable to employ straightforward, concise language and maintain a moderate speaking pace—not too fast or too slow. While hiring a professional voice actor is an option, the authenticity of an enthusiast deeply engaged in the topic can convey genuine sympathy, a key factor in capturing the audience's attention and fostering a willingness to learn.

When recording voiceovers in the studio, consider the following:

1. Prioritize recording before editing to synchronize scenes or animations with the voice-over.
2. Ensure the text printed out for a voice-over recording uses a font size of 16 pt for improved readability, with pauses indicated by blanks.
3. Emphasize understandability over perfection during recording. Utilize a semi-professional plug & play USB large diaphragm microphone like the Rode NT-USB.
4. When selecting a recording room, prioritize minimal reverb and ambient noise. Opt for a relatively small room with carpeting, curtains, upholstered furniture, and possibly soft materials like foam on the walls for sound absorption.

3.4. Production

At the end the video clips from PowerPoint have to be connected and edited to fit the voice-over. To edit films, we use the Adobe Premiere Pro program. It is recommended for professional video editing. If we create more complex animations with the Adobe After Effects program, the programs can be linked to each other. This can save rendering processes, which makes working easier. Even changes are applied automatically. The video editing process can be divided into three parts:

1. First, all raw data is imported and sorted. We distinguish within the editing program in folders whether it is video, audio or animation data.

2. After that, the audio data is loaded into the editing area. Important: always edit the video files to the audio files. This way the video will perfectly match the speech rate. This makes it easier to show exactly what is being talked about.
3. Once the film is edited, it can be rendered for the final time. After that, the film is watched again and again and mistakes are corrected.

4. Evaluation

Students rate the PowerPoint animation lecture videos neither as favorite nor as least choice (Figure 3) compared to other techniques, e.g. swipe, video scribe or slow motion. Therefore, the film format has no significant influence on the "joy of use" and on their learning progress.

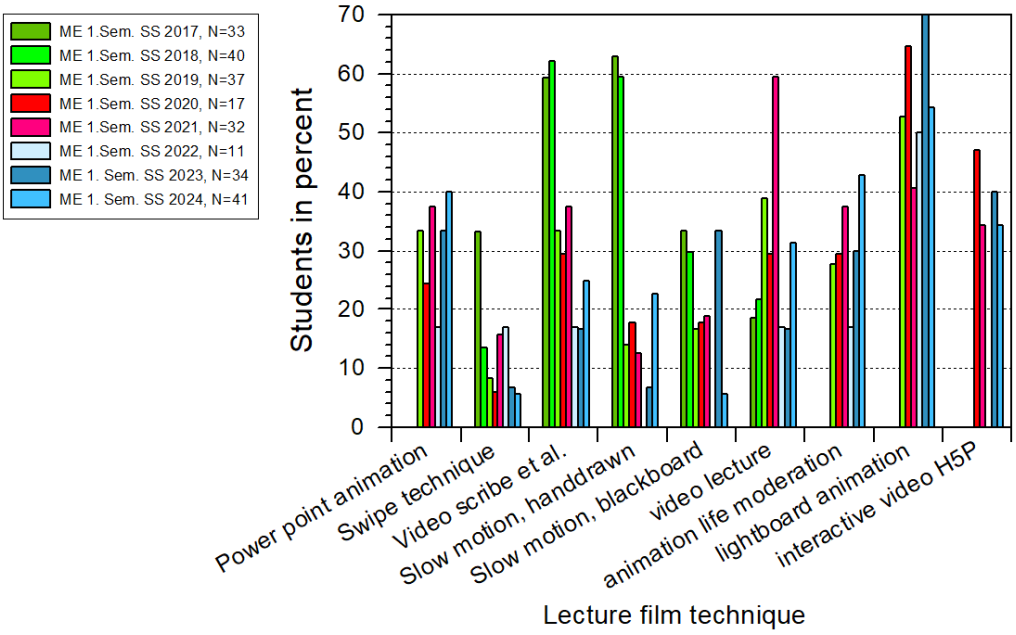


Figure. 3. Preference of video format in material science. (multiple choices were possible).

PowerPoint lecture videos are preferred over screen casts and other digital reading-based learning material such as: lectures or pdf. However, students prefer videos with "human touch" such as lightboard lectures, or hand-drawn slow-motion videos - allowing them to feel directly addressed by the instructor. The combination of interactive online lectures and quizzes with the videos provides a highly appreciated learning environment: Pfennig (2023).

Students working on the lecture films got acquainted with the PowerPoint animation functions rather quickly due to good tutorials (German, HTW Berlin: https://youtu.be/wxq00OpI0Ww).

But, they rated the workload unexpectedly high (mostly because they did not know the importance of a perfect script and because of their high attitude towards good grades resulting in “perfectionism”).

As PowerPoint lecture videos are very common in now-a-days digitalized teaching world one must be aware that this technique does not become overstressed which threatens to bore-out students. In a flipped classroom: (Gordon, Hughes and Smith, 2025) resulted that delivering content through spaced retrieval sessions may offer a new method of teaching that fosters student engagement through interactive learning while reducing the time needed for instructors to create and maintain video lectures. Therefore, a great variety of different teaching materials and the combination of reading, watching and hands-on-problem-solving seem to enhance the individual study progress the most. These findings are supported by: (Kazakov, 2025) who offers a new approach to the lecture process, based on the use of multimedia lectures with an intelligent pedagogical agent in the educational to help improve the effectiveness of training sessions.

5. Conclusion and recommendation from experience

PowerPoint is a versatile tool for creating animations and manipulating graphics effortlessly. PowerPoint lecture videos are low threshold to students due to availability, open access tutorials and common knowledge of the program. Therefore, these videos can be successfully produced by instructors as well as guided student project groups (peer-to-peer approach). PowerPoint allows users to organize slides into scenes based on scripts, with the ability to render each scene separately for streamlined editing. While rendering individual segments requires a one-time effort, the benefits include efficient rework and improved synchronization during post-production, especially when addressing imperfections in specific sections of a scene. The script is most important to guarantee the success of the lecture video in terms of understandability, wording and content. Along with a good voice these provide high stimulation and enhance the learning process. To create successful lecture videos using PowerPoint ppt, consider the following suggestions:

1. Peer-to-peer involvement: Engage students and draw upon their learning experiences to enhance the content.
2. Optimal length: Limit the video duration to 5-7 minutes to maintain viewer engagement and attention.
3. Simplicity: Keep assets, language, and setting simple for effective communication.
4. Screencast/Treatment preparation: Before starting, it is advisable to create a screencast or treatment to illustrate concepts and enhance overall video quality.
5. Meaningful illustrations: Focus on illustrating the meaning of sentences rather than merely emphasizing keywords to promote better understanding among viewers.

Note, that the author would like to recommend cut out animation over PPT animation to display complicated content because PPT requires advanced skills otherwise pauses during filming sequences will slow the lecture video and therefore may negatively influence student learning.

References

Bui, L. (2021). Using Lecture Videos in Flipped Classroom Model. *Advances in Social Science, Education and Humanities Research*, 621, 269-277. 18th International Conference of the Asia Association of Computer-Assisted Language Learning (AsiaCALL–2-2021). DOI: 10.2991/assehr.k.211224.026.

Chen, H.-T.M., Thomas, M. (2020). Effects of lecture video styles on engagement and learning. *Educational Technology Research and Development*. 1-35. DOI: 10.1007/s11423-020-09757-6.

Gordon, L.T.; Hughes, G.; Smith, A. (2025). Modernizing the Flipped Classroom: Replacing Lecture Time With Asynchronous Spaced Retrieval. *Teaching of Psychology*. DOI: 10.1177/00986283251325842.

Gulley, O.D., Jackson, A.L., (2016). A case study on using instructor-recorded videos in an upper level economics course. *International Review of Economics Education*, 23, 28–33.

Kay, R., Kletskin, I. (2012). Evaluating the use of problem-based video podcasts to teach mathematics in higher education. *Computers & Education,* 59, 619–627.

Kazakov, V.G. (2025). Multimedia Lecture with an Intelligent Pedagogical Agent – a New Approach to Organizing Lectures at a University. *Vestnik NSU Series Information Technologies* 22(4), 17-32.DOI: 10.25205/1818-7900-2024-22-4-17-32.

Mayer, R. (2009), *Multimedia Learning* (Cambridge: Cambridge University Press). https://doi.org/10.1017/CBO9780511811678.

Pfennig, A. (2019). "Making of" – Successfully Planning and Implementing peer-to-peer Lecture Films, *PEOPLE: Int. J. of Social Sciences*, 5(1), 795-815, https://dx.doi.org/10.20319/pijss.2019.51.795815.

Pfennig, A. (2023). Getting started - hands-on producing lecture films (Workshop). In: *PROCEEDINGS of the 51st ann. Conf. of the European Society for engineering education – Engin. Educ. for Sustainability SEFI*, 3231-3236. https://doi.org/10.21427/1XWQ-X307.

Robertson, B. and Flowers, M.J. (2020). Determining the impact of lecture videos on student outcomes. *Learning and Teaching,* 13(2), 25–40. doi: 10.3167/latiss.2020.130203.

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Language Proficiency Evaluation in the Age of AI: The Resurgence of Oral Production Skill

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Abstract
This article addresses a recent shift in the evaluation of language proficiency in our university courses towards the greater significance of oral production skill. Having compared language-practice and content-based French courses, we concluded that this shift represents a positive change in our teaching practice. We thus share our findings and thoughts on oral production and offer practical advice about the type of assessments and evaluation schemes that allow for the accurate and fair measurement of this skill.

Keywords: *oral production; language proficiency; evaluation.*

1. Introduction

About a century ago, Ferdinand de Saussure warned linguists about the unrightful place that written language tended to occupy in common opinion. "But the written word becomes so closely interwoven with the spoken word, of which it is the image," he taught in his *Cours de linguistique générale* in 1906-1911, "that it ends up usurping the leading role…" ("Mais le mot écrit se mêle si intimement au mot parlé dont il est l'image, qu'il finit par usurper le rôle principal …" ; de Saussure 1968, 45). In the same passage, he compared the study of a written image of the spoken word—instead of the direct study of the latter—to trying to know someone by looking at their photograph, rather than their actual face. A hundred years later, it turns out, our university language courses were still mostly doing exactly that: trying to judge our students' language proficiency based on their written exams (which equated 35-50 percent of the final mark in 2006-2011 at out department). Yet, slowly but surely, the situation has been changing.

Several factors contributed to the elimination of final written exams in the language practice courses at our department: First, the action-based approach (ABA) made the

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evaluation of grammar skills quasi impossible because of its focus on practice instead of theory. Second, the COVID-19 years forced us to find more diverse methods of evaluation because take-home written exams did not yield reliable results. Third, the arrival of machine-translation and AI available on minuscule electronic devices like the Apple watch, hidden cameras, and ear-fitting listening devices made even in-class written exams less reliable than 10 years ago.

In this article, we will argue that the events that contributed to this change have only precipitated the inevitable and improved our evaluation schemes, whose re-evaluation was long overdue. We will also give examples of the most successful formative and summative assessments that contribute to the development and a better evaluation of the oral production skill, as well as the evaluation rubrics best suitable for each assignment.

2. New Trends in Language Teaching and Proficiency Evaluation

In theory, all four language skills need to be evaluated to assess language proficiency. However, in practice, passive language skills – reading and listening – are evaluated, while active language skills – writing and speaking, and especially speaking – are often left aside by university placement tests because they are harder to evaluate and usually require a live examiner and, thus, additional resources. While TOEFL has experimented with involving AI and automated systems in the evaluation of recorded answers, the test still involves human raters, just like most English and French proficiency tests. Thus, these official tests prove costly and not suitable for placing students in university courses or evaluating their proficiency at the end of a course.

Yet several new approaches that gained popularity in this century favour oral production and its evaluation as part of language proficiency. As we mentioned in the introduction, with the adoption of ABA, our language courses shifted from written final exams to more graduated formative assessments, which now include oral examinations. This seems to be a general tendency for courses using action-based and task-based language teaching (TBLT), while the latest development is the use of technological resources to improve oral production through self-study in preparation of oral activities (Serna Silva 2022). The appearance of Multimedia TBLT (Bava Harji & Gheitanchian 2017) and production-oriented approaches (POA) thus placed even greater emphasis on oral production (Wen 2024) and its integration in the blended teaching of languages (Zhang 2023).

In addition to automated translation tools, the 20s of this century brought a new challenge to university language courses – GenAI. In an article on the impact of GenAI on higher education,

A. Duane has summarized the provisional outcomes of research on the challenges of AI's availability for university courses: "Methods of teaching, learning and assessment will have to radically change" (Duane, 2024, 15). This conclusion coincides with our experience in teaching university language courses: we have already changed our methods of teaching both in French- language courses and content-based courses taught in French to more emphasize oral skills; our students have learned to use multimedia resources to improve their oral production; and our methods of assessment have been heavily tilted towards oral assignments and oral exams. We see these changes as positive, and we believe they have improved our teaching and assessment methods. We will share our most successful new practices below.

2.1. New Approach and Evaluation Methods in Beginner French Courses

Our approach to beginner courses and requirements for pronunciation differ from the general CEFR (the Common European Framework of Reference) approach to oral production. While CEFR presupposes the gradual improvement of pronunciation – from inaccurate but understandable at the A1 level, still imperfect at A2 and clear at B2, to near-native at the C1 and flawless at the C2 levels – we observed that pronunciation does not improve by itself when students progress through our university courses without taking a specialized phonetics course. In fact, since the ABA does not include any conscious work on phonetics, students reinforce their erroneous articulation through their years of study, and their pronunciation skills do not evolve as described by CEFR. We therefore approach pronunciation scientifically from the start – while working on their A1 level, our beginners master the articulation of all French phonemes, as well as all reading and prosodic rules of the French language. All these criteria are included in the final evaluation of the reading test and a video project.

We call our new approach to teaching beginners Theory-and-Practice, or TaP (Sonina 2023). In teaching oral production, it differs from other approaches through the inclusion of linguistic theory – especially articulatory phonetics and the International Phonetic Alphabet (IPA). Naturally, for these classes, we simplify the theory and tailor it to the classroom's practical needs. However, the structured scientific approach to pronunciation ensures a quick mastery of all the particularities of French phonetics in

just one semester (12 weeks, or 6 weeks in intensive summer courses). These results are consistent with the experience of using IPA to teach English oral production described by our Algerian colleague (Beghoul 2017).

2.1.1. Evaluation of Oral Production in Introductory French I

Throughout the semester, students work on their pronunciation through e-exercises and graded recordings. For practice, they are encouraged to use all means available, including soundtracks of dictionaries and of Google Translate, as well as the dictate function available in Word. They also have the opportunity to sign up for individual consultations with TAs to practice their graded assignments.

At the end of the course, they have two oral assignments to demonstrate their ability to speak French without reading (final video project) and their mastery of French phonetics (reading test). The video is evaluated based on the following criteria:

- Creativity – 2% (Say something original, important, or make it interesting to watch)
- Grammar – 2% (Double-check your grammar during individual consultations)
- Vocabulary – 2% (Favour vocabulary that you have learned in the course)
- Pronunciation – 2% (Respect rhythmic groups and the articulation of important phonemes)
- Fluency – 2% (Memorize your lines and speak fluently. Do not read!)

To evaluate the pronunciation more accurately, we decided to introduce a reading test, which allows TAs to check the most important French phonemes and prosodic rules in the same context. Students have 30 minutes to practice and record a text that they have never seen before.

They have to mark the rhythmic groups, shade the silent letters, and indicate the consonants participating in a liaison with red colour, as well as highlight any reading difficulties by bolding, as shown below on a reading-test practice template.

The oral production evaluated in the video is not spontaneous and only 4 percent out of 10 percent of the mark represent the evaluation of speaking per se – fluency and pronunciation. However, together with the evaluation of the pronunciation on the reading test (5%), short oral presentations during tutorials (10%), and recordings produced during the semester (5%), the total evaluation of oral production skills adds up to almost 25 percent of the final mark.

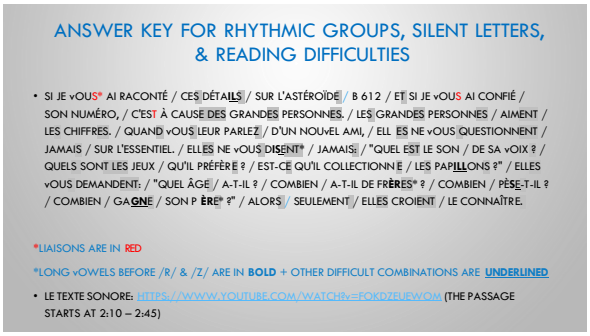


Figure 1. Reading-test template with examples of helpful highlights.

2.1.2. The Evaluation of Oral Production in Introductory French II

On the next level, the final video project is longer and requires cooperation with classmates, though the evaluation criteria remain the same. As for the reading test, it is conducted by TAs, so students prepare their reading in class and do not have an opportunity to listen to the text read by a computer program. Moreover, at the end of the reading, they have to answer two comprehension questions. The evaluation in class is possible on this higher level because students make fewer mistakes due to articulation: they review all the articulatory and prosodic difficulties learned in the Introductory French I, this time phonologically structured, and, as a result, most students master French pronunciation close to perfection. However, we still find that recording each student's performance is helpful, because the possibility of playing the recording many times over allows all mistakes to be marked accurately and to grade the test fairly after comparing students' success on the test.

2.2. New Evaluation Methods in Intermediate and Advanced French Courses

Following the evaluation methods applied in beginner-level courses, our university's intermediate and advanced French courses place an increasing emphasis on oral production. This shift reflects a progression in pedagogical goals, aiming to equip students with the skills necessary for effective communication in authentic contexts. The final course in this sequence, fourth-year Oral French, entirely dedicated to oral communication, represents a culmination of this focus. As students advance through the levels, evaluation methods evolve to prioritize interaction and improvisation, with evaluation criteria adapted to the specific course level. By encouraging spontaneity and adaptability, these methods not only strengthen language proficiency but also foster a

deeper engagement with the learning process, motivating students to transfer their linguistic knowledge to diverse real-life scenarios.

2.2.1. Evaluation of Oral Production in Language Practice at the Intermediate Level

At this level, oral production is assessed through group presentations (20%) and individual interviews (25%). Group presentations play a crucial role in assessing students' ability to work collaboratively and apply their linguistic knowledge in a structured format. The evaluation criteria for these presentations include:

- Narration Skills – 5% (Recounting and describing events or situations effectively)
- Vocabulary Use – 5% (Demonstrating a contextually appropriate lexicon)
- Grammar Use – 5% (Employing simple but appropriate grammatical structures)
- Pronunciation – 5% (Articulating clearly with correct rhythm)

In addition to group presentations, students undergo an individual interview, which evolves in complexity between first- and second-year courses. In the first course of the series, students prepare a short presentation on a course-related theme, followed by a guided discussion. In the next, an additional role-play component evaluates their ability to interact in more dynamic scenarios. In addition to the evaluation criteria applied to presentations, the interviews include points for social interaction, information exchange, and spontaneity.

2.2.2. Evaluation of Oral Production in Language Practice at the Advanced Level

In the higher-level courses, both group presentations and individual interviews are evaluated more rigorously. In presentations, in addition to the criteria listed above, fluency and presentation skills are evaluated individually, while the group work, representing 20 percent of the mark, is evaluated based on timing, organisation, originality, and the quality of visual aids. This dual evaluation ensures a balanced focus on both teamwork and individual performance. Additionally, students must submit a short video commentary on their peers' presentations, further reinforcing their oral skills.

The final course of the sequence entirely centred on oral communication incorporates a variety of innovative tasks designed to challenge students and help refine their skills. A task called Eloquence Capsule requires students to deliver a five-minute oral presentation on an idiomatic expression from the textbook, linking it to a social issue. This task evaluates their ability to research, synthesize, and present information creatively. The next task, Radio Show Simulation, allows students to collaborate,

exchange ideas, and demonstrate their ability to sustain a dynamic conversation during 15 minutes of "show time." Finally, the typical final interview consists of a 30-minute preparation period followed by two components: an argumentative presentation and a debate. These tasks assess students' ability to articulate opinions, defend ideas, and interact dynamically. On this level, all previous evaluation criteria remain in play, but more emphasis is given to coherence, linguistic precision, spontaneity, and task adherence.

2.3. New Evaluation Methods in Content-Based French Courses

Most of our content-based courses also include oral presentations and voice recordings as part of the final mark. For example, in Business French, weekly presentations account for 10 percent of the final mark, and the final oral presentation – a simulated job interview, which includes a self-introduction and a few "spontaneous" responses – accounts for another 10 percent of the final mark. At the beginning of the semester, the ungraded first attempt at self-introduction is recorded and submitted to the instructor who points out the pronunciation mistakes and assigns each student exercises useful to correct them. The "spontaneous" responses represent answers to typical job-interview questions. Students receive a list of questions in advance, but they do not know which exact questions will be asked during the simulation of the interview. Those unsure about their pronunciation can practice their answers using computer programs offering voiced versions of French sentences. The responses are evaluated based on purely oral criteria, 1 percent of each is given by the instructor, while the other represents the average of the evaluations provided by other students present in class:

- Intelligibility – 2% (Is the answer easy or difficult to understand?)
- Style – 2% (Is it simple and direct or complicated and tangled?)
- Tempo – 2% (Is it too fast, too slow, or just right?)
- Articulation – 2% (Is it clear and neat or unclear and inaccurate?)
- Intonation – 2% (Is it too monotonous, too agitated, or helpful for emphasis?)

Following the successful practice of an ungraded first-try recording in Business French, and due to the declining reliability of written exams, we also implemented entrance and exit recordings in our French Phonetics and Phonology course, which used to be purely theoretical. These recordings are evaluated based on the mastery of all phonological distinctions and prosodic particularities of French and now represent an integral part of the final mark.

3. Conclusion

When we compared our assessment methods, both between different courses and between the evaluation in each course now and 10 years ago, we found that within a decade, our assessment schemes had changed significantly in all language courses. The main tendency is apparent: all our language courses are now evaluated without final written exams, and all evaluation schemes include an oral examination or a voice recording. This alone proves the tendency of oral production regaining its rightful place in language proficiency. Two recent French monographs on the subject also confirm this tendency through the study of new didactic developments (De Pietro 2017) and of language facts pertinent to oral production (Cappeau 2021).

Certainly, there are still problems concerning official proficiency tests, which still either leave oral production aside or involve an interaction with an examiner (e.g., DELF/DALF tests) to evaluate speaking. For example, Evalang, used in our department for placement, does not evaluate any active language skills, but is based only on passive skill evaluation – reading and listening. However, it is possible to treat these tests as approximate and preliminary and then, in cases where it proves important, add to them an oral or written examination of active skills. We found that oral examinations do not always need to be thorough or lengthy – they just need to include all the components relevant to the given level, and above all, they need to be recorded, so it is possible to replay student's answers to ensure the accuracy of evaluation.

The innovative evaluation methods based on oral production implemented in our university's intermediate and advanced French courses are designed to foster authentic linguistic skills and to prepare students for real-world communication. By emphasizing interactive and improvised tasks, these approaches ensure that students develop both confidence and competence, while maintaining strong motivation throughout their learning journey. It is worth mentioning that students appreciate an opportunity to work with oral production. According to the end-of-term survey in 2024, 90 percent of students in Business French answered "YES" to the question "Do you think that correct pronunciation is important for your career?" while only 10 percent answered "more or less" and 0 percent chose "NO." Moreover, 71 percent of students found the initial evaluation of their pronunciation in the recorded first-try self-presentation "very helpful," 14 percent found it "quite helpful," 10 percent "more or less helpful," and only 5 percent did not find it helpful or have not done the first-try recording.

Overall, oral production proved to be the best way to evaluate student language proficiency, not only because it is AI-proof but also because it can be AI-enhanced in preparation for oral tasks and because it allows testing various language skills in one assessment. However, while working on this article, we concluded that we needed to do additional work on inclusiveness and on offsetting the anxiety experienced by some students while taking oral exams, especially when they are recorded and when the marks matter for their success. For now, we place our hopes on the preliminary, ungraded recording of the oral presentation, since this practice has proved successful in our content-based courses. We have also considered setting up a pronunciation clinic at our department, with students coming from diverse backgrounds and levels of language training. We will share our new experiments with the organization of oral exams in the next article. For now, we hope that the examples of formative assessments and marking schemes that we provided in this article will help language teachers to work more broadly with oral production and to administer oral examinations more often and more effectively.

References

Bava Harji, M., & Gheitanchian, M. (2017). Effects of Multimedia Task-Based Teaching and learning approach on EFL learners' accuracy, fluency and complexity of oral production. *TOJET The Turkish Online Journal Of Educational Technology*, 16(2), 25–34.

Beghoul, Y. (2017). Using the International Phonetic Alphabet in Teaching English Oral Production and Reception to Algerian Learners as a Potentially Efficient Solution to the Sound Spelling Incoherence. *Majallat al-'ulūm al-insānīyah* (Constantine, Algeria), ب(48), 63–78.

Cappeau, P. (2021). *Une grammaire à l'aune de l'oral ?* Presses universitaires de Rennes.

De Pietro, J.-F. et al. (2017). *L'oral aujourd'hui : Perspectives didactiques*. Presses universitaires de Namur.

Duane, A. (2024). Can Artificial Intelligence Complete My Assessment? A Student Led Initiative to Stress Test the Academic Integrity of University Course Work Using Generative AI. In: *10th International Conference on Higher Education Advances (HEAd'24)*. Valencia, 18-21 June 2024. https://doi.org/10.4995/HEAd24.2024.17143

Saussure, F. de. (1968). *Cours de linguistique générale*. Paris : Payot.

Serna Silva, I. (2022). From Language Teaching to Language Assessment with the Help of Technological Resources: Higher Education Students and Oral Production. *ELIA*, 22, 93–123. https://doi.org/10.12795/elia.2022.i22.04

Sonina S. (2023) Computerising and Intellectualising an Action-Based Approach for University Language Courses. In: *The Future of Education*, *13th Edition*. https://conference.pixel-online.net/library_scheda.php?id_abs=5986

Wen, Q. (2024). *A Production-Oriented Approach to Teaching Foreign Languages: Does a Post-Method Era Need a New Approach?* (1st ed.). Palgrave Macmillan.

Zhang, Y. (2023). Enhancing Oral Production in Integrated English Blended Teaching through a Production-Oriented Approach: An Action Research Study. *International Journal of Emerging Technologies in Learning*, 18(19), 61–71. https://doi.org/10.3991/ijet.v18i19.42477

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Comparison between Rasch analysis and Classical Test Theory for a Physics questionnaire validation

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Abstract

In academic year 2022/2023, an orientation course was proposed to high school students. The aim of the course was to help students to prepare for an admission test to engineering faculties. In this context, the students took a physics propaedeutical test, and their responses were used to validate the questionnaire by applying the Classical Test Theory. Consequently, a new analysis has been performed using the Rasch model instead. In this paper, a comparison between the results of these two different approaches is presented. The outcomes of these methodologies seem to be in a good accordance, and the combined use of them can provide more reliable information about either the test and the sample of students. This is particularly important for small samples, such as the one in our analysis.

Keywords: *Rasch; CTT; Test; Orientation; Physics.*

1. Introduction

In the last years, the importance of orientation activities proposed to high school students has grown up. As a consequence, Italian universities improved their offer of courses to help students deciding about their future academic path. In this context, during the academic year 2022/2023 the Politecnico di Milano offered a very wide range of orientation courses. The size of the catalogue was made possible by funds related to the National Recovery and Resilience Plan (Piano Nazionale di Ripresa e Resilienza, PNRR) (Decreto Ministeriale 934/22, 2022). According to PNRR requests, the courses had to span 15 hours and were to be designed with specific objectives. The main aim was to help students explore and understand the university environment, while also fostering awareness of their expectations and aspirations for future studies.

In this catalogue, there was a course run by the research groups ST2 and FDS of Politecnico di Milano named *Introduzione metodologica alla preparazione al test di Ingegneria*

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(Methodological Introduction to Engineering Test Preparation). This course was structured in 3 different activities. 3 hours were dedicated to a frontal lesson about motivation, 6 hours was dedicated to Mathematics activities and 6 hours were dedicated to Physics activities. More specifically, our research group (ST2) provided the physics contents, and this paper is focused only on this part.

The course addressed students who intended to take the Engineering Test of Politecnico di Milano named *Test OnLine* (TOL) and who wanted to prepare to pass it. The main objective of this activity were not to provide physics contents in a traditional way. On the contrary we aimed to develop skills in order to make students able to study and improve autonomously.

Our 6 hours were structured as follow. 2 hours were dedicated to an online introductory meeting about study methods during which students were asked to answer an 8-item propaedeutic physics test. The remaining 4 hours were dedicated to a laboratory session. Globally, 113 students joined the proposal.

Concerning the laboratory session, we decided to design our activities following an open-ended style (Trumper, 2003). This approach allows students to feel more protagonist and to discover that Physics has a strong experimental nature (Wilcox & Lewandowski, 2016). In addition, the open-ended style laboratory can foster the science self-efficacy (Hu et al., 2022) that provide several positive aspects to the learning process (Alhadabi, 2021; Bandura, 1997; Hazari et al., 2010). Other details about the propaedeutical test will be discussed in further paragraphs.

The test proposed in the introductory meeting has been validated using 2 different methodologies: the Classical Test Theory (CTT) and the Rasch Analysis. The main aim of this work is to compare the results of these validations to highlight similarities and differences

In this paper we present in Section 2 the objectives of the propaedeutical test. In Section 3 we explain the theoretical background concerning the Rasch Analysis and we list our research questions. In Section 4 we describe the structure of the test and the methods of analysis. In section 5 we present the results. Eventually, in section 6 we discuss our results.

2. The Propaedeutical Test

During the introductory online lesson, students were asked to answer an 8-item multiple choice questionnaire and immediately after this test, the teacher provided a feedback. The main purpose of the test was not to evaluate the student or to rank them based on their scores. Indeed, the aim was to conduct a survey to make students aware of some gaps or misconceptions. In this context, the use of feedback is very important because helps students to reflect on their knowledge and learning methods exploiting a meta-cognitive approach (Romainville, 2006). The feedback given by the teacher was useful to make students able to recognize their errors and avoid them

in the future (Hattie & Clarke, 2018). In the opposite direction, feedback provided by students was useful for the teacher to understand why they chose a specific incorrect answer.

In addition, there is another aim that is not strictly related to the specific course presented in the Introduction. Designing and analysing this test allowed us to validate it and to build a database of good items to use even in other courses or situations. In fact, our research group is often engaged in experimental teaching activities. In this context, having access to a reliable item bank is very useful. An example of these activities is the peer-learning strategy we experimented in last years (Bozzi et al., 2021) but also other researches like (Bozzi et al., 2019, 2020, 2021, 2023; Gondoni et al., 2021)

In a previous work (accepted and waiting for publication in a Springer book) we validated this questionnaire using the CTT. More specifically, we calculated the Difficulty Level, the Discrimination Index and the Point-Biserial Coefficient (Ding & Beichner, 2009). The results of this analysis will be reported in Section 5 to make a comparison with the results of the Rasch Analysis

3. Rasch Analysis

If the Classical Test Theory assigns at each item of a test a coefficient that describes different characteristics (difficulty level, discrimination index and others), the Rasch Analysis is based on a completely different approach. As suggested by its name, this methodology was proposed by Georg Rasch (Rasch, 1960). In a nutshell, the Rasch model is a psychometric framework used for analyzing data from assessments, particularly in educational and psychological testing. It is part of the broader family of Item Response Theory (IRT) models but stands out due to its simplicity and strict mathematical properties.

At its core, the Rasch model evaluates the interaction between two factors: the person's ability (or trait level) and the item difficulty. It assumes that the probability of a correct response to an item depends on the difference between the person's ability and the item's difficulty. The model uses a logistic function to express this probability (Wright & Stone, 1979):

$$P(X_{ij}) = \frac{e^{\theta_i - \beta_j}}{1 + e^{\theta_i - \beta_j}} \quad (1)$$

Where $P(X_{ij})$ is the probability that person i answers item j correctly, θ_i represents the person's ability and $\beta_j$represents the item's difficulty. The Rasch model has several important features (Boone et al., 2014). First the *unidimensionality* that assumes that the performance depends on a single latent trait (e.g., ability). Another one is the *invariance*. This means that the item difficulty is independent of the sample and person ability is independent of the item set, if the statistics is sufficiently large. In addition, thanks to the *additivity*, both abilities and difficulties are expressed on a logit scale, enabling meaningful comparisons. The logit scale is a linear scale

used in the Rasch model, representing the natural logarithm of odds (log-odds) for probabilities, enabling comparisons of person ability and item difficulty.

Applications of the Rasch model include test design, item calibration, and detecting biases in items or groups. Its strict assumptions make it valuable for ensuring data quality and validity. When the data fit the model, it provides robust and interpretable measures that are invariant across contexts, enhancing the fairness and comparability of assessments.

In this paper we will answer the following research questions. The first (RQ1) is: Can the Rasch model be applied to our test? Then (QR2) is: Is the item difficulty level of the CTT similar to the Rasch model one?

4. Structure and Methods

The test was proposed to 113 students attending our orientation course in academic year 2022/2023. The 8 items were multiple choice questions with one right answer and three distractors. The questions cover different topics as shown in Table 1.

Table 1. Topics covered by each item.

Item	Topic
Q1	Force and movement
Q2	Friction
Q3	Circular motion
Q4	Kinetic and potential energy
Q5	Electric field and electric potential
Q6	Period and angular velocity
Q7	Free fall
Q8	Electrostatic force and Newton's third law

All these questions were designed to highlight possible misconceptions or gap in preparation. Indeed our items have the structure and the aim that could be similar to items in more famous tests like CSEM(Maloney et al., 2001) or FCI (Hestenes et al., 1992).

To validate this questionnaire, we applied first the CTT calculating some coefficients including Difficulty Level, Discrimination Index and Point-Biserial coefficient. The Difficulty Level measures how much a question has been difficult dividing the number of right answers by the total number of answers. This means that the frequency of correct answers to each item is used as an indicator for the difficulty of that item. The Discrimination Index is useful to evaluate how much an item is able to make differences among high-level students and low-level students. More precisely, it is calculated by sorting the students based on their final scores and comparing the number of students at the top of the leaderboard who answered correctly with the number of students at the bottom who answered correctly. The Point-Biserial coefficient is another measure

of the discrimination of an item. It provides an evaluation of the correlation between the score in a single question and the total score. We made all our calculations using the software R.

Consequently, we took into account the Rasch Analysis. In this case, to proper calculate the indices we had to rely on a specific R package named "eRm". This package contains functions that calculate all the parameters useful for the Analysis.

We started estimating how much the data fit with the Rasch model. First, we performed a Chi-square test observing that almost all the p-values were greater than 0.05. The only exception was 0.045 for the item Q7. Then we went deeper finding the values of the indicators named *Infit* and *Outfit.* The first, similarly to the Chi-square, provides a measure of how data fit with the model excluding the outliners points. The second one provides the same information but considering all the data. As suggested by (Bond & Fox, 2001; Karabatsos, 2000) the values of Infit and Outfit should be between 0.7 and 1.3 to state that there is a good accordance between data and Rasch model. The results will be presented in next section.

Then we wanted to compare the β values with the difficulty coefficients obtained using the CTT. To make this comparison we relied on the classification of Difficulty levels proposed by (Crocker & Algina, 1986) and we found the corresponding upper and lower bounds of β for each level. We did it using the (1) in which P is equal to the bound values of difficulty levels in CTT and θ is assumed to be zero. This means that in this calculation we approximated the ability of all students to the theoretical average ability of a group of persons. We also considered the standard error of β to find a minimum and a maximum difficulty level.

5. Results

As far as the CTT concerns, we report in Table 2 the results of the analysis we performed in our previous work.

Table 2. Coefficient of Classical Test Theory: Difficulty level (P), Discrimination Index (D) and Point-Biserial Coefficient (r).

Item	P	P-level	D	D-level	r
Q1	0.32	Medium	0.48	Good	0.45
Q2	0.38	Medium	0.56	Good	0.45
Q3	0.19	Medium-High	0.47	Good	0.51
Q4	0.28	Medium	0.58	Good	0.52
Q5	0.25	Medium-High	0.33	Reasonably Good	0.30
Q6	0.50	Medium-Low	0.50	Good	0.37
Q7	0.58	Medium-Low	0.55	Good	0.44
Q8	0.20	Medium-High	0.27	Marginal	0.27

To assign a category to each difficulty level and discrimination index we followed the structure proposed by (Crocker & Algina, 1986; Ebel & Frisbie, 1972). Concerning the Point-Biserial coefficient, all the values are above 0.2 so they can be considered "acceptable" (Kline, 1986). An additional information is that, considering all the students that answered the test, the average final score in this test was 2.67 up to 8.

Table 3 shows the Item Difficulty levels obtained with the Rasch model with the standard error of each item, the converted β-level scale and the values of Infit and Outfit for each item.

Table 3. Summary of results related to the Rasch model. The columns contain Item number, Difficulty Level, Standard Error, Minimum of converted β-level scale, Maximum of converted β-level scale, Infit indicator, Outfit indicator.

Item	β	SE_β	β-level (min)	β-level (max)	Infit	Outfit
Q1	0.07	0.20	Medium-Low	Medium	0.95	0.95
Q2	-0.27	0.19	Medium-Low	Medium-Low	0.99	1.01
Q3	0.78	0.23	Medium	Medium-High	0.80	0.64
Q4	0.25	0.20	Medium	Medium	0.87	0.74
Q5	0.39	0.21	Medium	Medium	1.06	1.23
Q6	-0.81	0.19	Medium-Low	Medium-Low	1.09	1.07
Q7	-1.11	0.19	Easy	Medium-Low	0.97	1.01
Q8	0.72	0.22	Medium	Medium	1.07	0.92

6. Discussion and conclusion

To answer the RQ1 we observed that in Table 3 all the Infit values are between 0.7 and 1.3. The same happens with the Outfit values with a single exception in Q3. This means that the model is applicable even if the number of students involved is not particularly high, as would theoretically be required.

Concerning the RQ2, we compared the Difficulty levels of CTT reported in third column of Table 2 and the ones of Rasch model reported in fourth and fifth column of Table 3. We notice that, in most cases, the categories overlap. We also observe that when β-level is different from P-level, the difficulty estimated with the Rasch model is always lower than the one obtained with the CTT. We think that this is probably due to the low level of preparation of students in our sample. Indeed, knowing that the average final score was 2.67 we thought that our students had a bad performance. Nevertheless, according to the validation we performed in our previous work, this test is not suitable for evaluating students' level, so we could not confirm this perception. From our point of view, it is therefore interesting to find that β, which does not depend on the sample, is actually lower than P. This can confirm the low level of our students.

Considering the results presented in this paper we can add another consideration. A sample of 113 students is not enough to completely trust neither the outcomes of CTT nor the Rasch model.

On the other hand, we found that in our work the data fit the Rasch model and the results are comparable with the CTT. This means that, in this case, running both analysis is useful to find more reliable information and come to stronger conclusions. We are waiting to verify this aspect more precisely using data from further editions, which involved a larger number of students.

References

Alhadabi, A. (2021). Science Interest, Utility, Self-Efficacy, Identity, and Science Achievement Among High School Students: An Application of SEM Tree. *Frontiers in Psychology*, *12*. https://doi.org/10.3389/fpsyg.2021.634120

Bandura, A. (1997). *Self-efficacy: The exercise of control* (pp. ix, 604). W H Freeman/Times Books/ Henry Holt & Co.

Bond, T. G., & Fox, C. M. (2001). *Applying the Rasch Model: Fundamental Measurement in the Human Sciences*. Psychology Press. https://doi.org/10.4324/9781410600127

Boone, W. J., Staver, J. R., & Yale, M. S. (2014). *Rasch Analysis in the Human Sciences*. Springer Netherlands. https://doi.org/10.1007/978-94-007-6857-4

Bozzi, M., Balossi, B., Sieno, L. D., Ganzer, L., Gondoni, P., Genco, I., Minnai, C., Pini, A., Rezoagli, F., Zanoletti, M., & Zani, M. (2019). Securing Freshmen's Learning Through A Physics Refresher Course: A Breakthrough Experience At Politecnico Di Milano. *ICERI2019 Proceedings*, 2237–2243. 12th annual International Conference of Education, Research and Innovation. https://doi.org/10.21125/iceri.2019.0610

Bozzi, M., Ghislandi, P., & Zani, M. (2020). Misconceptions in physics: an uphill climb. *INTED2020 Proceedings*, 2162–2170. 14th International Technology, Education and Development Conference. https://doi.org/10.21125/inted.2020.0670

Bozzi, M., Ghislandi, P., & Zani, M. (2021). Misconception in fisica: Un'opportunità di collaborazione tra università e scuola superiore. *Nuova Secondaria*, *XXXVIII*(5), 81–85.

Bozzi, M., Mazzola, R., & Zani, M. (2023). Peer learning in higher education: An example of practices. *Il Nuovo Cimento C*, *46*(6), 1–11. https://doi.org/10.1393/ncc/i2023-23206-7

Bozzi, M., Raffaghelli, J. E., & Zani, M. (2021). Peer Learning as a Key Component of an Integrated Teaching Method: Overcoming the Complexities of Physics Teaching in Large Size Classes. *Education Sciences*, *11*(2), Article 2. https://doi.org/10.3390/educsci11020067

Crocker, L., & Algina, J. (1986). *Introduction to Classical and Modern Test Theory.* Holt, Rinehart and Winston, 6277 Sea Harbor Drive, Orlando, FL 32887 ($44.75). https://eric.ed.gov/?id=ed312281

Decreto Ministeriale 934/22, Pub. L. No. 934/2022 (2022). https://www.mur.gov.it/it/atti-e-normativa/decreto-ministeriale-n-934-del-03-08-2022

Ding, L., & Beichner, R. (2009). Approaches to data analysis of multiple-choice questions. *Physical Review Special Topics - Physics Education Research*, *5*(2). Scopus. https://doi.org/10.1103/PhysRevSTPER.5.020103

Ebel, R. L., & Frisbie, D. A. (1972). *Essentials of educational measurement*. https://www.academia.edu/download/62436844/Essentials_of_Educational_Measurement20200321-35262-g74v5m.pdf

Gondoni, P., Bozzi, M., Balossi, B., Calisesi, G., Ferocino, E., Genco, I., Molteni, L. M., Pini, A., Rezoagli, F., Zanoletti, M., & Zani, M. (2021). A novel approach to online physics refresher courses at Politecnico di Milano. *INTED2021 Proceedings*, 1471–1475. 15th International Technology, Education and Development Conference. https://doi.org/10.21125/inted.2021.0336

Hattie, J., & Clarke, S. (2018). *Visible Learning: Feedback*. Routledge. https://doi.org/10.4324/9780429485480

Hazari, Z., Potvin, G., Tai, R. H., & Almarode, J. (2010). For the love of learning science: Connecting learning orientation and career productivity in physics and chemistry. *Physical Review Special Topics - Physics Education Research*, *6*(1), 010107. https://doi.org/10.1103/PhysRevSTPER.6.010107

Hestenes, D., Wells, M., & Swackhamer, G. (1992). Force concept inventory. *The Physics Teacher*, *30*(3), 141–158. https://doi.org/10.1119/1.2343497

Karabatsos, G. (2000). A critique of Rasch residual fit statistics. *Journal of Applied Measurement*, *1*(2), 152–176.

Kline, P. (1986). *A handbook of test construction: Introduction to psychometric design* (pp. xi, 259). Methuen.

Maloney, D. P., O'Kuma, T. L., Hieggelke, C. J., & Van Heuvelen, A. (2001). Surveying students' conceptual knowledge of electricity and magnetism. *American Journal of Physics*, *69*(S1), S12–S23. https://doi.org/10.1119/1.1371296

Rasch, G. (1960). *Probabilistic Models for Some Intelligence and Attainment Tests*. Danmarks Paedagogiske Institut.

Romainville, M. (2006). *Awareness of cognitive strategies: The relationship between university students' metacognition and their performance: Studies in Higher Education: Vol 19, No 3*. https://www.tandfonline.com/doi/abs/10.1080/03075079412331381930

Trumper, R. (2003). The Physics Laboratory – A Historical Overview and Future Perspectives. *Science & Education*, *12*(7), 645–670. https://doi.org/10.1023/A:1025692409001

Wilcox, B. R., & Lewandowski, H. J. (2016). Open-ended versus guided laboratory activities:Impact on students' beliefs about experimental physics. *Physical Review Physics Education Research*, *12*(2), 020132. https://doi.org/10.1103/PhysRevPhysEducRes.12.020132

Wright, B., & Stone, M. (1979). Best test design. *Measurement and Statistics*. https://research.acer.edu.au/measurement/1

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Interactive simulations with PhET as a design tool for engineering education: design of an energy integration network

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Abstract

This work describes the use of interactive simulations as learning spaces for digital transformation of engineering education. Students carried out collaborative activities using Matlab-GUI (Graphical User Interface). An interactive simulation was prepared to design an energy integration network that minimizes the use of utilities in a chemical process. Students used the interactive tool to assess the effect of the minimum difference of temperature between the hot and cold streams on the cost of the proposed network and its economic viability. Motivation and academic performance were the variables analyzed in this study. Motivation was measured with the MUSIC model (eMpowerment, Usefulness, Success, Interest, and Caring). Mann-Whitney technique was utilized to measure the differences between the students in the group under study and the control group. Results indicated that the interest of the students in the learning activity and their expectation for usefulness were statistically higher when interactive simulation tools were utilized.

Keywords: *Educational innovation; PhETs; Interactive-simulation; Higher education.*

1. Introduction

Nowadays there are a variety of digital strategies and tools that allow students to be more active and motivated to collaborate, socialize, and share ideas in learning activities (Al Mamun et al. 2022; Motyl et al. 2021). These strategies can merge with each other, looking for students to take a more active role and assume greater responsibility in the construction of their own learning and that of their peers. This competency constitutes the basis of continuous learning, particularly in technical fields. In this study, a learning experience using flipped classroom technique, collaborative learning and interactive simulations is described. The experience consisted in the design and implementation of Matlab-GUI (Graphical User Interface) application aimed to improve the understanding and interest of college students in engineering

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topics such as energy integration. Its impact on motivation and academic performance of students was measured using the MUSIC instrument (Jones, 2018), which assesses the student perception in terms of eMpowerment, Usefulness, Success, Interest and Care.

In the teaching of science and engineering, the execution of practices in laboratories is essential to facilitate the understanding of physical phenomena and develop specific engineering skills. However, access to these experiences is frequently limited by the lack of space, material and human resources, and even extraordinary situations such as the SARS-CoV-2 pandemic (Vanoye et al. 2020).

Although there are commercial simulators, with applications in the chemical in-dustry, such as Aspen Plus, these simulators are not as readily available to students due to the prior knowledge required for their use, in addition to computational requirements and licensing costs. Few interactive resources have been developed for didactic purposes, focused on illustrating specific concepts within chemical engineering courses. Vanoye et al. (2020) present a compilation of virtual reality applications in chemical engineering. Particularly noteworthy is Learncheme.com, a website that includes video recordings, interactive simulations, Polymath files, short quizzes, and a virtual laboratory (Granjo y Rasteiro, 2020). On the other hand, PhET interactive simulations are educational resources originally conceived for teaching of physics, the use of which has become popular and today is used in multiple educational innovations, including some on chemical engineering concepts (Khatri et al. 2014, Gargallo et al. 2009).

In the area of engineering, the understanding of concepts has been facilitated using computational tools such as Maple and MATLAB. MATLAB is a technical calculation language and programming environment for algorithm development, data analysis, visualization, and calculation developed by the Mathworks company, and with great popularity around the world. Majid et al. (2012) evaluated the effectiveness of its use on students' attitudes and motivation and its impact on learning. Gemechu et al. (2018) found, for example, that the use of MATLAB software can improve students' conceptual understanding, even if their mathematical skills are weak.

In the area of chemical engineering teaching, the use of MATLAB has begun to be explored in material balance applications (Domínguez-Candela et al. 2021), chemical reactors (Molina et al. 2020), heat transfer operations (Lobato et al. 2021), process optimization (Jeraal, et al. 2021), among others. Specifically, Pinch point analysis, also known as energy integration, is an important concept in chemical engineering instruction. The Pinch method is a systematic approach to designing processes, which incorporates techniques to maximize energy efficiency and minimize energy consumption for utilities in a chemical plant.

2. Description of the educational innovation

In this project, graphical user interfaces were created using MATLAB GUI (Graphical User Interface). These MATLAB interfaces or APPS are stand-alone programs that allow the automatization of a task or calculation. Typically, these interfaces include controls such as buttons, toolbars, and sliders. The graphical interface that was created is shown in Figure 1. The elements present in the graphical interface are:

a) A diagram of an industrial chemical process. In this process stream 1 must be heated from 20 to 135°C to be fed to still T1. The distilled product (stream 3) leaves T1 at 80°C and must be heated to 140°C to be fed to still T2. The bottom stream of T2 (stream 2) leaves the equipment at 170°C and must be cooled to 60°C. Finally, the bottom stream of T1 (stream 4) must be cooled from 150 to 30°C. All these heating and cooling processes are carried out in heat exchangers that use external services: cooling water to cool the hot streams and steam to heat the cold streams. These services represent operation costs and contribute to the emission of greenhouse gases.

b) A table with the characteristics of the hot streams (which require cooling) and cold streams (which require heating) in the process. This table specifies the inlet and outlet temperatures for each stream, as well as the amount of heat (Q) that must be added or removed from each stream and the product of the mass flow and the specific heat capacity for each stream.

c) A composite curve that relates the temperatures of the hot and cold streams to the amount of heat exchanged by the streams. As can be seen in Figure 1, the curve of the hot currents has higher temperatures than the curve of the cold currents, in such a way that there can be a flow of heat between both currents. The minimum temperature difference between the curve of hot and cold currents (ΔT_{min}) is a very relevant parameter for the design of the energy integration network. In the graphical interface, this composite curve has a slider bar that allows the student to define the value that the ΔT_{min} parameter will have in his energy integration network proposal. Figure 1 shows the composite curve for $\Delta T_{min} = 15°C$. The effect of ΔT_{min} on the design of the heat exchangers surface area is inverse, decreasing ΔT_{min} would increase the surface area of the heat exchanges and consequently the capital cost of the project.

The educational innovation was implemented in the IQ2017 Chemical Process Design course, which is offered during the fifth semester of the Chemical Engineer program (Tec21) at Tecnologico de Monterrey, a private university located in Monterrey, Mexico. The experimental design consisted of a classical experiment with a control group and an experimental group. The population of the control group was 38 students, while the experimental group was 33 students. The variables of interest were "academic performance" and "motivation".

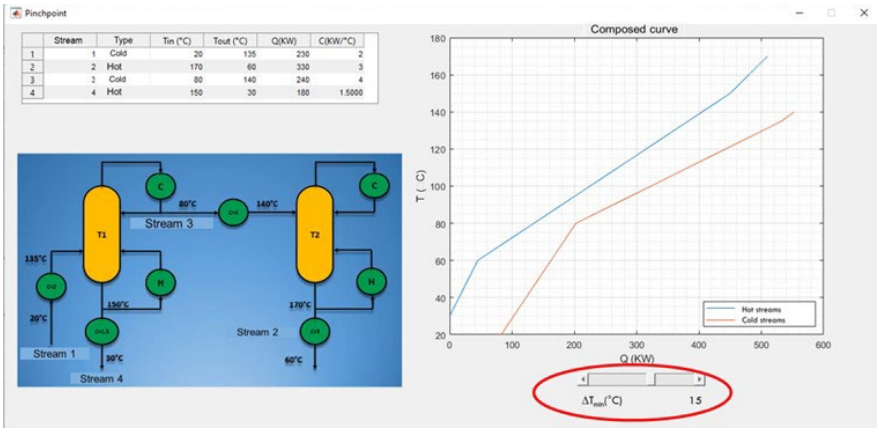


Figure 1. Graphical interface created for the interactive simulation as part of the learning activity in the Chemical Process Design course.

The measurement instrument for "academic performance" was a rubric and to measure the variable "motivation" the MUSIC inventory of academic motivation was used. The MUSIC model of motivation was developed by Dr. Brett D. Jones as a research-based model to explain the relationships between factors that affect people's motivation to participate in activities, such as courses and class assignments (Jones, 2009). The instrument developed for this measurement is composed of 26 items divided into 5 sub-scales: empowerment, usefulness, success, interest, and care. Each item has 6 response options. The English version has been used and validated in terms of reliability by various studies. For example, a publication by Chittum et al. (2019) on 552 college students demonstrated Cronbach's alpha of 0.85. In a recent study, Bendicho et al. (2018) found that the instrument has a Cronbach's alpha of 0.79 (teacher as instructor) or 0.94 (when another student was used as instructor). Jones (2009) found a Cronbach's alpha of 0.92 in a sample of 201 Spanish-speaking university students.

A scoring rubric was used as an instrument for assessing the students' achievement of their academic performance. The rubric assessed 6 performance indicators of the learning outcomes: a) Strategy, b) Tools used, c) Analysis, d) Synthesis, e) Solution approach, and f) Report.

Responses were quantified through a Likert-type summated scale, designed to assess students´ demonstration of the competency key actions (0= unacceptable, 1=marginal, 2= acceptable, 3= very good). Validation of the instrument for assessing the students' achievements was carried out using the technique of expert judgement, which allows identifying inconsistencies in terms of sufficiency, clarity, coherence, and relevance. A total score was calculated with the sum of the assessment ratings of the six performance indicators of the learning outcome.

The learning activity was planned to take place during a two-hour session. Before the session, the professor uploaded the link to the CANVAS platform of the course "Design of chemical processes" to access the description of the activity and complementary information. During the

session, the students were divided into small groups, discussed the activity, and clarified doubts with their teacher. Subsequently, they solved the problem presented in the activity and uploaded the result of their work to the CANVAS platform. The purpose of the learning activity is to learn how to use the methodology known as "pinch point" to create an energy integration network in a chemical process. Through a systematic procedure, the network is defined in which the hot streams of the process can be in contact with the cold streams in such a way that the consumption of external services (steam and cooling water) is minimized. Specifically, the learning activity seeks that students evaluate the effect of the minimum temperature difference (ΔTmin) on the consumption of external services, and on the cost of the energy integration network. The control group used the traditional approach, where they solve all the system mathematical equations that model the heating phenomena, including heat and mass balances as well as heat transfer equations for each heat exchanger. The experimental group used the PhET app described above.

3. Results and discussion

The MUSIC inventory of academic motivations was used to measure the "motivation" of the students in the learning activity. Each of the 26 items on the instrument has 6 response options, on a scale of 1 to 6, where 1 represents "strongly disagree" and 6 represents "strongly agree". Student responses were used to calculate motivation on each of the model's 5 subscales: empowerment, usefulness, success, interest, and caring. The statistical analysis of the results was carried out with Minitab version 21, using the non-parametric Mann-Withney test. The p-value < 0.05 was used as a criterion to differentiate results that are statistically significant.

Table 1 and Table 2 show the results of the Mann-Whitney test for the experimental group and the control group. As can be seen, the results indicate that the Interest of the students in the learning activity and their expectations of Usefulness are statistically higher when the interactive simulation tools were used. As can be observed in Table 1, the p-value for the Usefulness category is 0.04, lower than the criterion established for statistical significance (0.05). Also, in Table 2, the p-value for the Interest category is 0.013, considerably lower than the p-value of 0.05. These findings support the idea that the use of this digital education technology has a relevant impact on the motivation of the students.

Table 1. Results of the Mann-Whitney test for the variable "motivation" using the MUSIC model, for the eMpowerment, Usefulness and Success categories.

Group	Samples	eMpowerment		Usefulness		Success	
		Median	p-value	Median	p-value	Median	p-value
Experimental	27	4.6	0.395	5.4	0.040	5.0	0.185
Control	36	4.5		4.9		4.75	

Table 2. Results of the Mann-Whitney test for the variable "motivation" using the MUSIC model, for the Interest and Care categories.

Group	Samples	Interest		Care	
		Median	p-value	Median	p-value
Experimental	27	5.1	0.013	6	0.264
Control	36	4.7		6	

As shown in Figure 2, the 95% confidence intervals for the average academic performance measured in the PhET group do not overlap with the confidence interval for the traditional group measurements, which means that the null hypothesis: "there are differences between the results obtained by the two different learning processes", is accepted. The results obtained by the students in the experimental group are better than the results obtained by the control group.

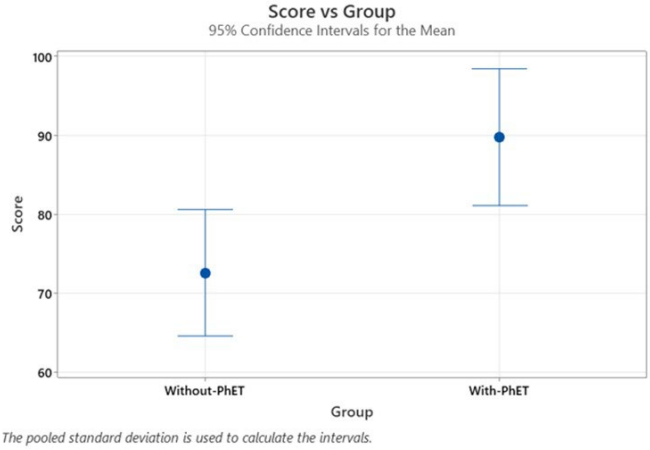


Figure 2. Comparison of the average score of students in the learning activity with PhET and without PhET.

The interactive graphical interface allowed the students to visualize more clearly the effect of the minimum temperature difference (ΔTmin) on relevant process variables such as the consumption of external services and the temperature differences between hot and cold currents in the different sections of the diagram.

In this project, an interactive simulation digital tool was developed to be used in the design of a heat exchange network proposal that contributes to the efficient use of energy in chemical processes. The digital tool allowed evaluating the effect that some important variables of the network design have on the cost of the energy integration proposal. The variables of motivation and academic performance of the students were evaluated. It was observed that collaborative learning activities with interactive simulators (PhET) are more Interesting and have higher

expectations of Usefulness than activities that do not use this digital tool. This improvement in student motivation can be considered as a strength of the project. The difference between the experimental group (with PhET) and the control group (without PhET) was statistically significant at the 95% confidence level. The students in the experimental group that used the PhET tool obtained a higher academic performance than the students in the control group. The students in the experimental group had more time to analyze the effect of the change in the relevant variables of the design of the heat exchanger network than the students in the control group. The latter required a considerable amount of time solving the system of mathematical equations and less time analyzing the entire system. Furthermore, the control group was subjected to miscalculations that could mislead the conclusion. Overall, this work contributes to the continuous improvement process of engineering courses and can be replicated in other schools. In a second phase of implementation, an increase in the number of interactive simulators will be sought to build a virtual laboratory that contributes to the digital transformation of engineering education.

4. Conclusions

This work contributed by providing more insight into the interest of the students in learning activities and their expectations of usefulness, which were statistically higher when the interactive simulation tools were used. The results supports the idea that the use of digital educational technology significantly improved the learning process.

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References

Al Mamun, M. A., Azad, M. A. K., & Boyle, M. (2022). Review of flipped learning in engineering education: Scientific mapping and research horizon. *Education and information technologies*, *27*(1), 1261-1286.

Bendicho, M. D. L. P. F., Pérez, S. G., & Luis, C. E. M. (2018). Docencia por iguales en prácticas de electrónica y su efecto sobre la motivación. In *Tecnología, Aprendizaje y Enseñanza de la Electrónica: Actas del XIII Congreso de Tecnología, Aprendizaje y Enseñanza de la Electrónica, Tenerife, 20-22 de junio, 2018* (pp. 152-157). Universidad de La Laguna.

Chittum, J. R., Jones, B. D., & Carter, D. M. (2019). A person-centered investigation of patterns in college students' perceptions of motivation in a course. *Learning and Individual Differences*, *69*, 94-107.

Domínguez-Candela, I., Cardona, S. C., Lora-García, J., López Pérez, M. F., & Fombuena, V. (2021). Assessment of students in the use of matlab guide templates for solving material balances. A teaching experience in chemical engineering degree. *INTED2021 Proceedings*, 5926-5933.

Gargallo, B., Jesús, S. R., & Pérez-Pérez, C. (2009). El cuestionario CEVEAPEU. Un instrumento para la evaluación de las estrategias de aprendizaje de los estudiantes universitarios. RELIEVE. *Revista Electrónica de Investigación y Evaluación Educativa*, 15(2), 1-31.

Gemechu, E., Kassa, M., & Atnafu, M. (2018). Matlab supported learning and students'conceptual understanding of functions of two variables: Experiences from Wolkite University. *Bulgarian Journal of Science and Education Policy*, *12*(2), 314-344.

Granjo, J. F., & Rasteiro, M. G. (2020). Enhancing the autonomy of students in chemical engineering education with LABVIRTUAL platform. *Education for Chemical Engineers*. 31, 21-28

Jeraal, M. I., Sung, S., & Lapkin, A. A. (2021). A Machine Learning-Enabled Autonomous Flow Chemistry Platform for Process Optimization of Multiple Reaction Metrics. *Chemistry-Methods*, *1*(1), 71-77.

Jones, B. D. (2009). Motivating students to engage in learning: the MUSIC model of academic motivation. *International Journal of Teaching and Learning in Higher Education*, *21*(2), 272-285.

Jones, B. D. (2018). *Motivating students by design: Practical strategies for professors*. CreateSpace Independent Publishing Platform.

Khatri, R., Henderson, C., Cole, R., & Froyd, J. (2014). Over one hundred million simulations delivered: A case study of the PhET interactive simulations. *Proceedings of the Physics Education Research Conference* (pp. 205-208).

Lobato, F. S., de Oliveira Arouca, F., & Libotte, G. B. (2021). Development of an Educational Environment by Using Graphical User Interfaces Applied to Heat Transfer Problems. *Latin-American Journal of Physics Education*, *15*(1), 11.

Majid, M. A., Huneiti, Z. A., Al-Naafa, M. A., & Balachandran, W. (2012, September). A study of the effects of using MATLAB as a pedagogical tool for engineering mathematics students. In *2012 15th International Conference on Interactive Collaborative Learning (ICL)* (pp. 1-9). IEEE.

Molina, R., Orcajo, G., Segura, Y., Moreno, J., & Martínez, F. (2021). KMS platform: A complete tool for modeling chemical and biochemical reactors. *Education for Chemical Engineers*, *34*, 127-137.

Motyl, B., & Filippi, S. (2021). Trends in engineering education for additive manufacturing in the industry 4.0 era: a systematic literature review. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, *15*(1), 103-106.

Vanoye, A.Y., Carrera, H.E., Romero, M.A. (2020) Haciendo biodiesel en Realidad Virtual. *Memorias del VII Congreso Internacional de Innovación Educativa*. Monterrey, México.

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The development of a medicines management module for undergraduate nursing students

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Abstract

Nursing students find pharmacology and medicines management a very challenging aspect of their undergraduate learning. To address this, we have we have developed a module that incorporates a number of interlocking features: flipped lectures with exercises, regular formative assessments, team-based activities, weekly Q&A sessions and a simulation exercise; these are conducted over a 7-week period at the end of their 3rd year. Student performance in the module has been very good, and student feedback has been very positive. We believe that the combination of pedagogical modalities have made a significant contribution to the success of the module and we will continue to develop the module, to further enhance the student learning experience

Keywords: *Medication management; Pharmacology; dosage calculations; large classes*

1. Introduction

The safe management and administration of medicines is a key skill for nurses. It requires a knowledge of how medicines work (pharmacology), coupled with skills in calculating dosages of medications (drug calculations) that are situated within the context of the nursing environment of patient care. As a consequence, the development of these skills is attempted within the undergraduate curriculum but often has not been successfully embedded upon graduation (Gill et al., 2019). The Bachelor of Nursing Science is a 4-year programme of study at the University of Galway, which was introduced across Ireland in 2002 to replace the hospital-based education training approach that existed up until that time. Students are taught within the first three years of the programme by a combination of theory (University-based) and clinical practice (hospital-based). Until relatively recently, the subjects of Pharmacology and medication management were taught in separate parts of the curriculum, but there was a growing awareness of the intersections of these areas that could be more valuable to incorporate into a single module. This paper provides an overview of how we have developed a medicines management

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module at the University of Galway, using a complementary range of pedagogical strategies that will be useful in a variety of settings across the healthcare sector and beyond.

2. Description of the Teaching/Learning Context

The class typically consists of approximately 120 students, drawn from 3 subgroups, namely General Nursing (63% in AY 2023-2024), Mental Health (20%) and Midwifery (17%). The module (NU3105: Medicines and Clinical Practice) is delivered over a 7-week period immediately following a clinical placement in the first half of the semester. The module lies at a pivotal juncture, positioned at the point before students embark on their final year of the programme which largely consists of an internship where practice skills are honed.

The inaugural year when the module was introduced was AY 2020-2021, at the peak of the COVID-19 pandemic when all instruction took place online. On return to on-campus teaching, we preserved some of the elements of online instruction to produce a blended teaching approach, with self-directed learning being a key component. In the few short years since its inception, the module has gone through considerable evolution, driven by discussions amongst the teaching team and student feedback. The main features of the module are summarised in Table 1. The series of interlocking features includes "equipping" lectures, team-based exercises and assignments, a weekly online Q&A session and a simulation session.

Table 1. The main features of NU3105 (Medicines and Clinical Practice)

- A 1 hour "equipping" lecture in each week
- A 2-hour in-class interactive session each week
- An assessment at the end of each unit
- Team-based assignments (continuous assessment)
- A weekly Q&A with the Module Lead
- A simulation session
- An end of semester assessment

Figure 1 describes the composition of the module in 3 units, which takes the student on a journey from the theoretical underpinning of Pharmacology (Unit 1), its application in the pharmacological treatment of a range of diseases (Unit 2), and finally to the management of medications (Unit 3).

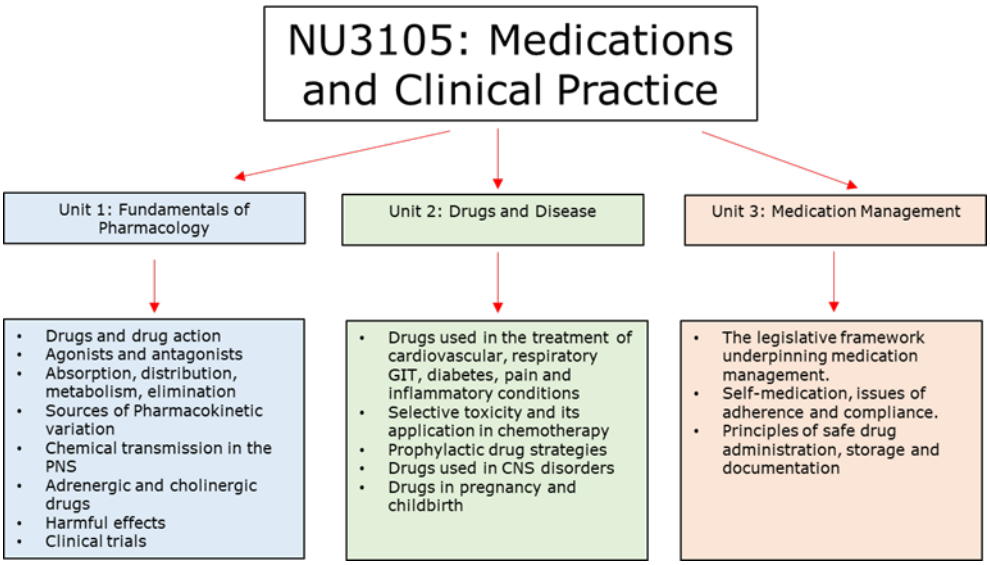


Figure 1. The composition of each unit of NU3105

During our first on-campus session, we ask students a range of questions using the Vevox polling software (Golden, 2023). Such icebreaker questions are an opportunity to reduce the apprehension that students might have and to create a welcoming environment (Frisby and Martin, 2010). They include questions that ask about the students' background, expectations and acknowledging the diversity of challenges that students face in pursuing a full-time programme of study. Towards the end of the session, the questions become more focused on the module itself asking about drugs and conditions that the students would like to learn more about. These types of questions have been asked at introductory pharmacology classes for a number of years and have helped to shape the content of the module. For example, when the fundamentals of pharmacology are described, we draw on the most common responses, such as painkilling medications. These questions also enable the specialist groups of students to have a voice and so medications and conditions employed in midwifery and mental health are featured.

Table 2. Questions posed at the introductory session

1.	Which group do you belong to (General, Midwifery, Mental Health)?
2.	Michael is suffering from an attack of wheezing. He takes his prescribed inhaler and within minutes his symptoms improve. How do you think that the inhaler worked to produce this effect?
3.	What do you think are the main goals of a University education?
4.	How do you learn something new?
5.	What are your expectations of this module?
6.	What prior learning do you think will help you succeed with this module?
7.	What do you see as the principal role of a Lecturer?
8.	What do you see as the principal role of a Student?
9.	In consideration of ALL of your modules, how many hours EACH WEEK do you plan to spend this Semester?
10.	What is your average commute time to the University?
11.	What will be the average number of hours each week that you intend working (either paid or caring duties) outside of my studies?
12.	Have both, one or neither of your parents obtained a bachelor's degree?
13.	Is English your first language?
14.	What are your expectations for inclusivity (i.e. an equitable, welcoming environment)?
15.	Write down 3 drugs you would like to learn more about
16.	Write down 3 diseases/conditions that you have encountered in your clinical experience that you would like to learn more about
17.	Write down an example of a drug effect on the body (e.g. adrenaline increases heart rate)
18.	Write down a "drug story" that you'd like to learn more about

The students are also provided with a Handbook that provides all of the relevant information regarding the module, including the recommended student effort for each week (Table 3). These are based on the module having 10 ECTS, which typically equates to 250 hours of student effort (European Commission, 2015), which we have reduced to 200 hours to take into consideration the shortened period that the module runs over.

Table 3. Recommended contact hours for each week of the module

Week	Synchronous sessions (h)	Self-study (h)	Team-based activities (h)	Total effort (h)
Week 1	4	16		20
Week 2	4	16		20
Week 3	4	9	7	20
Week 4	4	9	7	20
Week 5	4	9	7	20
Week 6	6	7	7	20
Week 7		13	7	20
Reading Week		30		30
Assessment Week		30		30
Totals	**26**	**139**	**35**	**200**

At the end of the introductory session, the students are divided into teams of 5 of a similar specialty and are asked to sit together for any subsequent on-campus sessions providing the students with a map of the room. The weekly Exercise sessions consist of a series of questions that focus on certain aspects of the content that the students have been able to access using the online resources (Figure 2), and a representative of each team posts their answers using the Vevox polling software.

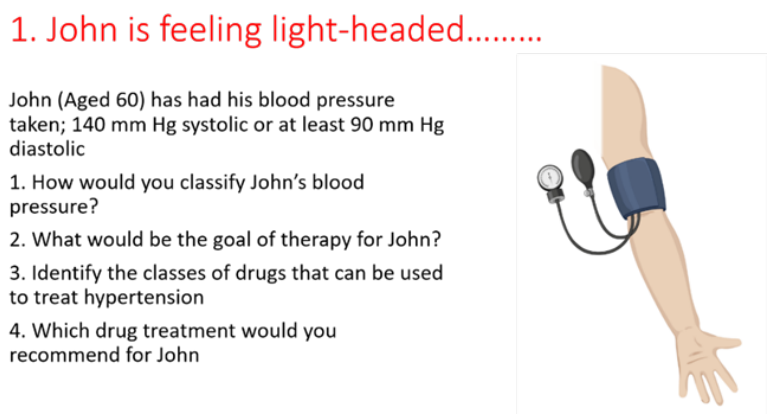


Figure 2. An example of the team-based questions asked during the Exercise sessions

3. Key features of the module

Students access the learning resources at the beginning of each unit via Canvas (the University's learning management system). This is the lecture content that has been converted into an online interactive resources using the Articulate Rise 360 e-learning platform. Initially, only the first 2 units were in this format (i.e. the pharmacology content), but in advance of AY 2023-2024, we converted the third unit into the same format. Thus, the students experienced a consistency of

delivery across the entire module, with an equipping lecture at the beginning of each week where the principal learning challenges would be highlighted that would be followed by the on-campus exercise session later in the week.

In our conversations as a teaching team, we acknowledged that there are a range of features associated with medication management. We came up with the idea of a "threaded case" where all of the teaching contributors could apply to their topic. We created a case that would be recognizable in some features to all 3 of our student cohorts. The case that we decided upon was: *"Mary is 32 years old who is 30 weeks pregnant, has a history of type 1 diabetes (diagnosed at age 13) and depression (diagnosed at age 24). Mary has presented with a urinary tract infection (UTI)".* This case enables us to the pharmacology of the drugs, medication risk management, legislation regarding administration of medications, drug calculations, safe drug administration and documentation amongst other features.

Working in teams that we have incorporated into the exercises sessions is a key skill for students in healthcare to develop and can be incorporated into a large class environment (Burgess et al., 2020). To encourage team participation, the students sign a contract which outlines their obligations as a team member for the module. Working together in the earlier weeks is developed further during the 3rd week, when the teams are provided with an assignment that consists of creating a case that revolves around a patient (for example a Parkinson's Disease patient) from which they can draw on their clinical placement experience to produce a recorded PowerPoint presentation. In addition, they produce a drugs fact sheet geared towards the patient.

In the latter stages of the module, students receive a simulations session which serves as a capstone activity where all the features can be applied. Simulations are a very valuable training opportunity where students can make decisions about medication management in a safe and supportive environment (Koukourikis et al., 2021).

Continuous assessment amounts to 30% of the module mark (15% team-based assignments and 3 x 5% for interim assessments). The end of semester assessment consists of 60 questions, mostly MCQs, with a small number that require calculations and the entering of numerical values.

4. Findings

The average mark for the module was 66% (min 44 – max 89%). On completion of the module, we conducted a paper-based survey. Overall, the feedback has been very positive, with a high level of agreement on most of the Likert-type statements (Figure 3).

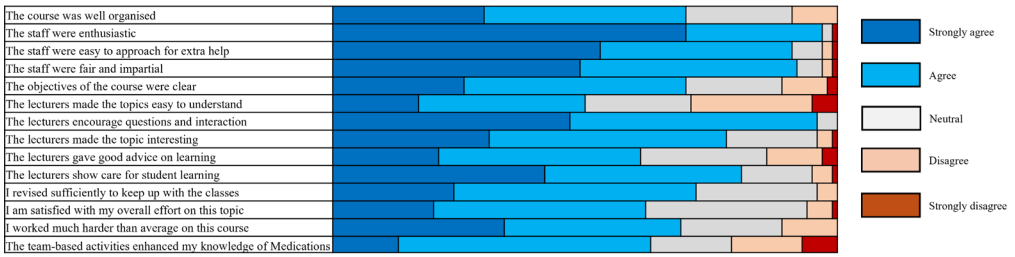


Figure 3. The responses to structured feedback questions in AY 2023-2024 for NU3105, conducted at the end of the teaching period, and prior to the end of semester assessment; 116 students out of a class of 118 (98%) completed the survey.

Aspects that students particularly liked were the degree of interaction, drug calculations, team-based activities, regular assessments, and its relevance to practice (Table 4). The most common suggestion for improvement was the provision of more in-class lectures, more resources particularly for drug calculations, for the module time period to be extended and more content relating to the specialties of the nursing cohort.

Table 4. Main themes identified from free text responses

How much time did you spend/week? 17 hours
What did you like most?
Interactive and Engaging Lectures (34 mentions); Drug Calculations and Medication Knowledge (21 mentions); Team-Based and Collaborative Activities (16 mentions); Continuous Assessments and MCQs (15 mentions); Relevance to Practice and Practical Applications (14 mentions)
What could be improved upon?
More in-Class Teaching (46 mentions); More support on drug calculations (22 mentions); More time for the module (16 mentions); Additional Practice Materials and Resources (13 mentions); More tailoring of content to specific nursing disciplines, e.g. Midwifery and Mental Health (11 mentions)

5. Reflection

The components that currently make up our medication management module have been developed to maximize student engagement and active learning. The module has evolved to its current configuration by means of a series of steps, one of the most challenging of which has been the blended teaching approach, that takes adjustment on the part of students as it is not embedded elsewhere in their studies. As this approach is not widely embedded elsewhere in the degree programme, it necessitated additional support, communication and scaffolding to ensure all participants were confident in navigating the new learning environment.

Another difficulty in implementing the module was aligning the assessment design with professional standards and programme-level learning outcomes within the limited timeframe available (7 weeks). This required strategic planning to ensure that students could engage meaningfully with the material and demonstrate deep learning without being overwhelmed. Additionally, accommodating diverse prior learning experiences, both from university coursework and clinical placements, proved complex in terms of content delivery and assessment fairness. Despite these challenges, the module effectively builds upon students' prior learning, and creates opportunities to consolidate and apply this knowledge meaningfully. While the condensed timeframe of presents constraints in terms of depth and pacing, student performance and feedback suggest that the overall approach is effective. Nevertheless, these challenges have underscored the need for continued refinement, particularly in enhancing the integration of blended learning and ensuring alignment with the wider nursing curriculum.

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References

Burgess, A., van Diggele, C., Roberts, C. & Mellis, C. (2020). Team-based learning: design, facilitation and participation. *BMC Medical Education* 20 (Suppl 2), 461 https://doi.org/10.1186/s12909-020-02287-y

European Commission: Directorate-General for Education, Youth, Sport and Culture, ECTS users' guide 2015, Publications Office of the European Union, 2015, https://data.europa.eu/doi/10.2766/87192

Frisby, B. N., & Martin, M. M. (2010). Instructor-student and student-student rapport in the classroom. Communication Education, 59(2), 146-164. https://doi.org/10.1080/03634520903564362

Fuller, K., Gray, M., Bradley-Ridout, G. & Nekolaichuk, E. (2021). Flipping it online: re-imagining teaching search skills for knowledge syntheses. *Journal of the Canadian Health Libraries Association,* 42(2): 100–109. DOI: https://doi.org/10.29173%2Fjchla29492

Gill, M., Andersen, E. & Hilsmann, N. (2019). Best practices for teaching pharmacology to undergraduate nursing students: A systematic review of the literature. *Nurse Education Today,* 74, 15-24. https://doi.org/10.1016/j.nedt.2018.11.017

Golden, W. (2023). Student Response Systems: Enabler of Active Learning in a Large Class. Editorial Universitat Politècnica de València. 195-202. https://doi.org/10.4995/HEAd23.2023.16207

Koukourikos K., Areti Tsaloglidou A., Kourkouta L., Papathanasiou, I.V., Iliadis, C., Fratzana, A. & Panagiotou, A. (2021). Simulation in Clinical Nursing Education. *Acta Inform Med,* 29(1), 15-20. https://doi.org/10.5455/aim.2021.29.15-20

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Inclusive Pharmacology: Using Objective Structured Practical Examinations (OSPEs) to Identify Knowledge Gaps in Pharmacology Undergraduates

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Abstract

This paper explores the learning benefit of an inclusive Objective Structured Practical Examination (OSPE) in a second-year biomolecular integrative pharmacology course to identify gaps in student knowledge and evaluate their confidence in applying their knowledge in the laboratory setting. The OSPE was co-designed through incorporating input from students and staff. Its introduction aimed to aid formative feedback as students transition from different levels of pharmacology study. While further research is needed to fully evaluate the long-term impact of this approach across our student cohorts, this project suggests that OSPEs can effectively identify key gaps in student practical skills and provide valuable feedback on how improvements can be made in an applied pharmacology setting. We anticipate that wide-spread sharing of best practices learned from different OSPE formats will be an inclusive educational resource for the wider pharmacology educator community who must teach the discipline as part of an integrated curriculum.

Keywords: *Higher education, Pharmacology education, Inclusive Assessment.*

1. Introduction and Background

There is growing recognition that inclusive education must meet the needs of all learners (Koenig & Tucker, 2025), a principle that strongly aligns with Education for Sustainable Development (ESD). While higher education plays a vital role in advancing ESD, creating a truly inclusive environment for diverse student populations remains a struggle. Scientific literacy is a critical component of ESD, emphasising the crucial role of education in promoting

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a more sustainable future (Iyengar & Caman, 2022). However, integrating ESD principles, particularly within STEM fields, imposes significant challenges, including the need for inclusive educational practices that facilitate deeper student learning. In Howell (2021), active learning (AL) is highlighted to be a practice that enables higher-cognitive levels through problem-based tasks, inherently integrating ESD principles and promoting critical thinking. Given that AL is an umbrella term for pedagogical techniques that engage students in an activity, encouraging them to reflect upon material and how they are using that material (Linton et al., 2014), Objective Structured Practical Examinations (OSPEs) can be considered an AL technique and have been used in combination with problem-based learning (PBL) and competency-based pharmacy (Dymek et al., 2022). These approaches require students to apply knowledge practically, fostering deeper cognitive processing beyond surface-level recall.

As Batty & Reilly (2022) highlight, despite increased diversity in UK higher education institutions (HEIs), STEM fields often fail to create inclusive environments, particularly within the laboratory. Ensuring the inclusivity of the UK pharmacology curriculum is a key objective, by addressing decolonisation, democratisation, diversification, and accessibility (Tucker et al., 2022). This aligns with the broader understanding that inclusive education must be accessible to all students, whilst also meeting the needs of specific groups (Bain, 2023). One way to achieve this is by identifying and integrating core concepts (CCs) and associated sub-concepts within pharmacology (Guilding et al., 2023). CCs offer a framework for inclusive pedagogy therefore effective integration necessitates inclusive assessment strategies. Assessments are key to student learning, offering feedback and identifying knowledge gaps (Bain, 2023). This study develops a second-year biomolecular pharmacology OSPE to pinpoint knowledge gaps as part of their introduction to CCs in pharmacology. Literature supports that practical application enhances learning (Brinkman et al., 2018), potentially increasing attainment and deepening understanding, which CCs can structure within inclusive assessments.

1.1. Aligning IUPHAR-Ed Core Concepts with Accreditation Requirements within the Evolving Landscape of Pharmacology

The International Society for Basic and Clinical Pharmacology Education (IUPHAR-Ed) Section group (Santiago et al., 2021) has developed a comprehensive list of CCs as a standardised tool for pharmacology curriculum benchmarking. These CCs align with the Quality Assurance Agency (QAA) benchmarks for UK biomedical science programmes (QAA, 2023). Currently being developed are resources for teaching, learning, and assessment (Guilding et al., 2024; Babey et al., 2025; Kelly-Laubscher et al., 2025), informed by identified student misconceptions (Figure 1). This knowledge could help with the development of more inclusive strategies to support the diverse learning needs of different student cohorts who are taught pharmacology. Inclusive assessments cannot be planned in isolation (Bain, 2023) and instead should be integrated into curriculum and refined through feedback. This demands a

collaborative approach that considers various pedagogical considerations, taking all aspects of teaching and learning into account, and translates theoretical frameworks into practical applications. This project highlighted the use of Braun & Clarke's (2006) inductive analysis for identifying course knowledge gaps within OSPE performance data. Furthermore, a well-designed inclusive assessment has the potential to assess the attainment and application of CCs. Simple measures could be achieved by providing extended time for students with additional learning requirements, offering alternative formats, and ensuring clear language in all instructions to accommodate diverse language backgrounds. With the appropriate analysis methods, these assessments can identify misunderstandings, contributing to the development of more effective educational resources.

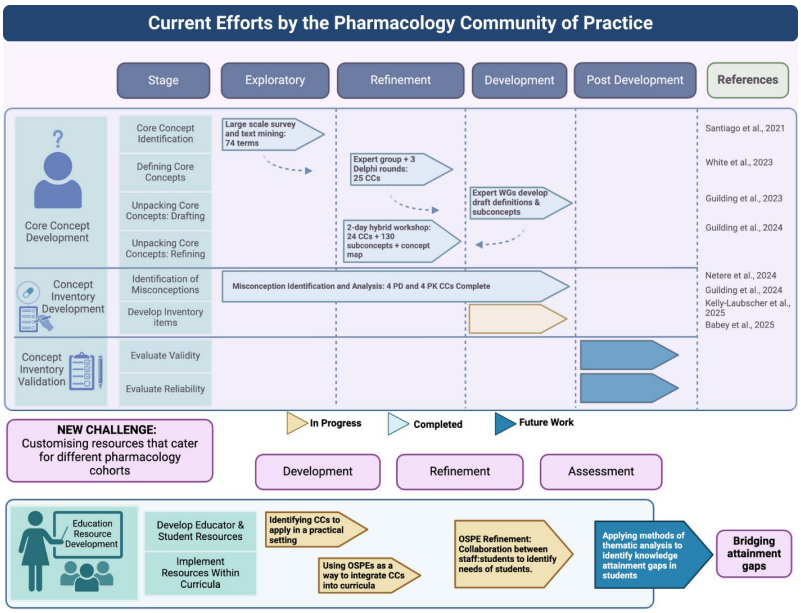


Figure 1. New Challenge: Customising Resources for Diverse Pharmacology Cohorts
The Pharmacology Community of Practice, guided by IUPHAR-Ed, is focusing on core concept development. The 'New Challenge' panel highlights a shift towards tailored resources for diverse cohorts to support application of concepts in the practical setting. Figure created in BioRender.

2. Moving Towards an Inclusive Curriculum

Through acknowledging the diversity within the pharmacology community, the British Pharmacological Society (BPS) is committed to innovating pharmacology teaching by making it more inclusive and equitable (Tucker et al., 2022). Beyond the UK, a professional network called the Teaching Innovation Network in Pharmacology (TINP) has advanced pedagogical

practices towards innovative ways of teaching pharmacology, with one of the shared objectives being to encourage critical thinking in students (Baños et al., 2024). The need to move beyond traditional teaching and assessment methods is incentivised by the understanding that assessments often struggle to bridge theory and practice and effectively engage students.

2.1. Implementation of OSPE

Typically used in clinical degrees as a practical assessment, OSPEs provide a versatile foundation for inclusive assessment. They provide an objective framework that allows students to be examined on individual practical skills, helping to identify gaps in student knowledge. By determining these gaps, OSPEs have the potential to direct teaching approaches and curriculum modifications through regular feedback between educators and students to enhance student learning (Lakum et al., 2023). Our stationary OSPE (rather than OSPE stations), where students did not move and instead were given individual trays with the necessary equipment, was developed for a second-year cohort of biomolecular pharmacologists (151 students). This format accommodated the large cohort side. With an appreciation for collaboration, our OSPE was developed with consultation between administration staff, PhD students, technical staff and teaching staff (Figure 2).

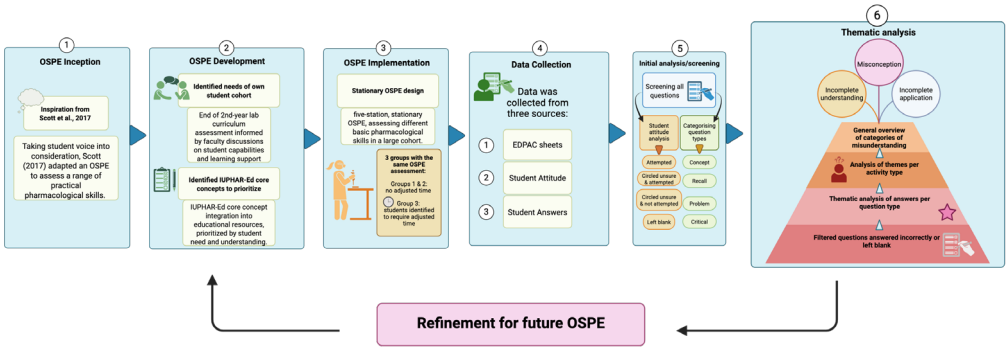


Figure 2. OSPE Development Workflow: Refining and integrating OSPE into the curriculum included identifying misconceptions through various analyses. Students completed the OSPE in three groups. Initial screening explored student attitudes and categorised question types. Thematic analysis then identified key areas of misunderstanding. Figure created using BioRender.

OSPEs have been well received in other degree disciplines (Brinkman et al., 2017), further evidenced in Makwana's (2025) recent study, which revealed 70.84% of students who completed a traditional assessment and an OSPE, one week apart, preferred OSPEs, with only 4% disagreeing. OSPEs also resulted in significantly higher marks. However, it should also be

noted that feelings of 'embarrassment' or 'intimidation' with assessor observation were also acknowledged in that study. This should be considered in OSPE design. To address identified gaps in student skills and knowledge, as observed by teaching staff, this OSPE assessed basic skills, like pipetting, and foundational knowledge, such as dose-response relationships. The OSPE was set as an informal assessment and allowed students to opt out of answering the question by including a 'circle unsure' option, aiming to reduce anxiety around assessment. Technical staff were integral in designing the stationary aspect of this OSPE, and other members of teaching staff were given checklists to objectively assess the students. This approach helped to minimise bias and ensure that all students have an equal opportunity to demonstrate their competence, knowledge and understanding of concepts fundamental to pharmacology. In one of the tasks, (Figure 3), students were first asked to define EC_{50} and then asked to highlight the EC_{50} on a concentration-response curve. This was a fundamental measurement the students had to derived from laboratories across the semester and is an essential term pharmacology students should understand. EC_{50} itself is a sub-concept of CC5: dose / concentration-response relationships and CC8: drug potency. The visualisation of the EC_{50} example used here clearly highlights the diversity in misconceptions across a single student cohort. Out of 151 students who completed the OSPE, 66.2% answered correctly. Out of the 33.8% of students who answered incorrectly, obvious knowledge gaps were identified (Panel B-G), with students unable to estimate EC_{50} placement on a sigmoidal curve (Panel H-I). This highlights the diversity in misconceptions across a single student cohort.

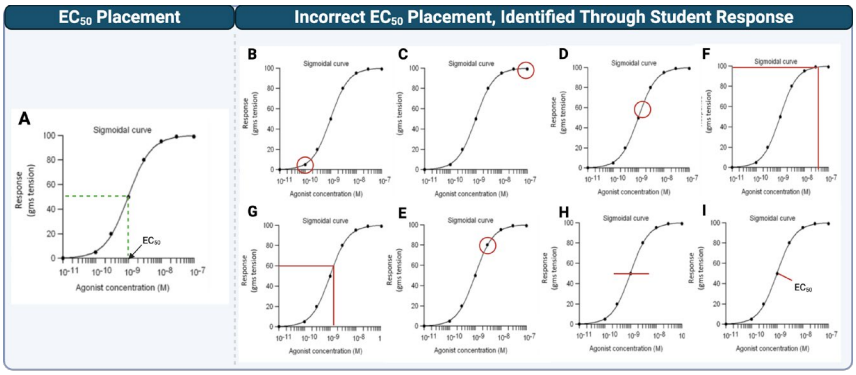


Figure 3. Student representation of EC50 on a Sigmoidal Concentration–Response Curve: (A) Correct EC50 labelling. (B–G) Incorrect labelling, revealing knowledge gaps. (H–I) Technically correct labelling, but explanations showed limited understanding. Figure created in BioRender.

3. Discussion

Our project holds importance for the greater higher education and pharmacology community as OSPEs provide a versatile framework for inclusive educational resources. Given that pharmacology is an ever evolving, multidisciplinary field, it is unsurprising that it is a global struggle to decide how to inclusively teach and assess pharmacology. The expected *information overload* is the result (Guilding et al., 2023), and in turn, there has been an overdependence on traditional didactic teaching and rote learning. As OSPEs are adaptable, they can be tailored to assess a range of fundamental practical skills, learning objectives and competencies. Varying literature supports the use of OSPEs across clinical disciplines, as they can be used for formative and summative assessments (Dhar et al., 2023). OSPEs have received positive feedback both from students and staff (Hultgren et al., 2023). Opinion-based data, gathered from pre- and post-OSPE surveys, can then help to develop future OSPEs further, aiming to improve student experience, engagement and performance overall and will be incorporated into our OSPE as part of future developments. This OSPE effectively identified knowledge gaps in the cohort's understanding of fundamental course content. Building on this knowledge, the development of future OSPEs can integrate the IUPHAR-Ed CCs to identify misconceptions of these.

Using Braun & Clarke's (2006) inductive thematic analysis, we aim to identify any misunderstandings revealed in student responses to OSPE questions. This method, which allows for coding data without preconceived themes, is particularly valuable for exploring the nuanced and complex qualitative data generated by student answers within the practical assessment. By systematically analysing how students articulate their responses and identify potential errors, inductive analysis can pinpoint specific areas of conceptual difficulty. Furthermore, this approach can highlight common behavioural patterns, such as 'competence with a lack of confidence' (Akbari & Sahibzada, 2020), where students possess the knowledge but express uncertainty in their answers. This identification can inform strategies to improve attitudes and inclusivity (Bain, 2023). Scaling OSPEs for larger cohorts or other disciplines that are integrated with pharmacology presents logistical challenges, particularly concerning laboratory space due to their traditional station-based design. Stationary OSPEs, using individual trays, suit basic skill assessments; however, equipping numerous students for advanced skill assessments is a challenge. Individual specialised equipment could hinder sustainable practices.

While our primary focus at this early stage is on exploring the viability of OSPEs as an inclusive assessment tool for identifying knowledge gaps, we recognise the importance of quantitative data and comparative studies for evaluating their effectiveness. Makwana (2025) has demonstrated significantly higher scores with OSPEs compared to traditional assessments, suggesting a positive impact of OSPEs on student performance. Although further research is needed to assess long-term effects, our current findings indicate that OSPEs effectively identify student misconceptions and gaps in understanding of core concepts, while also providing

targeted feedback. This approach has the potential to improve student engagement, enhance learning outcomes, and contribute to a more inclusive and accessible learning environment across pharmacology curricula.

References

Akbari, O., & Sahibzada, J. (2020). Students' Self-Confidence and Its Impacts on Their Learning Process. *Am. Int. J. Soc. Sci. Res.*, 5, 1-15. https://doi.org/10.46281/aijssr.v5i1.462

Babey, A. M., Koenig, J., et al., (2025). Evaluating student understanding of core pharmacokinetic concepts. *Eur. J. Pharm.*, *990*, 177256. https://doi.org/10.1016/j.ejphar.2025.177256

Bain, K. (2023). Inclusive assessment in higher education: what does the literature tells us on how to define and design inclusive assessments?. *J. Learn Dev. High Educ.*, (27). https://doi.org/10.47408/jldhe.vi27.1014

Baños, J. E., Blanco-Reina, E., et al., (2024). Beyond lectures and practical courses: Teaching pharmacology using imaginative pedagogical tools. *Pharm. Res.*, *202*, 107130. https://doi.org/10.1016/j.phrs.2024.107130

Batty, L., & Reilly, K. (2022). Understanding barriers to participation within undergraduate STEM laboratories: towards development of an inclusive curriculum. *J. Bio. Edu.*, *57*(5), 1147–1169. https://doi.org/10.1080/00219266.2021.2012227

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qual. Res. Psychol.*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brinkman, D. J., Tichelaar, J., et al., (2017). Pharmacology and Therapeutics Education in the European Union Needs Harmonization and Modernization: A Cross-sectional Survey Among 185 Medical Schools in 27 Countries. *Clin Pharm. Ther.*, *102*(5), 815–822. https://doi.org/10.1002/cpt.682

Brinkman, D. J., Tichelaar, J., et al., (2018). Key Learning Outcomes for Clinical Pharmacology and Therapeutics Education in Europe: A Modified Delphi Study. *Clin Pharm. Ther.*, *104*(2), 317–325. https://doi.org/10.1002/cpt.962

Dhar R., Dalvi A., et al., (2023), OSPE as a Method of Learning and Assessment for Undergraduate Practical Pathology versus Traditional Learning and Assessment. *J. Med. Sci Health*, 9(2):146-151. doi:10.46347/jmsh.v9i2.22.445

Dymek, J., Kowalski, T.M., et al., (2022), The influence of OSPE and PBL on competency-based pharmacy student self-assessment. *BMC Med. Educ.* **22**, 190 https://doi.org/10.1186/s12909-022-03246-5

Guilding, C., Kelly-Laubscher, et al., (2023). Developing an international concept-based curriculum for pharmacology education: The promise of core concepts and concept inventories. *Br. J. Clin Pharm.*, 10.1111/bcp.15985. Advance online publication. https://doi.org/10.1111/bcp.15985

Guilding, C., White, P. J., et al., (2024). Defining and unpacking the core concepts of pharmacology: A global initiative. *Br. J. Pharm.*, *181*(3), 375–392. https://doi.org/10.1111/bph.16222

Howell, Rachel. (2021). Engaging students in education for sustainable development: The benefits of active learning, reflective practices and flipped classroom pedagogies. *J. Clean. Prod*. 325. 129318. 10.1016/j.jclepro.2021.129318.

Hultgren, C., Lindkvist, A., et al., (2023). Students' performance of and perspective on an objective structured practical examination for the assessment of preclinical and practical skills in biomedical laboratory science students in Sweden: a 5-year longitudinal study. *J. Educ. Eval. Health Prof.*, *20*, 13. https://doi.org/10.3352/jeehp.2023.20.13

Iyengar, R., & Caman, O. K. (Eds.). (2022). *Rethinking education for sustainable development: Research, policy and practice*.

Kelly-Laubscher, R., Koenig, J., et al., (2025). Evaluating student understanding of pharmacodynamics core concepts. *Eur. J. Pharm.*, *990*, 177257. https://doi.org/10.1016/j.ejphar.2025.177257

Koenig, J., & Tucker, S. (2025). What do We Mean by an Inclusive Pharmacology Education?. *Pharm. Res. Perspect.*, *13*(1), e70050. https://doi.org/10.1002/prp2.70050

Lakum, N. R., Maru, A. M., et al., (2023). Objective Structured Practical Examination (OSPE) as a Tool for the Formative Assessment of Practical Skills in the Subject of Physiology: A Comparative Cross-Sectional Analysis. *Cureus*, *15*(9), e46104. https://doi.org/10.7759/cureus.46104

Linton, D. L., Pangle, W. M., et al., (2014). Identifying key features of effective active learning: the effects of writing and peer discussion. *CBE Life Sci. Edu.*, *13*(3), 469–477. https://doi.org/10.1187/cbe.13-12-0242

Makwana, A. H., Patel, J., et al., (2025). Traditional physiology practical examination versus OSPE in first-year MBBS: A comparative study. *J. Adv. Med. Pharm. Sci. 7*(1), 808-810. https://doi.org/10.47009/jamp.2025.7.1.159

Santiago, M., Davis, E. A., et al., (2021). Defining and unpacking the core concepts of pharmacology education. *Pharm. Res. Perspect.*, *9*(6), e00894. https://doi.org/10.1002/prp2.894

Scott, D. A., & Jenkinson, A. (2017). Adapting Objective Structured Practical Examinations (OSPE's) to assess laboratory science skills. Paper presented at HEA STEM Annual Conference, Manchester, United Kingdom.

Tucker, S. J., Zecharia, A., et al., (2022). Recognising and redressing inequity and bias through pharmacology education: a modern, practical and inclusive curriculum. *Pharmacology Matters*. Retrieved from: https://www.bps.ac.uk/publishing/pharmacology-matters/august-2022/recognising-and-redressing-inequity-and-bias-throu

White, P. J., Guilding, C., et al., (2023). Identifying the core concepts of pharmacology education: A global initiative. *Br. J. pharm.*, *180*(9), 1197–1209. https://doi.org/10.1111/bph.16000

Whitworth, D.E. and Wright, K. (2015), Case study: melding traditional and e-assessment. *Br J. Educ. Technol.*, 46: 1201-1213. https://doi.org/10.1111/bjet.12193

Quality Assurance Agency. (2023). *Subject benchmark statement: Biomedical science and biomedical sciences*. Retrieved from: https://www.qaa.ac.uk/the-quality-code/subject-benchmark-statements/subject-benchmark-statement-biomedical-science-and-biomedical-sciences#

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Remediation of Muddy Concepts in Chemical Pathology Enhances Medical Students' Summative Performance

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Abstract

A pilot three-week Chemical Pathology (CP) remediation online programme targeted muddy concepts to support medical students preparing for supplementary examination. Online teaching tools incorporated discussion groups, short-narrated lectures, and quizzes. Student online programme engagement, and formative and summative performance (categorised by Bloom's Taxonomy's cognitive domain) were analysed by descriptive statistics. Results showed all students accessed online content and engaged with formative assessments. Test items examined factual and conceptual knowledge in CP, Clinical Sciences and Basic Sciences. Students' pre-remediation formative assessment scores showed better performance on multiple-choice test questions which examined lower cognitive domains than short-answer questions embedded in case vignettes. Scores on the post-remediation summative performance identified higher total mean scores and pass rates across most CP topics; however, students still obtained lower scores on case vignettes items. Online remediation helps students engage effectively and improves overall pass rates but challenges their higher-order thinking in CP examined by clinical vignettes.

Keywords: *Chemical pathology; remediation; online teaching; Bloom's Taxonomy.*

1. Introduction

Chemical Pathology (CP) is a medical specialisation in laboratory medicine that focuses on understanding diseases and supporting patient care by analysis of abnormal biochemical parameters in the body related to metabolism, organ function and hormone balance (Marshall

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and Bangert, 2012). Undergraduate medical students are required to utilise higher-order cognitive thinking to evaluate biochemical disease patterns derived from laboratory tests and consider them in the context of relevant clinical patient data. Therefore, students are required to integrate pre-clinical Basic Science and Clinical Science knowledge in patient disease conditions. The primary aim of this module is for students to make a correct biochemical diagnosis and assist with patient care decisions by evaluating clinical vignettes. Some students struggle integrating CP, and clinical and fundamental science knowledge dimensions and applying high-order cognitive processing to make sense of CP in a clinical context.

Remediation in education aims to support struggling students to achieve acceptable professional competency (Kalet et al, 2017). This non-punitive support is organized as a discrete, time-bound and standard-focussed programme (Ellaway, 2018). The remediation programme encompasses four key steps: identifying the need for remediation, setting targeted learning outcomes, implementing structured training with monitoring, and assessing progress toward pre-defined goals (Ellaway, 2018; Kalet et al., 2017).

This study aimed to develop and evaluate a targeted online remediation programme in CP for underperforming second-year medical students enrolled at the Faculty of Health Sciences, University of Cape Town (UCT), South Africa.

2. Methodology

2.1 Remedial programme design and implementation

A remedial online programme was developed for second-year UCT medical students undertaking supplementary examinations in CP (n=12). The programme aimed to clarify muddy concepts and support examination preparation during student vacation (Figure 1). The muddy concept themes, summarised in Figure 1, were identified by evaluation of students' feedback and performance data, and a student questionnaire. The online learning material was delivered by a learning management system (LMS) and consisted of lectures, videos, case studies, and quizzes. The teaching material emphasised threshold concepts and the integration of Clinical and Basic Science knowledge; aligned with the identified muddy conceptual themes. Participation was voluntary, with all students providing written consent. The study received institutional ethical approval (HREC reference: 983/2024).

2.2 Data collection of student engagement and performance

Student engagement with learning material and activities was measured by monitoring their online attendance and engagement with online resources (lectures and narrated PowerPoints, discussion threads and formative quizzes). Student formative and summative scores for multiple-choice (MCQ) and short-answer questions (SAQs) - which were embedded in case

vignettes, and student pass rates (with a pass score cutoff □ 50%) were evaluated post-remediation.

2.3 Data analysis

Quantitative data were extracted from the LMS for analysis of engagement metrics. All assessments were classified for knowledge dimensions and cognitive processes using Bloom's Revised Taxonomy of educational objectives (Anderson et al., 2001). Within the Knowledge dimension, each assessment item was analysed and categorised as either factual or conceptual knowledge, and further grouped according to its content as relating to Chemical Pathology, Biological Science, or Clinical Science.The six cognitive domains (L1-L6) classified test items across the various CP themes assessed. All quantitative data were analysed by descriptive statistics and assessment scores expressed as mean percentage±standard deviation (SD) using MS Excel (Microsoft 365 MSO, Microsoft Corporation, Version 2501, USA).

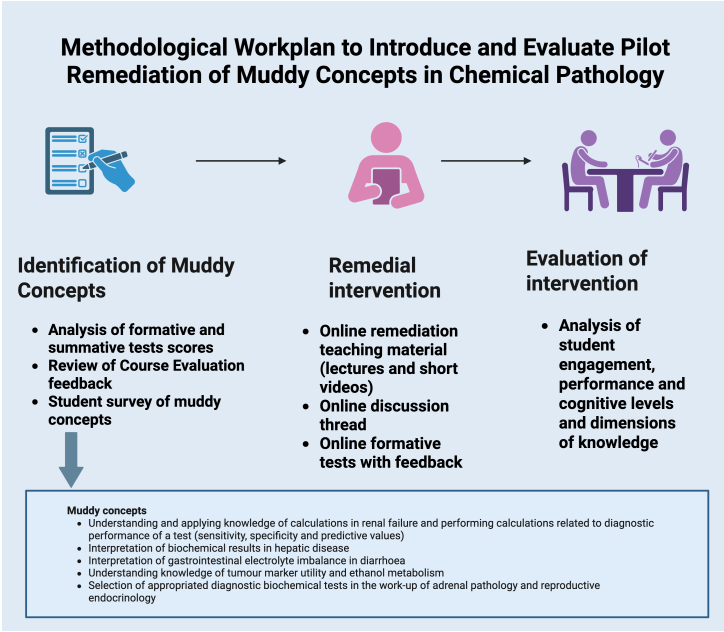


Figure 1. Development, implementation and evaluation of the pilot remediation programme (image created in BioRender.com)

3. Results

3.1. Student access and engagement with the online remediation programme

All students engaged with the online programme (100%, n=12), evidenced by LMS access metrics which showed online course access for the duration of the course enrolment. The proportional distribution of student access to the three online tools was content access (58%), forum discussion threads (14%) and online quizzes (28%).

3.2. Student performance on formative assessments

Students' performance (Table 1) showed that many students failed the CP assessments obtaining <50% pass score. The students obtained scores of 58%±10 and 41%±22 on the two MCQ assessments which evaluated five CP themes and 33%±13 on SAQs embedded in case vignettes. In assessment one, students consistently obtained lower scores on identical CP themes tested using SAQs compared with MCQs.

Table 1: Formative assessments examined in Chemical Pathology topics using MCQs and SAQs.

	MCQ FORMATIVE ASSESSMENT						
	US	GIT	HS	TOTAL SCORE	MRS	FRS	TOTAL SCORE
MEAN (%)	42	65	54	58	33	48	41
SD (%)	21	14	14	10	22	25	22
PASS RATE (%)	33	100	100	92	42	75	50
PASS (n)	4	12	12	11	5	9	6

	SAQ FORMATIVE ASSESSMENT			
	US	GIT	HS	TOTAL SCORE
MEAN (%)	39	27	36	33
SD (%)	20	13	24	13
PASS RATE (%)	33	17	17	8
PASS (n)	4	2	2	1

Abbreviations: US, Urinary System; GIT, gastrointestinal system; HS, hepatic system; MRS, male reproductive system; FRS, female reproductive system.

3.3. Comparison of student performance in summative assessment post-remediation

A comparison of student pass category and student total mean scores on summative assessments showed improvement in post-remediation across most CP themes (Table 2). The total scores obtained in post-remediation for MCQs was 67%±9 compared with pre-remediation, 55%±17. The students' performance improved overall on SAQs (post-remediation total score of 48%±11 compared with pre-remediation, 32%±13). The pass rate for SAQs was 42% (n=5) compared to the MCQ pass rate of 67% (n=8).

Table 2. Comparison of summative test scores pre-remediation versus post-remediation

	SUMMATIVE SAQ													
	HS		GIT		MRS		US		CVS		TOX		TOTAL SCORE	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
MEAN (%)	44	78	43	49	40	50	25	39	25	48	14	26	32	48
SD (%)	16	16	19	14	24	32	24	21	38	26	17	37	13	11
PASS RATE (%)	50	100	58	67	58	42	8	42	17	42	8	17	17	42
PASS (n)	6	12	7	8	7	5	1	5	2	5	1	2	2	5

	SUMMATIVE MCQ									
	HS		MRS		RS		FRS		TOTAL SCORE	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
MEAN (%)	75	100	35	32	75	92	33	46	55	67
SD (%)	45	0	15	13	45	29	15	10	17	9
PASS RATE (%)	75	100	17	8	75	92	8	33	25	67
PASS (n)	9	12	2	1	9	11	1	4	3	8

Abbreviations: PRE, pre-remediation; POST, post-remediation; Total Score, total score based on the average performance of all CP themes.

3.4. Knowledge dimensions assessed in summative assessment post-remediation

All three areas of Biological Sciences, Clinical Sciences and core CP were examined by summative test items, SAQs and MCQs (Figure 2). The summative SAQs, which were embedded in clinical case scenarios, contained a greater proportion of Clinical Science and Biological Science content compared to the formative assessment. This identifies that the summative assessment placed a stronger emphasis on applying foundational knowledge to real-world clinical contexts and aligned with the learning outcomes of the CP course, and broadly with professional practice competency requirement of a medical intern after graduating from undergraduate medicine.

Abbreviations: FRS, female reproductive system; MRS, male reproductive system; RS, respiratory system; HS, hepatic system; TOX, toxicology; CVS, cardiovascular system, GIT, gastrointestinal system, CS, Clinical Science; BS, Biological Science; CP, Chemical Pathology.

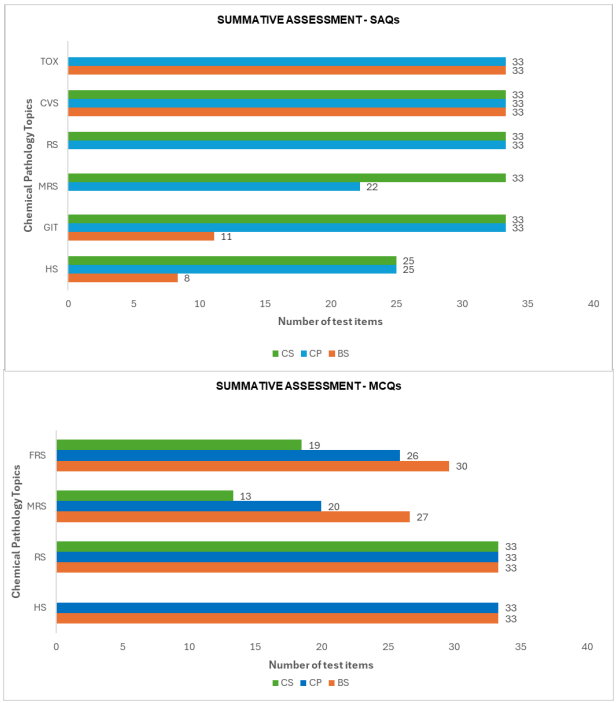


Figure 2. Knowledge dimensions assessed during the post-remediation summative assessment.

3.5. Categorisation of cognitive domains assessed in summative assessment post-remediation

The summative assessments showed evaluation of higher cognitive thinking (L4 and L5) by SAQs in case studies in comparison to MCQ testing (L1 and L2). There was variation noted in the distribution of cognitive levels tested between CP themes (Table 3).

Table 3. Assessment of cognitive domains on SAQ and MCQ items for summative assessments.

SUMMATIVE SAQs						
	L1	L2	L3	L4	L5	L6
HS	0	0	0	45	55	0
GIT	0	0	0	25	75	0
MRS	40	20	40	0	0	0
RS	0	37	63	0	0	0
CVS	0	100	0	0	0	0
TOX	0	100	0	0	0	0

SUMMATIVE MCQs						
	L1	L2	L3	L4	L5	L6
HS	0	0	100	0	0	0
RS	100	0	0	0	0	0
MRS	60	0	20	20	0	0
FRS	22	11	67	0	0	0

Abbreviations: L1, Remember; L2 Understand; L3, Apply; L4, Analyze; L5, Evaluate; and L6, Create; HS, hepatic system; GIT, gastrointestinal system; MRS, male reproductive system; RS, respiratory system; CVS, cardiovascular system; TOX, toxicology.

4. Discussion

This study investigated the benefit of a three-week online remediation program targeting challenging concepts in CP by evaluating student engagement and summative assessment performance. The findings indicate active student engagement and an overall improvement in the pass rate following remediation. The study also highlights that delivering remediation through an online LMS is both feasible and accessible, particularly for supporting students remotely as they prepare for supplementary exams during vacation periods. This study also identified that the opportunity to engage in online discussions with peers and lecturers was underutilised. This limited interaction may have hindered students from fully addressing evolving conceptual difficulties, particularly in understanding case-based CP concepts presented in clinical vignettes.

Ellaway et al. (2018) conceptualise medical education performance as core subsystems (success and failure) with remediation bridging these subsystems. Remediation in medical education has shown positive education effect in assessment outcomes. For example, tailored remedial support of underperforming medical students at the pre-clinical phase for a Biochemistry course demonstrated improved performance scores post-remediation (Hedge et al., 2024). Further, Joshi et al (2021) observed in medical students studying Osteopathy that remediation by utilising formative quizzes and assignments encouraged positive learning strategies and assessment outcomes. The findings of these studies are consistent with both the improved outcome scores and pass rate observed after the remediation intervention of the current study.

In this study, students were able to access and engage with all materials. The study also highlights that the online LMS delivery method is feasible and accessible as a route for administering remediation to students remotely, preparing for supplementary exams during the vacation period. The utility of developing online discussion with peers and lecturers was underutilized in the study; and this may have contributed to students not optimally redressing evolving areas of conceptual difficulty in case-based CP concepts examined in case vignettes.

We observed that students struggled on constructive test items in case vignettes. This highlights challenges that medical students experience in the pre-clinical phase of integrating the three factual and conceptual knowledge dimensions tested in CP coupled with deploying high cognitive thinking of Analysis and Evaluation cognitive domains (Bloom, 1956, Anderson et al, 2001) to answer CP assessments.

Undergraduate medical students who fail high-stakes exams often use ineffective study methods for both clinical and written tests and struggle to cope productively with failure (Patel et al., 2015). For example, studies report that underperforming medical students struggle to integrate large volumes of medical material, experience poor time and stress management, and have inefficient test-taking skills (Guerrasio, 2014).

Therefore, a structured programme of remediation to target deficiencies in content knowledge and high-order cognitive domains may be beneficial. A focus on analysing and evaluating clinical vignettes in CP can potentially improve underperforming students' ability to solve problems and make medical sense of relevant pathophysiology linked to laboratory test data. Remediation thereby has the potential to increase the students' pass rates.

Self-regulation theory (SRT) describes the cyclical process by which learners control their academic and clinical performance through key mechanisms such as goal-directed behaviour, the use of specific learning strategies, and the ongoing adaptation of these strategies to optimise learning and performance outcomes (Sandars et al., 2011). Research has shown that undergraduate medical students who struggle academically often have difficulties with self-regulation. Although the findings of this study do not explore academic and non-academic factors contributing to the sub-optimal student performance, it is likely that managing cognitive demands of clinical case vignettes challenged student performance. These findings suggest that remedial programmes for students studying CP should focus on strengthening student goal-setting and learning behaviours to support answering CP-based evaluation of case studies. By adopting an SRT informed approach, educators can better appreciate the variation in learners' self-efficacy and adaptive behaviours, and thus design more effective and individualised remediation strategies (Durning et al., 2011).

5. Conclusion

The development of a targeted remedial programme in CP requires identification of core conceptual problems that undergraduate medical students experience during their studies of CP. Targeted remediation can support students to effectively improve their performance and develop self-efficacy to answer authentic CP questions in clinical cases. A structured remedial approach which considers time-bound outcomes and feasible delivery via an LMS can consider use of discussion forums, short-narrated lectures and formative assessments to engage students. An emphasis on higher cognitive domains in clinical case-based scenarios needs to emphasise

Analysis and Synthesis domains as CP integrates core factual and conceptual knowledge dimensions, coupled with Biological and Clinical Science knowledge. Future studies need to investigate online versus in-person delivery modes, the impact of item selection on performance and mastery of threshold concepts, and non-academic factors that influence participation and performance in remediation interventions framed by self-regulation theory.

References

Anderson, L. W. & Krathwohl, D.R., et al (2001) A taxonomy for learning, teaching and assessing: A revision of Bloom's taxonomy of educational objectives. New York: Longman.

Bloom, B. S. (1956). *Taxonomy of educational objectives: The classification of educational goals.* Longmans G.

Durning, S. J., Cleary, T. J., Sandars, J., Hemmer, P., Kokotailo, P., & Artino, A. R. (2011). Perspective: Viewing "strugglers" through a different lens: How a self-regulated learning perspective can help medical educators with assessment and remediation. *Academic Medicine: Journal of the Association of American Medical Colleges, 86*(4), 488–495. https://doi.org/10.1097/ACM.0b013e31820dc384

Ellaway, R. H., Chou, C. L., & Kalet, A. L. (2018). Situating remediation: Accommodating success and failure in medical education systems. *Academic Medicine, 93*(3), 391–398. https://doi.org/10.1097/ACM.0000000000001899

Guerrasio, J., Garrity, M. J., & Aagaard, E. M. (2014). Learner deficits and academic outcomes of medical students, residents, fellows, and attending physicians referred to a remediation program, 2006–2012. *Academic Medicine, 89*(2), 1–6. https://doi.org/10.1097/ACM.0000000000000110

Hegde, S. V., Shetty, P. P., Senthilkumar, M., Kandimalla, R., Bernhardt, G. V., Pinto, J. R. T., et al. (2024). Bridging knowledge gaps: Impact of remedial classes on first-year medical students in biochemistry – A cross-sectional study. *BMC Medical Education, 24*(1), 1375. https://doi.org/10.1186/s12909-024-04572-6

Marshall, W. J., Bangert, S. K. (2012). *Clinical Chemistry*. 7th ed. Elsevier Health Sciences

Joshi, V., Younger, J., Joshİ, B., & Khan, S. (2021). Utilizing formative assessment to encourage study strategy modifications by osteopathic medical students: An observational study. *Düzce Tıp Fakültesi Dergisi, 23*(1), 1–10.

Kalet, A., Chou, C. L., & Ellaway, R. H. (2017). To fail is human: Remediating remediation in medical education. *Perspectives on Medical Education, 6*(6), 418–424. https://doi.org/10.1007/s40037-017-0385-9

Patel, R., Tarrant, C., Bonas, S., Yates, J., & Sandars, J. (2015). The struggling student: A thematic analysis from the self-regulated learning perspective. *Medical Education, 49*(4), 417– 426. https://doi.org/10.1111/medu.12651

Sandars, J., & Cleary, T. J. (2011). Self-regulation theory: Applications to medical education: AMEE Guide No. 58. *Medical Teacher, 33*(11), 875–886. https://doi.org/10.3109/0142159X.2011.595434

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Industrial waste transformation through an immersive experience in industrial design education

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Abstract

Industrial waste management needs sustainable and creative solutions. This study addresses an immersive approach to teaching industrial design, integrating academia and industry to transform waste into valuable resources. Collaborative workshops with companies applied a structured six-step method, ranging from material identification to prototyping and technical validation of practical solutions. Immersion in industrial environments favored students' creativity and reflective learning. Furthermore, academic-business partnerships have strengthened the educational impact, aligning the training of future designers with market demands and the challenges of environmental sustainability.

Keywords: *industrial waste; sustainability; design; immersive approach*

1. Introduction

Industrial waste is one of the greatest global challenges, with significant environmental, economic and social implications. The search for sustainable solutions positions industrial design as a fundamental field for transforming waste into valuable resources, using innovative approaches. However, traditional teaching methods often do not provide the immersion needed to effectively address the complexity of this topic. Teaching outside the classroom, in non-formal and extracurricular spaces, can significantly increase the effectiveness of learning, promoting the consolidation of knowledge and skills. These spaces are recognized as important sources of knowledge (Oliveira & Gastal, 2007; Scherer Júnior, 2018). When used as an extension of the classroom, they contribute to the diversification of pedagogical practices, offering more comprehensive learning (Rosa, 2002; Nogueira, 2016). Several authors have investigated teaching practices that go beyond the traditional classroom space, such as online teaching (Garrison & Vaughan, 2008; Horn & Staker, 2015; Means et al., 2010). Within these practices, the use of virtual reality (VR) stands out as an immersive tool, capable of enhancing participation and knowledge retention (Chen et al., 2019). In the context of our immersive

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experience, the concept of learning outside the classroom expands beyond online learning to encompass business and industrial environments. The ability to make complex decisions based on reflection during action is central to the concept of "reflective practice." Introduced by Schön (1983), this concept demonstrates that continuous learning, combined with practical experience, is essential for creative professions such as industrial design. Although it is a consolidated approach, its relevance persists in contemporary times and in design teaching. Furthermore, collaborations between academia and industry have shown a positive impact on industrial design education. These partnerships enrich pedagogy by integrating real market challenges with educational practices, allowing students to develop practical and innovative solutions. Such initiatives highlight the importance of aligning education with industry needs to prepare designers for the future (Blevis & Stolterman, 2007). In this context, the following question was asked: how can immersive educational practices in industrial design, integrating advanced technologies and partnerships with industry, promote the sustainable transformation of industrial waste into innovative solutions? This question aims to address innovative teaching practices, the connection with industry needs and the creation of sustainable solutions to the problem of industrial waste. Therefore, this article shows how the transformation of industrial waste can be promoted through immersive educational practices in industrial design. By incorporating advanced technologies, immersive methodologies and industry partnerships, aiming to foster sustainable innovation while promoting education aligned with market and environmental needs

2. Method and planning

To find an answer to the question posed, a working method was established with the aim of planning a series of steps and procedures whose result would lead to a possible answer. The method presented is composed of six main steps, organized sequentially, which structure the development of the project involving the reuse of industrial waste (Figure 1). Each phase presents well-defined inputs and outputs, ensuring systematization and clarity in the process. In the first stage, called Project Preparation, companies suitable for the type of material to be addressed are identified and selected. Preliminary visits are carried out to structure the briefing with the company management and prepare the workplace. At this stage, workshop participants are selected, and relevant communication materials are prepared.

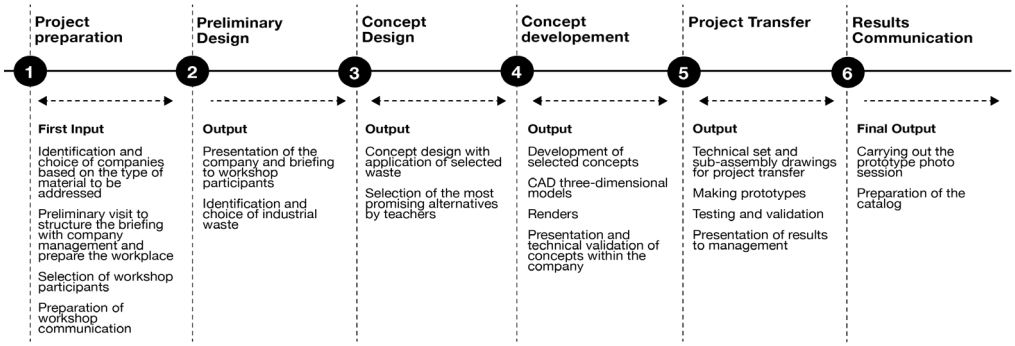


Figure 1. Flowchart of the structured method for project development.

The result of this stage is the presentation of the company and the briefing to the workshop participants, establishing the initial alignment and corresponding to the second stage of the process. The third stage, called Concept Design, involves identifying and selecting industrial waste that will be used in the project. The objective is to generate initial concepts that use this waste in a creative and functional way. In this phase, the most promising alternatives are chosen, resulting in the development of concepts applicable to the proposed context. The fourth stage, Concept Development, focuses on the evolution of selected concepts through three-dimensional CAD modelling and the creation of renders. These visual materials are presented for technical validation, ensuring alignment with the company's expectations and needs. The main output of this stage consists of technically validated concepts, accompanied by detailed three-dimensional representations. In the fifth stage, Project Transfer, the technical subassembly drawings necessary for project implementation are prepared. Prototyping is carried out, followed by testing and validation. As a result, the finalized and technically validated prototypes are ready to be used or demonstrated. Finally, the sixth stage, Communication of Results, includes the final presentation of the project to the company's board of directors. This phase includes complementary activities, such as carrying out photo sessions of the prototypes and creating a catalogue to document the results. This method stands out for its structured integration of stages, focusing on the reuse of industrial waste in a creative and technical way, ensuring alignment with business needs and providing consistent and well-documented results.

3. Discussion and results

3.1. Project Preparation

To effectively address the proposed research question, the professors selected industries with concrete concerns about sustainability and waste management, exploring alternatives to conventional recycling. The research was organized in annual workshops, held at the end of each school year, allowing students to experience immersion in industrial contexts, focusing on

local raw materials such as iron, aluminium and wood, given the location of ESD-IPCA in the region. from Minho in northern Portugal. The companies were formally invited and, after accepting, meetings were held between the teachers and the CEOs, where the purpose of the project was presented: to implement innovative pedagogical practices, align with the needs of the industry and develop sustainable solutions. These meetings allowed us to adjust expectations and ensure efficient collaboration. In the first workshop, BySteel, part of the DST Group, challenged participants to create urban furniture using waste metal structures destined for Schiphol Airport. The students worked in an office in the centre of the factory, immersed in the industrial environment. In the second year, with Navarra, participants developed urban furniture for rest areas in the factory, using defective aluminium profiles. The project was carried out in a vacant and fully equipped warehouse. In the third year, in partnership with Tmodular, objects were created for a prototype microcity, the Living Lab, a project led by Norman Foster, with students working in several meeting rooms on the DST campus. Participants were selected by invitation from 10 students with suitable profiles, while the workshops were widely publicized to inform the school community and foster student interest in future editions. Each workshop began with a company presentation and briefing, establishing a solid foundation for the development of practical and sustainable projects.

3.2. Preliminary Design

This phase begins with the formation of work groups, followed by a guided tour of the factory facilities to provide an overview of the production processes, the characteristics and possible transformations of the materials and to understand construction techniques, such as fitting, joining and cutting. At Bysteel, students observed an industrial metalworking shop equipped with advanced technology for working with metals such as iron and steel, following the entire process, from project planning in CAD/CAM software to the precise shaping of raw materials, with high quality standards. and security. At Navarra, specialized in aluminum profile extrusion, they had the opportunity to see the entire production cycle, from design to shipment, highlighting the precision required in the production of products. In addition, the factory areas were also presented for intervention. At Tmodular, participants delved deeper into the workings of an industrial carpentry shop, focused on customized interior solutions. The visit highlighted the integration between the stages, the qualification of the teams and the use of specific machinery, with a strong emphasis on modular construction. After the visits, the groups identified and selected industrial waste to materialize their ideas. This stage was crucial, as the careful selection of materials is essential to achieve excellent results in projects (Figure 2).



Figure 2. Collection of waste and industrial waste from Bysteel, Navarra and Tmodular.

3.3. Concept Design

In the three case studies analyzed, participants transported the waste samples they considered most relevant to their respective workplaces. The objective was to generate initial concepts that integrated these materials in a creative and functional way, responding to both technical constraints and practical needs. The ideas were initially conceptualized and recorded in the form of drawings, representing the first proposals for solving the challenges presented. These proposals went through several iterations and alternatives, resulting from brainstorming sessions carried out in collaboration with each of the factories involved. The initial concepts developed were submitted to the teachers for validation. Based on this analysis, the most promising proposals were selected and underwent further development.

3.4. Concept Development

The Concept Development phase focuses on selecting the most promising ideas and developing a more in-depth concept. This evolution of concepts is developed and validated through three-dimensional modeling in CAD and the creation of renders. 3D CAD modeling is performed using Solidworks parametric modeling software. At this stage, the teams proceeded to virtually implement the ideas, a materialization where the detailing, dimensional control and all functional and construction details were carried out. To finish and as a way of validating the modeling, materials and proportions, renders were created, that is, realistic images of the proposals. The result of these images, in addition to the approval of the ideas by the participants and advisors, were also essential to support the presentation of the proposals to the technical and design department of the companies. The projects were exhibited, by groups, and presented to the CEOs of the companies involved and their respective technical and design teams. With this presentation and the evaluations, the participants obtained approval of their projects and indications of technical changes for the implementation of the proposals. This ensured that the ideas aligned with the proposed objectives and thus moved on to a new phase, the preparation of projects for production.

3.5. Project Transfer

Simultaneously with the renderings, the teams created the technical drawings for each solution. In addition to the execution of conventional technical drawings, developed in accordance with established standards and rules, detailed axonometries of the sets were also prepared. These axonometries allow a clear and precise three-dimensional representation, providing a global vision of the products and their structural relationships, facilitating the understanding of the product, both for the technical teams responsible for production and for other actors in the process. In this way, technical drawings play a central role in technical communication, in optimizing production and in ensuring the final quality of the products developed. The prototype construction phase is one of the most intense and favorite for all participants, it is when the projects come to life, the ideas leave the paper and become reality. Whenever possible, and for safety reasons, the members of each group actively participate in the prototype production process under the guidance of the responsible technicians (Figure 3).



Figure 3. Production of prototypes as Bysteel, Navarra and Tmodular.

Prototypes aim to test and evaluate the functionality, design and feasibility of the concept before final production. At this stage, it is possible to identify and correct problems, validate ideas and improve the design, ensuring that the product meets established expectations and requirements. After identifying, correcting and improving the issues detected in the initial prototypes, production of the final prototypes began. In this phase, the objects materialized as they had been idealized and designed, fully meeting the criteria defined in formal, functional and aesthetic terms. The production process of the final prototypes involved rigorous quality control, ensuring that every detail was aligned with the predefined objectives and the established technical and conceptual parameters.

3.6. Results Communication

After the prototypes were completed, they were installed in strategic locations in the participating industries, allowing the projects to be presented to company managers. The solutions were praised by the CEOs for their aesthetics, functionality and ergonomics, as well as for the results achieved in the short period of the workshop. Certificates of participation were given to all participants. Some solutions were later produced and implemented by industries. The photo sessions of the prototypes were carried out by professionals, also highlighting some functional details (Figure 4). At Bysteel, the photos were taken in a concrete setting, highlighting the finishes of the pieces. In Navarra, the workshop pavilion was used, while at Tmodular, due to industrial secrecy restrictions, the session took place in the factory's paint shop. Each workshop resulted in a publication that systematically documented the results and methodologies applied. The organization was coordinated by teachers, ensuring academic rigor. At Bysteel, the graphic component was developed internally and in the workshops with Navarra and Tmodular, the collaboration of designer Marco Oliveira was counted on, ensuring high visual and editorial quality, reinforcing the value of publications as instruments of scientific and technical dissemination.

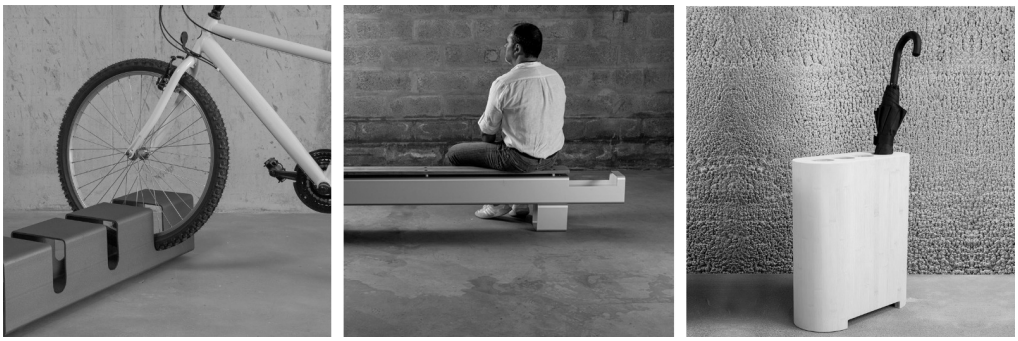


Figure 4. Prototypes photography at Bysteel, Navarra and Tmodular.

4. Conclusions

It is concluded that industrial waste management requires innovative solutions that reconcile sustainability and creativity. The immersive approach adopted in teaching industrial design has proven to be effective in integrating students into real business environments, promoting practical and reflective learning. The structured six-step method allowed developing viable and technically validated solutions aligned with industrial needs. Partnerships between academia and companies have strengthened the training of future designers, meeting market needs and reinforcing the commitment to responsible environmental practices. Thus, similar initiatives can

foster innovations that contribute significantly to the global challenges of sustainability and circular economy. As future work, it is suggested to explore the application of emerging technologies, such as artificial intelligence and additive manufacturing, to further optimize the process of transforming industrial waste into innovative solutions.

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References

Blevis, E., & Stolterman, E. (2007). The Confluence of Design Education and Design Research: The Impact of Industry Collaborations on Industrial Design Pedagogy. International Journal of Design, 1(1), 45-55.

Chen, Z., Zhang, Z., & Xie, X. (2019). Virtual Reality Applications in Industrial Design Education: Engagement and Motivation. Journal of Learning and Instruction, 63, 92–105.

Garrison, D. R., & Vaughan, N. D. (2008). Blended Learning in Higher Education: Framework, Principles, and Guidelines. San Francisco, CA: Jossey-Bass.

Horn, M. B., & Staker, H. (2015). Blended: Using Disruptive Innovation to Improve Schools. San Francisco, CA: Jossey-Bass.

Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2010). Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies. U.S. Department of Education, Office of Planning, Evaluation, and Policy Development. Washington, DC. Disponível em https://www2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf

Nogueira, R. M. (2016). O aprendizado fora da sala de aula: Atividades diferenciadas. Cadernos PDE: Universidade Estadual do Norte do Paraná (UENP), Secretaria de Educação do Estado do Paraná, Brasil. Disponível em https://www.diaadiaeducacao.pr.gov.br

Oliveira, R. I. R., & Gastal, M. L. A. (2007). Educação formal fora da sala de aula – Olhares sobre o ensino de Ciências Naturais utilizando espaços não-formais. Caderno Brasileiro de Ensino de Física, 24(1), 90-108. Disponível em https://www.researchgate.net

Rosa, N. P. (2022). Espaço exterior da escola: Uma sala de aula a descobrir. Dissertação de Mestrado. Instituto Universitário de Lisboa (ISCTE-IUL). Disponível em https://repositorio.iscte-iul.pt

Scherer Júnior, C. R. A. (2018). Aprender na escola para além da sala de aula: Comunidades de prática, participação periférica legítima e espaços de afinidade no ambiente escolar formal. Cadernos de Humanidades, 21(41), 115-129. Universidade do Oeste Paulista (UNOESTE). Disponível em https://journal.unoeste.br

Schön, D. A. (1983). The Reflective Practitioner: How Professionals Think in Action. Basic Books.

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Pragmatic strategies in English as a Lingua Franca (ELF) for tourism

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Abstract

Rooted in Jenkins's (2015) multilingual perspective on ELF communication, this investigation analyses overt, covert, and translanguaging practices within the specialised language domain of tourism.

It aims to yield practical insights into the strategic and dynamic use of speakers' multilingual repertoires as pragmatic strategies (i.e., the pedagogical, interpersonal, and interpreting functions) in accomplishing complex social and cognitive activities in the Italian tourist industry.

Data triangulation from an emic observational perspective, through the Ethnography of Communication, illustrates speakers' complex multilingual and expanded linguistic repertoires, further enriched by the etic standpoint offered by Conversation Analysis as a microanalytic approach to language.

Findings informed by interactants' attitudes and orientations towards ELF communication ascertain how they assist in achieving communicative functions. They foster implications for teaching and learning practices through naturally occurring conversation extracts within a constructivist approach to language learning, enabling one to take advantage of the complexities of language and communication more holistically.

Keywords: *multilingual strategies; overt, covert, and translanguaging practices; ELF, constructivism.*

1. Introduction

The article discusses Tourism English as a significant research area within English as a Lingua Franca (ELF), emphasising its sociocultural, discursive, and sociolinguistic dimensions. It highlights the dynamic nature of ELF as a language-contact phenomenon, where speakers utilise multilingual and semiotic resources to enhance communication. Jenkins's contributions have

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redefined ELF as English as a Multilingua Franca, positioning it as one resource among many in multilingual interactions. This perspective showcases the variability and complexity of ELF and underscores the difference between multilingual and monolingual users in terms of intercultural communicative competence. Furthermore, closely related to this research, which aims to explore the pragmatic functionality and multilingual strategic use of individual repertoires in tourism, Cogo (2016) seeks to capture "languaging" or "translanguaging" practices within speakers' repertoires. Languages in contact with English utilise multilingual resources based on communicative needs, contextual factors, and ideological implications for meaning-making. The theoretical perspective emphasises speakers' conscious resistance to the monolingual ideological separation of languages, enabling them to intentionally convey meaning and address power asymmetries.

This approach matches recent research on multilingualism and includes different ideas within the same framework. These ideas involve flexible bilingual teaching (e. g., Creese & Blackledge, 2010; 2015), translanguaging (e. g., García, 2009; García & Li Wei, 2014), translingual practices (e. g., Canagarajah, 2011; 2013), polylanguaging (e. g., Jørgensen, 2008; Jørgensen et al., 2011), super- diversity (e. g., Vertovec, 2006; 2007), and mobile resources (e. g., Blommaert, 2010). Communicative strategies connect directly to multilingual resources, as they are part of what people learn and experience with languages over time and in different places. Therefore, translingual practices and other multilingual strategies aid communication by recognising each person's uniqueness and diversity as distinguished strengths.

This study challenges fixed language boundaries and identity limits by using data from the tourism field to explore and explain practical strategies and multilingual resources as language forms that arise from a specific psychological and social setting.

Finally, this article proposes an innovative learning approach that begins with natural conversations and integrates research data into academic practice for added value, following Biggs' Constructive Alignment approach (2003). Its teaching activities aim to present relevant knowledge and skills, fostering critical thinking and transformative learning through group work and discussion. The assessment aligns with the intended learning outcomes, promoting a learner-centred approach that recognises student diversity and utilises technology to reduce emotional barriers, enhance motivation, and encourage creativity.

2. This Study's Multilingual Approach.

Research has demonstrated that multilingual elements are a prevalent feature of ELF communication. Although references to other languages are not unusual, ELF interactions are not solely based on the English language but frequently incorporate items from different languages, primarily from the mother tongues of ELF users.

The multilingual aspects of English as a Lingua Franca (ELF) can be categorised into *overt and covert multilingual phenomena* (Cogo, 2018). On the one hand, spoken and written ELF communication encompasses two or more languages, each serving distinct roles or communicative functions within discourse. These *overt multilingual phenomena may include* code-switching or similar practices of alternating between two or more languages or varieties in conversation (e.g., transfer, approximation through form-based and semantic strategies, approximate idioms and collocations, new word formation, and novel idiomatic expressions). Furthermore, instances of a more fluid approach to multilingual practices, such as translanguaging, also belong to this category. On the other hand, specific grammatical elements, vocabulary, or other linguistic features influenced by speakers' diverse languages may go unnoticed due to their more cognitive nature. Although communication in English often remains superficial, these multilingual influences are covertly recognised or manifested in conversation and are referred to as *covert multilingual phenomena*.

The practice of translanguaging among speakers showcases the creative potential of connecting linguistic forms and other modes of communication with indistinct boundaries. For instance, various languages, prefixes, suffixes, and the simultaneous use of modes such as text, photos, emoticons, ideograms, symbols, and punctuation create a unique, original, and unrepeatable effect. Consequently, separately analysing these modes would obliterate the intended meaning and impact of the message, disregarding the "transgressive mixture of modalities" (Dovchin et al., 2015, p. 16) it embodies. It represents a "process of transmodal translation in chains of semiosis" (Newfield, 2017, p. 103), which transcends multimodality (Kress & van Leeuwen, 2001), as the boundaries of each mode blur when they converge, resulting in a meaning that is uncommon yet consistently acceptable among multilingual and multicultural individuals who share common trans-experiences.

3. Methodology of Investigation.

The study employs an ethnographic approach, combining conversation analysis with the ethnography of communication to examine spoken interactions in natural conversations. It explores speakers' attitudes toward English as a Lingua Franca (ELF) in international communication and their management of linguistic resources in tourism contexts.

Data analysis is enriched by semi-structured interviews, which include questions about linguistic practices and provide insights into speakers' real-time choices (for detailed analysis, see Parise, 2022). Triangulation of various information sources enhances the objectivity of the data. The researcher interprets the unique resources constructed during interactions, focusing on language mixing and meshing phenomena such as code-switching and translanguaging. A detailed analysis is conducted on specific words and constructions that approximate or deviate

from standard English at the phonological and morphological levels. Some linguistic resources are *ad hoc* usages (Widdowson, 2020), arising from bilingual forms used by speakers.

Retrospective interviews and metalinguistic reflections help assess participants' language repertoires and attitudes toward multilingualism. Conversation analysis (CA) examines accommodation and recipient design in English as a Lingua Franca (ELF) to achieve shared understanding (Kaur, 2016). The study explores tensions between local practices and broader contexts to understand how speakers adapt to communicative demands while fulfilling their roles in institutional discourse. Emphasising sequential communication patterns rather than isolated utterances reveals the social organisation of conversation and the normative expectations behind discourse sequences. This highlights the need to revise conventional turn-taking awareness and address misunderstandings, errors, and corrections, underscoring participants' commitment to effective communication. Regular sense-making offers sociological insights into interpersonal relationships and the meanings derived from dialogue.

The Ethnography of Communication grounds this study in the interdependence of language use and social context. This framework (Gumperz & Hymes, 1964, 1972) encompasses diverse means and practices of communication, enhancing methodological rigour in analysing authentic communication events in the tourism sector. The reflexive analysis of interview data reveals attitudes toward ELF and multilingual strategies in multi/transcultural communication. Engaging with international tourists allows for developing probing questions through questionnaires and interviews, supporting the primary data collection of naturally occurring conversations.

The SPEAKING acronym, adapted from Hymes (1972), addresses processual and situational aspects of conversations and interviews. While Speech Act Theory (Austin, 1962; Searle, 1969) typically focuses on using utterances for communicative actions through 'performative verbs' and 'sentential moods' (Searle, 1969), this study employs it to analyse both the speaker's intention and the listener's inference capacity. The analysis reveals strategies that enhance communication effectiveness by examining the locutionary, illocutionary, and perlocutionary forces of conversational turns from a syntagmatic and paradigmatic perspective. The social exchanges also illustrate intertextuality and multimodal hybridity in postmodern communication. Evidence from conversations and interview responses reflects participants' attitudes and motivations towards multilingualism, demonstrating that accommodative language behaviour impacts performance rates, processes, and efficiency, regardless of sociocultural backgrounds. Participants demonstrate sensitivity to English as a Lingua Franca (ELF), using it to construct identities and creatively assert their purposes through text organisation, knowledge negotiation, and meaning expansion. This highlights how non-standard English usage interrelates with social practices, influencing attitudes toward ELF and enhancing conversation analysis among its users.

The pedagogic approach it inspires is centred on learning outcomes (LOs) to enhance student understanding and skills in English as a Lingua Franca (ELF) and sociolinguistics. The LOs focus on three key areas: a) declarative knowledge of ELF principles; b) cognitive or practical skills for task accomplishment in the tourist domain; and c) evidence of competence for professional development in the special language of tourism.

The approach to learning emphasises transformative education, encouraging students to reflect critically and engage in deep learning rather than superficial knowledge retention. The teaching praxis has six sections: 1. Ice-breaking activity and content presentation; 2. Introduction to ELF research; 3. Data presentation and background information; 4. Teaching activity using naturally occurring conversation; 5. Workshop analysing data for pragmatic language strategies; 6. Conclusion and assignment instructions for support.

4. Data Analysis.

The epistemological standpoint of this study sample regards speakers' "languaging" (Jœrgensen, 2008) of semiotic resources as a pragmatic strategy for achieving situated meaning-making.

First, *overt* multilingual strategies were examined to verify their functional purposes and interrelations. For example: a) the shared experience of non-nativeness; b) the collaborative creation of meaning; and c) the development of a sense of intercultural community belonging or identity. These practices include translanguaging (cf. Jenkins, 2015; Cogo, 2018), which represents a flexible and integrated approach to utilising one's original repertoire of communicative resources, transcending the rigid and fixed separation between languages (Garcia & Li, 2014; Li, 2016; Cogo, 2012, 2018). Next, *covert* multilingual influences are highlighted, denoting cognitive associations across languages that facilitate understanding among speakers with a common linguistic repertoire.

In certain instances, analyses have examined occurrences that evoke non-standard phonetic or morphological forms. Conversely, the investigation began with pronunciation as a clear manifestation of more complex semantic implications concerning word meaning. Furthermore, specific attention has been devoted to the pragmatic perlocutionary effect intended by the speaker to inspire and enlighten the audience.

Extract 1: *"Necropolis"* (S1: Italian; SS: Italian, Argentinian, American, Japanese, Swedish, Polish, Romanian, Korean, French, Belgian; S2: Argentinian; S3: French) – Part 1.

8	**S1:**	this plain and this hills are occupied by <CL1/><LNlat> enotrions </LNlat></CL1> er
9		er indigenous people who lived principally er in- on the hill and IN this ROOM in particular we

10 can see the <pvc> (abjects) /abdʒɛkt/{objects} </pvc> coming from erm the sites of <L1it>
11 torre mordillo </L1it> (.) the site of <L1it> broia di trebisacce </L1it> and the **necropolis** of <fast>

The linguistic and cultural backgrounds of the participants in the interaction—Latin, Italian, and English—are shared and continually negotiated to enhance mutual understanding. The tour guide (line 8) refers to the local inhabitants of the region by their Latin name – ***enotrions -*** without translating it into English. To ensure clarity, she employs a pre-realisation strategy, anticipating that her audience may not be familiar with the term. The paraphrased description that follows ensures understanding and alleviates potential difficulties. The absence of prolonged hesitations after this utterance and the lack of questions from the museum visitors define the conversational segment from lines 8 to 10. The guide receives non-verbal feedback through the participants' gazes, indicating their engagement.

She employs a consolidated translation technique to clarify a related term by paraphrasing the concept in more general language. This approach likely reflects her experience with other groups, as she articulates it fluently. However, there is a brief hesitation in selecting the correct preposition, "in" versus "on", when describing the location. Observing visitors' reactions to the name, she confidently asserts that "Enotria" is a brand of red wine distributed globally by Calabria. Tourists often try, buy, or read about this wine before visiting the museum, providing the guide with a shared cultural framework upon which to build.

This subtle multilingual strategy establishes a semantic connection between various linguistic elements, particularly the term "wine" and the toponym "Enotria," enhancing comprehension. It connects expressions in a formula (Enotria: Calabrian world-renowned wine = Enotrions: indigenous people of Calabria), organising understanding across different local, regional, and global contexts. The extract proceeds with a dialogic sequence.

Extract 2: *"Necropolis"* (S1: Italian; SS: Italian, Argentinian, American, Japanese, Swedish, Polish, Romanian, Korean, French, Belgian; S2: Argentinian; S3: French) – Part Two.

12 **<L1it>francavilla marittima </L1it> </fast> (.)** er something, er **do you know the words**
13 **mecropoli…**er the **meaning the means of the word me- mecropol- necropolis?**
14 **SS:** Yeah
15 **S1:** mhm yeah what is?
16 **SS:** **<1> cemetery </1>**

The tour guide poses a question to the audience (line 12) - ***do you know the words mecropoli… er the meaning of me- necropolis- necropolis?***'. She establishes a precedent during the visit, facilitating tourists' understanding and appreciation of the information provided. In doing so,

the guide hesitates, repeats herself, and mispronounces a well-known term. This deliberate repetition reassures the audience and instils confidence in their understanding. She inquiries about the meaning of (line 13) ***me- necropolis- necropolis***. This parallel phrasing, keyword repetition, and corrected repetition primarily seek to prevent misunderstandings from substituting the alveolar voiced nasal /n/ with the bilabial voiced nasal /m/ in the technical term necropolis. This deviation from the norm suggests personal involvement and diminishes any power dynamics among the participants who collectively respond to her commitment (line 14). Her didactic approach continues to monitor understanding, accelerating her speech in the subsequent turn (line 15), resulting in a truncated utterance, ***mhm yeah***, and an open Wh-clarification question - ***what is?*** She ensures that what she articulates collaboratively advances the conversation's purpose. She requests explicit confirmation of her meaning, which is met with a concerted response from the group of visitors: 'the cemetery' (line 16). She seeks to illustrate the challenges of using and interpreting specific terminology when engaging with non-specialist speakers in the specialised tourism domain by asking for understanding on two occasions. In this excerpt, the guide emphasises parallel phrasing, keyword repetition, and thoughtful repetition to prevent misunderstanding, underscoring her commitment to ensuring the audience's comprehension.

5. Discussion and conclusion.

This analysis highlights the respondents' subjective perceptions of our study on pragmatic strategies for effective communication and overcoming cultural stereotypes (Baker, 2015; 2012b; 2011). Spoken interactions reveal multilingual and multimodal strategies to achieve the following interactive functions: a) the pedagogical function, b) the interpersonal function, and c) the interpreting function.

The research indicates that participants strive to meet each other's learning needs with kindness and mutual understanding to facilitate effective intercultural communication. English serves as a foundation for international socialising (Jenkins, 2015). Respondents observe that interlocutors recognise strong multilingual knowledge, which can enhance comprehensibility. Additionally, each individual's linguacultural background is connected to their personal choices and life experiences, making it essential to establish connections with speaking partners within a communication fellowship. Consequently, tourists may develop more stable relationships rather than remain in a transient community of speakers (Pitzl, 2016). Their interactions are sufficiently long to cement these relationships and foster a strong sense of belonging. Due to their shared experiences, they naturally tend to accommodate one another, facilitating smoother conversations. In summary, the Framework for Appropriate Interactions in Tourism puts a) emphasis on multicultural and multilingual perspectives, b) negotiation of meaning among conversation partners, c) contextual factors and belief systems in stance-taking, and d) understanding the cognitive process of translanguaging through linguistic forms at the phonetic,

morphological, and syntactic levels. The active incorporation of diverse languages and multi-semiotic resources in conversation reveals a significant trend in this specialised linguistic domain, enacted by an international audience influenced by socio-historical contexts across time and space.

The prominence of these features can delineate a distinct genre within the English as a Lingua Franca (ELF) paradigm, where the "T" for tourism can be grounded in ELF principles. Teaching English for Tourism (TELF) is a multifaceted social practice with general and specific objectives that aim to influence educational, social, and economic spheres. Examining this unique area of ELF can deepen the application of sociolinguistic theory within the research community. Moreover, this study supports previous findings and provides interpretative solutions to issues that can be replicated as effective collective investigative practices. What we have learned from the strategic, dynamic, and creative use of semiotic resources to convey knowledge, skills, and competencies can inform pedagogy, facilitating improved training for tourist operators and more effective marketing strategies for promoting cultural and historical resources and local products.

Despite these promising results, there remains significant potential for further development in understanding the scope and functionality of multilingual resources in TELF. This includes addressing this study's geographical limitations and its population characteristics. Consequently, I am fully committed to outlining future trajectories and implications for classifying TELF as a genre and identifying the most effective methods and practices for teaching English, guided by these theoretical and practical findings. Therefore, a proposal for a pedagogical approach integrates disciplinary content with higher education literature to achieve action-oriented learning outcomes. It is informed by constructivist theory, which suggests that knowledge is created through personal experiences (cf. Jean Piaget, 1971; the socio-historical work of Lev Vygotsky, 1978; and the discovery learning account by Jerome Bruner, 1983). Constructivists assert that knowledge is subjective and arises from personal interpretations of experiences, indicating that understanding is context-dependent. Learning involves constructing personal interpretations that can evolve rather than merely transferring fixed knowledge from the external world. Consequently, pedagogical goals include a) exploring the English as a Lingua Franca (ELF) paradigm; b) familiarising students with qualitative research methods; c) utilising natural conversation extracts to enable students to design assessments; d) fostering connections between language use and teaching design. Teaching strategies promote group work and class discussions while providing tutorial support. In line with the Universal Design for Learning model, resources will be available in both electronic and printed formats to promote social justice and accommodate diverse learning needs.

The special language for tourism course syllabus equips future professionals with the skills necessary for effective international communication in English while also addressing language policies and individual contexts.

References

Baker, W. (2011). Intercultural awareness: Modelling an understanding of cultures in intercultural communication through English as a lingua franca. *Language and Intercultural Communication* 11/3: pp. 197–214.

Baker, W. (2012b). From cultural awareness to intercultural awareness: culture in ELT. *ELT Journal*, 66, (1), pp. 62–70.

Baker, W. (2015). *Culture and Identity through English as a Lingua Franca*. Berlin: De Gruyter Mouton.

Biggs, J. (2003). *Aligning teaching for constructing learning*. Advance HE.

Biggs, J. (2003). *Teaching for quality learning at university*. Maidenhead: Society for Research into Higher Education & Open University Press.

Blommaert, J. (2010). *The Sociolinguistics of Globalisation*. Cambridge: Cambridge University Press.

Bruner, J. S. (1983). Education as Social Invention. *Journal of Social Issues*, *39*(4), 129–141. https://doi.org/10.1111/j.1540-4560.1983.tb00179.x

Canagarajah, S. (2011). The plurilingual tradition and the English language in South Asia. AILA Review vol. 22, Multilingual Globalising Asia, ed. Lim & Low.

Canagarajah, S. (2013). *Translingual Practice*. London: Routledge.

Cogo, A. (2012). ELF and super-diversity: A case study of ELF multilingual practices from a business context. *Journal of English as a Lingua Franca* 1(2). 287–313.

Cogo, A. (2016). Visibility and absence: ideologies of 'diversity' in BELF. In M-L. Pitzl & R. Osimk-Teasdale (eds), *English as a Lingua Franca: Perspectives and Prospects. Contributions in Honour of Barbara Seidlhofer*. Berlin: De Gruyter, 39-48.

Cogo, A. (2018). ELF and Multilingualism. In Jenkins, J., Baker, W., & Dewey, M. (Eds.). The Routledge Handbook of English as a Lingua Franca, 1st Edition. Routledge, Abingdon. Available from: Bookshelf Online, pp. 357–368.Creese, A. & A. Blackledge (2015). Translanguaging and identity in educational settings. *Annual Review of Applied Linguistics* 35: 20–35.

Dovchin, S., Sultana, S., & Pennycook, A. (2015). Relocalising the translingual practices of young adults in Mongolia and Bangladesh. *Translation and Translanguaging in Multilingual Contexts*, *1*(1), 4–26.

García, O. (2009). Bilingual Education in the 21st Century. Oxford: Wiley-Blackwell.

García, O. & L. Wei (2014). Translanguaging: Language, Bilingualism and Education. Houndmills, Basingstoke: Palgrave Macmillan.

Gumperz, J. J. (1972). Introduction. In Gumperz, J. J. And D. Hymes (eds.), (1964). Special issue of American Anthropologist. (eds.). *Directions in Sociolinguistics*. New York: Holt, 1-25.

Gumperz, J. J. And D. Hymes (eds.), (1964). Special issue of American Anthropologist. (eds.) (1972). Directions in Sociolinguistics. New York: Holt.

Hymes, D. H. (1972). On Communicative Competence. In Pride, J. B., & Holmes, J.(Eds.), Sociolinguistics, 269–293. Baltimore, USA: Penguin Education, Penguin Books Ltd.

Jenkins, J. (2015). Repositioning English and multilingualism in English as a Lingua Franca. *Englishes in Practice*, 2015, 2(3). 49–85.

Jørgensen, J.N. (2008), Introduction. Polylingual languaging around and among children and adolescents. *International Journal of Multilingualism* 5(3), 161-176.

Jørgensen, N., M. Karrebæk, L. Madsen & J. Møller (2011). Polylanguaging in Superdiversity. *Diversities* 13/2: 23-37.

Newfield, C. (2017). Remaking College: The Changing Ecology of Higher Education. *Learning and Teaching: The International Journal of Higher Education in the Social Sciences*. Vol. 10, N. 3, pp. 85–88.

Kaur, J. (2016). "Conversation analysis and ELF". *English as a Lingua Franca: Perspectives and Prospects: Contributions in Honour of Barbara Seidlhofer*, edited by Marie-Luise Pitzl and Ruth Osimk-Teasdale, Berlin, Boston: De Gruyter Mouton, pp. 161–168. https://doi.org/10.1515/9781501503177-023.

Kress, G., & Van Leeuwen, T. (2001). El discurso multimodal. Los modos y medios de la comunicación contemporánea. *London: Arnold*.

Parise, I. (2022). English as a Lingua Franca for Tourism: A Pragmatic Study in the Italian Context. https://doi.org/10.25602/GOLD.00034168.

Piaget, J. (1971). *Biology and knowledge*. Edinburgh University Press.

Pitzl, M.-L. (2016). World Englishes and creative idioms in English as a lingua franca. *World Englishes*, 35: pp. 293–309.

Vertovec, S. (2006). The emergence of super-diversity in Britain. *Working Paper No. 25*, Centre on Migration, Policy and Society, University of Oxford.

Vertovec, S. (2007). Super-diversity and its implications. *Ethnic and Racial Studies*. 30(6). 1024–1054.

Vygotsky, L. (1978). Interaction between learning and development. In Gauvain& Cole (Eds.), *Readings on the Development of Children* (pp. 34–40). Scientific American Books.

Widdowson, H. (2020). Linguistics, language teaching objectives and the language learning process. *Pedagogical Linguistics*, *1*(1), 34–43.

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Evaluation of Learning in Applied Economics: An Approach Based on the Use of ChatGPT

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Abstract

This study evaluates the integration of ChatGPT as a complementary tool in applied economics courses, aiming to enhance student learning and skill acquisition. Over two academic years, three student groups were analyzed: a traditional group, an AI group using ChatGPT without guidance, and a combined group receiving both instructor guidance and ChatGPT training. Results from the 2023-2024 academic year revealed significant challenges, including poor performance in the AI group due to insufficient training and unfamiliarity with international databases. In contrast, the 2024-2025 combined group demonstrated improved outcomes, with 100% participation and pass rates, alongside positive student feedback on ChatGPT's utility for tasks and comprehension. The findings suggest that guided integration of AI tools, coupled with proper training, can significantly enhance learning outcomes, advocating for a hybrid model in higher education.

Keywords: *ChatGPT; artificial intelligence; applied economics; higher education; learning outcomes; hybrid learning.*

1. Introduction

Generative artificial intelligence is here to stay, and its applications in personal and professional spheres are countless, including, of course, higher education teaching (Crompton & Burke, 2023; Luckin et al., 2016). Promoting its use in the classroom presents at least two potential benefits. First, AI is a tool that can enhance and complement the teaching-learning process of the specific content and skills of each subject (Holmes, 2019; Zawacki-Richter et al., 2019). Second, it encourages the proper and responsible use of this powerful tool among students (U.S. Department of Education, Office of Educational Technology, 2023). Additionally, it has been shown that students who use an AI tutor learn more than twice as much in less time, while also feeling more motivated and engaged in the educational process (Miller et al., 2024).

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In applied economics courses, students are expected to acquire key professional competencies, such as identifying and managing relevant databases, using software for data processing and analysis, applying the principles of economic analysis to diagnose and solve problems, and developing critical thinking. These skills are essential for students' future employability, and their effective acquisition is therefore a central goal of our teaching approach.

Thus, the main objective is to evaluate the potential complementary role of artificial intelligence (ChatGPT) alongside the lecturer in the teaching-learning process for skill acquisition. Specifically, the aim is to assess how artificial intelligence can assist students in developing the competencies required in applied economics courses, such as identifying and managing relevant databases, using software like Excel, preparing and presenting documents in economic report formats, and fostering critical thinking (Williamson and Eynon, 2020).

To achieve our objective, students completed a final practical exercise focused on managing and critically analyzing economic data. This analysis compared three distinct groups:

1. Traditional Group: Students who followed conventional teaching with the guidance of the professor throughout the course.
2. AI Group: Students who did not receive specific guidance from the professor on completing the exercise but were allowed to use ChatGPT on the day of the final practical exercise.
3. Combined Group: Students who received guidance from the professor during the course, both on how to complete the exercise and how to effectively use ChatGPT.

2. Framework

The study was conducted during the 2023-2024 and 2024-2025 academic years in the course *Economía Española*, part of the Economics degree program, and in *Economía de la Unión Europea*, included in the double degree program in Business Administration and Law. Both courses are mandatory and taught in the third year. However, *Economía Española* is offered in the second semester, while *Economía de la Unión Europea* is taught in the first semester.

In the second semester of the 2023-2024 academic year, the study was carried out in two groups within the Economía Española course: one labeled the "Traditional Group" and the other the "AI Group." In the first semester of the 2024-2025 academic year, the study was conducted with one group, referred to as the "Combined Group." During the 2023-2024 academic year, ChatGPT version 3.5 was available, while version 4.0 was used in the 2024-2025 academic year.

The Traditional Group consisted of 49 students, with instruction provided in Valencian during morning hours, and 71% of students were enrolled for the first time. The AI Group included 44 students, also taught in Valencian, but during afternoon hours, with 61% enrolled for the first

time. Lastly, the Combined Group comprised 32 students, taught in Valencian during morning hours, with 97% of the students enrolled for the first time.

The exercise assigned to the students involved using a dataset from an international database (Eurostat) and utilizing Excel to conduct relevant statistical analyses and create graphical representations of the data. Finally, based on the information collected and analyzed, and supported by a news article, they were required to perform a critical evaluation of an economic event related to the course content.

During both academic years, the final exercise was part of the continuous assessment. Although continuous assessment accounted for 20% of the final grade in both cases, in the 2023-2024 academic year, this exercise made up only 5% of the final grade in the *Economía Española* course, while in the *Economía de la Unión Europea* course in the 2024-2025 academic year, it accounted for 10%.

3. Results

3.1. Academic Year 2023-2024: *Economía Española* – AI Group and Traditional Group

During the 2023-2024 academic year, a notable difference in participation and performance was observed between the two groups analyzed. In the traditional group, participation was 82%, whereas in the group that used artificial intelligence (AI), this figure dropped to 48%. Regarding academic performance, the traditional group achieved an average grade of 9, in contrast to the AI group, which obtained an average grade of 2.4. Additionally, the pass rate was 100% in the traditional group, while only 10% of students in the AI group managed to pass.

However, during this first year, both the limitations of ChatGPT and the challenges these types of exercises posed for students became evident.

Regarding ChatGPT, one of the main difficulties identified was its limitation in handling international databases. This significantly impacted the poor performance of the group using this tool, as it was unable to retrieve the required information from Eurostat to complete the task.

Likewise, we were able to identify the challenges of the exercise for the students (especially in the AI group). These were:

- Lack of familiarity with international databases: The students, particularly those in the AI group, showed a significant lack of knowledge about the use and access to international databases, which limited their ability to complete tasks requiring these types of resources.

- Lack of application of theoretical concepts: Despite having received training in class, the students were unable to adequately apply the concepts covered, which was reflected in their poor performance.
- Lack of training in the use of ChatGPT: The students were not sufficiently prepared to use ChatGPT effectively, which likely contributed to their poor performance.

In conclusion, these results allowed us to identify the need to strengthen training in the use of AI tools, such as ChatGPT, and to improve students' familiarity with international databases.

3.2. Academic Year 2024-2025: *Economía de la Unión Europea* – Combined Group

During the second course, in European Union Economics, we have incorporated training in the use of ChatGPT as an integral part of the learning process. Throughout the course, students not only practiced weekly to prepare for the final exercise but also used ChatGPT as a support tool. At the beginning of each class, the lecturer presents examples of how to formulate effective queries to ChatGPT related to the exercise to be carried out in that session. Furthermore, while working on the exercise, students are encouraged to ask questions about how to use ChatGPT to address any doubts that may arise.

In this course, participation was 100%, and the pass rate was also 100%. The average grade was 8.8. However, the most significant aspect of this course was the final questionnaire that students were able to complete regarding the inclusion of ChatGPT in class activities. This questionnaire was answered by 81% of the class.

In the questionnaire, we compared how students used ChatGPT before and after the course. Additionally, we assessed their opinions on the use of ChatGPT in the subject. Finally, we were able to identify the limitations they perceive in its use.

From this questionnaire, we can draw the following conclusions:

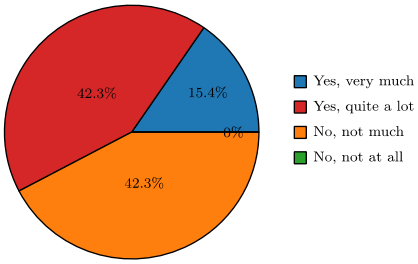


Figure 1. Responses to the question: "Has your use of ChatGPT increased after this course?". Source: Authors' calculations.

1. Although 100% of the students used ChatGPT before the course, approximately 60% have increased their usage after the course, as can be seen in Figure 1.
2. The vast majority of students affirm that the introduction of ChatGPT in the course has been beneficial both for completing the practical exercises and for better understanding the course material.

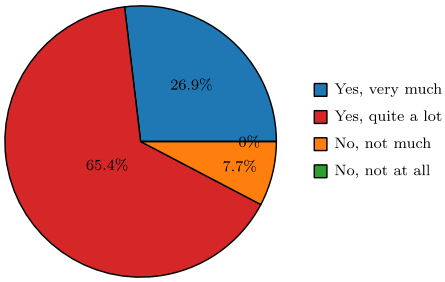


Figure 2. A Responses to the question: "Did ChatGPT help you complete the graded assignment for the course?". Source: Authors' calculations.

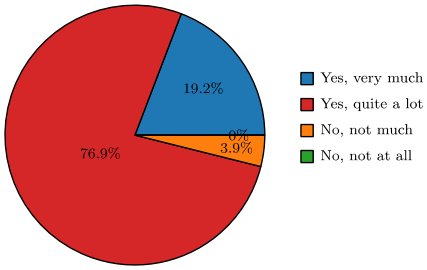


Figure 3. Responses to the question: "Did ChatGPT help you better understand the course content?". Source: Authors' calculations.

3. Based on the students' responses, a significant increase in the use of ChatGPT for various academic tasks is observed. The highest usage is recorded in text writing, which rose from 73.1% to 88.5%, and in extracting ideas from a text, which increased from 69.2% to 80.8%. The growth in the interpretation of tables or graphs also stands out, rising from 30.8% to 69.2%.
4. Students perceive several advantages in using ChatGPT for their studies, primarily highlighting its usefulness for saving time (84.6%) and aiding in the understanding of

concepts (88.5%). Additionally, they value its ability to quickly clarify doubts (76.9%) and generate ideas for assignments (53.8%). However, they also identify drawbacks, such as the possibility of receiving incorrect or confusing answers (73.1%) and excessive reliance on the tool (53.8%). Some students mention that it may reduce their critical thinking skills (34.6%) and hinder the development of their own abilities (38.5%).

4. Conclusion

Over the course of two academic years, we have been able to conduct an initial evaluation of the introduction of Artificial Intelligence (AI) in Applied Economics courses.

The results of this teaching innovation project highlight the importance of properly integrating artificial intelligence tools into applied economics courses. The initial experience during the 2023–2024 academic year revealed significant challenges related to students' lack of familiarity with both international databases and the effective use of ChatGPT, resulting in poor performance. Additionally, prior learning is of great relevance if one aims to avoid increasing inequality (Roldan, 2024).

In contrast, the redesigned 2024–2025 course, which included structured training in AI use and regular classroom practice, showed marked improvements in participation, performance, and student satisfaction. The data suggest that when AI is introduced in a guided and pedagogically sound manner, it can serve as a valuable complement to traditional teaching methods, enhancing student engagement and supporting the development of key academic skills. Nonetheless, the findings also underscore the need to address the limitations of AI tools and to foster their responsible use to avoid overdependence and ensure meaningful learning.

Based on the results obtained, several practical recommendations can be made to enhance the integration of artificial intelligence tools in applied economics education. First, it is essential to provide structured and continuous training in the use of AI tools, such as ChatGPT, from the beginning of the course. This training should include not only technical aspects (e.g., how to formulate effective prompts) but also guidance on their appropriate academic use. Second, exercises involving AI should be carefully designed to complement core learning objectives and include resources that are accessible to both students and AI tools—for instance, ensuring that datasets or data sources are compatible with the capabilities of the chosen AI system. Third, AI use should always be integrated within a broader pedagogical strategy that reinforces theoretical knowledge, critical thinking, and the independent development of skills. Finally, it is advisable to implement regular feedback mechanisms—such as surveys or reflection exercises—to monitor students' perceptions, adjust the instructional approach, and promote responsible and reflective use of AI.

This study suggests that the future of higher education could benefit significantly from a hybrid model that combines traditional instruction with guided use of AI (Luckin, 2017), provided that adequate training is offered both in the use of the tool and in the development of the critical thinking necessary for its effective use (Selwyn, 2019; Williamson and Eynon, 2020).

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References

Crompton, H., & Burke, D. (2023). Artificial intelligence in higher education: The state of the field. *International Journal of Educational Technology in Higher Education, 20*(1), 22. https://doi.org/10.1186/s41239-023-00392-8

Holmes, W. (2019). *Artificial intelligence in education: Promises and implications for teaching and learning*. Center for Curriculum Redesign.

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence unleashed: An argument for AI in education*. Pearson. https://doi.org/10.13140/RG.2.1.3616.8562

Luckin, R. (2017). Towards artificial intelligence-based assessment systems. *Nature Human Behaviour, 1*(3), 0028. https://doi.org/10.1038/s41562-016-0028

Miller, K., Klales, A., Milbourne, T., & Ponti, G. (2024). AI tutoring outperforms active learning. Research Square.

Roldan, A. (2024). *When GenAI increases inequality: Evidence from a university debating competition* (Technical Report POIDWP096). Programme on Innovation and Diffusion, London School of Economics and Political Science.

Selwyn, N. (2019). *Should robots replace teachers? AI and the future of education*. John Wiley & Sons.

U.S. Department of Education, Office of Educational Technology. (2023). *Artificial intelligence and the future of teaching and learning: Insights and recommendations*. U.S. Department of Education. https://www2.ed.gov/documents/ai-report/ai-report.pdf

Williamson, B., & Eynon, R. (2020). Historical threads, missing links, and future directions in AI in education. *Learning, Media and Technology, 45*(3), 223–235. https://doi.org/10.1080/17439884.2020.1798995

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – Where are the educators? *International Journal of Educational Technology in Higher Education, 16*(1), 39. https://doi.org/10.1186/s41239-019-0171-0

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A first approach to Design through a hands-on 3D printing introductory course

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Abstract

A university orientation course, "Basics and Principles of Rapid Prototyping in 3D Printing", was conducted for 137 prospective students. The primary objective was to introduce them to the Design discipline by teaching them fundamental concepts and practical skills in 3D printing. This technology was ideal for combining technical constraints with creative stimulation, guiding students through their first design process. The course featured hands-on activities where students worked on redesigning objects while learning essential skills like object dimensioning, sketching, 3D modelling, printing, and post-production. A learning-by-doing approach was employed, blending interactive lectures with practical exercises, yielding positive student learning assessment results. Student progress was assessed using a Retrospective Pre-test methodology for a subset of available participants. By the end of the three-day course, all students demonstrated the ability to conceptualise and materialise design proposals, create 3D models, and operate 3D printers to produce tangible objects.

Keywords: *3D Printing; Design Education; Retrospective Learning Assessment; Introductory Course.*

1. Introduction

Over the last two years at Politecnico di Milano, an introductory course called "Designing with Basics and Principles of Rapid Prototyping in 3D Printing" was offered as part of the National Recovery and Resilience Plan (PNRR) orientation and tutoring activities for prospective students in preparation for university. The single course, comprising three lessons for a total of 15 hours per student group, aimed to give the students - without previous design knowledge - an overview of the Design discipline and a first encounter with its process through the application of basic principles of 3D printing, modelling and post-producing useful to manage a low-complexity level project. It included theoretical lectures and practical projects where students redesigned tangible everyday objects using 3D printing technology, letting them

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practice inside a hands-on design project while dealing with technical and technological requirements and constraints. The course also offered fundamental technical skills and a conceptual understanding of 3D printing technology, including printer structure, printable materials, and various applications. Most importantly, it fostered the development of additional methodological skills, including critical thinking, creativity, design thinking, and collaborative abilities. These skills have been identified among the learning outcomes associated with 3D printing teaching in educational programs (Trust et al., 2018). Ford and Minshall, when synthesising the current state of the integration of 3D printing technology within the educational system (Ford & Minshall, 2019), highlighted numerous advantages, such as the promotion of design creativity and student engagement, enhancing attitudes towards techno-practical subjects, and cultivating teachers' interest within the classroom setting. Thus, additional studies within the field have underscored the educational capacity associated with integrating 3D printing into classroom settings, benefiting both educators and students (Buehler et al., 2015; Pearson & Dubé, 2022; Schelly et al., 2015; Song, 2018).

2. Designing the course: a hands-on redesign approach

The "Basics and Principles of Rapid Prototyping in 3D Printing" course generally adopted a 'learning by doing' approach, where theoretical lectures were interspersed with hands-on activities. These practical activities delineated students' first "redesign project". Adopting a 'learning by doing' approach enhanced student engagement, enabling them to comprehend the process of creating a 3D model or how 3D printing operates through their actions. (Anzai & Simon, 1979; Macpherson, 1999; Thompson, 2010). For each class, the course was divided into three sessions of five hours each. Key topics covered in the course are listed above in the figure (Fig.1), including an overview of 3D printing technology, materials, structures, functionalities, and applications. Students engaged in hands-on activities like sketching, practising 3D modelling through the online software Tinkercad, and redesigning activities by guiding their design process following specific requirements and technical constraints. Due to temporal limits, tutors 3D printed students' redesigned objects before the final session, which focused on post-production techniques and common design errors for 3D printing. Specifics of the project are detailed in Section 3. Summarising, the course gave the students an overview of how different design strategies can be adopted inside the process based on a specific technology.

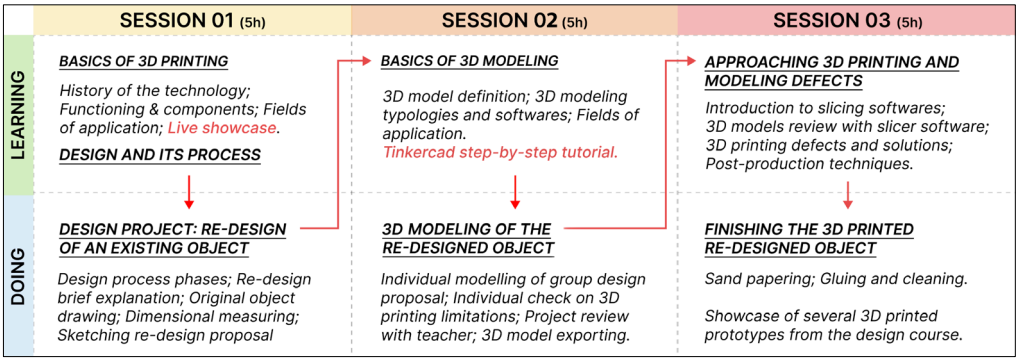


Figure 1. Schematic representation of the main activities (lectures, tutorials, design projects)

All teaching materials, including slides and step-by-step tutorials on printer functioning and 3D modeling, are available upon request by contacting the authors for educational purposes only.

2.1. Audience and Group Work Management

One hundred and thirty-seven students from five groups attended the course, while only sixty-six students completed the initial poll, due to temporary lack of internet connection. Students were between seventeen and nineteen years old and prospective university students with no significant gender or background differences among groups. Crucially, none had prior training in design or 3D modelling and printing technology, as verified by an initial exploratory survey conducted with the Wooclap platform, which was useful for assessing their prior knowledge of the topics and engaging them during the lessons. The results of the initial questions posed to the students - though to gauge their understanding of 3D printing themes before the lessons - indicate that most students (57 of 66 answerings) had 'zero' to 'a little' prior knowledge of the subjects. In contrast, five students claimed to have 'some' knowledge. If prompted, "How much do you think you know about 3D printing?" fifty-nine students answered "Zero" or "A little". Seven responded "Some", mentioning they gained previous knowledge from online videos related to technology fields. After the initial poll, students were grouped into three or four teams, depending on their class size. Each group selected an object to redesign, but each single student completed all the tasks, including measuring, sketching, modelling, and sandpaper finishing.

2.2. Course strategy: lectures alternating 3D learning and practical redesigning

2.2.1. Interactive presentation and initial design brief.

The course aimed to make theoretical sessions more interactive for student engagement. Tutors created presentation slides for visual support, with QR codes embedded to encourage student participation through smartphone responses, fostering engagement and attention by interacting with an online tool. The online platform Wooclap was employed as an open dialogue tool, as it

has already been used in other educational case studies (Marin et al., 2021; Moreno-Medina et al., 2023). In session 01 (see Fig.1), an overview of the design discipline was given through the lens of 3D printing technology for a typical product design project, focusing on production constraints and prototyping opportunities while developing creative solutions. Thus, students had to select small everyday objects, measure them thanks to callipers, and redesign their shapes on paper for aesthetic or functional scopes according to their experience with the object and their related needs. This non-conventional activity, differing from the theoretical lessons students were used to, effectively captured students' attention and engaged them with the course.

2.2.2. Tutorial and modelling

The second session (see Fig.1) focused on "materialising" the design project from paper to 3D models using the Tinkercad app. Students, provided with individual workstations, received step-by-step tutorials from tutors. This activity was unusual for the students, but they quickly adapted and learned the software's basic functions and logic in about two hours. Visualising and constructing their redesign proposal in 3D was captivating and encouraging work, but most importantly, it clarified the product design process. By the end of the lesson, each student successfully modelled their project, detailing it based on the software possibilities and the 3D printing technology constraints. At this stage, the tutor transforms into a mediator, guiding students in their methods to execute their projects (Granjeiro, 2019).

2.2.3. Review-presentation and finishing

In last sessions 03 (see Fig.1), students received their 3D printed projects and participated in a guided observation of the pieces led by tutors. Tutors delivered a lesson on common 3D printing mistakes, with slides showcasing errors and solutions using students' prints and explaining how design choices impacted them. This action allowed students to analyse case studies and understand common mistakes visually and collectively. After receiving their objects, tutors explained the theory behind the post-processing operations needed to complete the 3D printed parts. Ultimately, an overview of other case studies in several design fields (e.g., fashion, interior, interaction, etc…) was provided to help students translate the acquired knowledge of the process into practice using examples from the university design courses. Theoretical lectures were tailored to students' interests, and observed mistakes, allowing tutors to adapt content lesson by lesson to meet evolving class needs: the customised content has enhanced learning engagement among student groups. (Huang et al., 2023)

3. Development of the Project

In the initial stages, student groups selected everyday little-sized objects, including items like glass jars, clothes pegs, and keys. They practised observational skills by sketching the objects' basic shapes on paper. Tutors introduced callipers and their use for dimensioning so that each

group could measure their sketches, emphasising the importance of accurate observation and recording measurements. After the drawing activity, students had to redesign their objects' shapes and functions by modifying, adding or removing elements. They creatively 'hacked' the objects as desired, starting with a group brainstorming session to generate ideas. Based on previous sketches, students redrawn the objects, incorporating proposed changes while considering recorded measurements. The first day's output was the representation on paper of the newly redesigned and measured project (Frame '1' in Fig. 2).

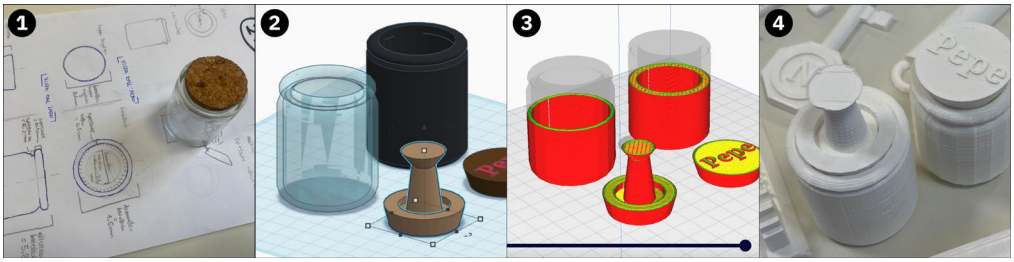


Figure 2. Example of outputs from the steps of the design project completed by the students.

The project's next stage involved transitioning from 2D paper to 3D space: following a frontal tutorial in the classroom, each student - provided with a computer - was tasked with modelling their redesigned object using a 3D modelling web app (Tinkercad). The role of tutors was to individually assist students at their workstations, providing guidance, refreshing tutorial steps as needed, and reviewing the shape elements of the redesign object to ensure the 3D model was printable to the highest standard possible. This part of the exercise has been functional in teaching how technical and production requirements should be considered in the design process and idea development while trying to define the functions and aesthetics of objects. Despite being their first experience with 3D modelling software and concepts, every student successfully produced a 3D model without substantial errors (Frame '2' in Fig. 2). Before the third and final lesson, tutors conducted final slicing operations of the 3D models using the Ultimaker Cura slicing software and subsequently 3D printed the objects to ensure timely delivery to the group. Although tutors conducted this activity separately, students could review their objects with them. Supporting slides displayed the main design mistakes encountered during the slicing activity and provided students with common errors to avoid in the future. Students could perform post-production operations on the parts at the end of the process by sandpapering the surfaces. Many students expressed interest in further steps, such as painting or cleaning their objects at home, indicating a desire to pursue additional activities driven by personal curiosity and interest. Frames '3' and '4' of Fig. 2 show the slicing operation and final 3D printed object. The ultimate goal of the course was to introduce students to the redesign process of an everyday life object through the application of 3D printing technology possibilities: this was their first experience in a design process that challenged them to think out of the box, produce solutions and practice new skills while respecting the technical constraints.

3.1. Students' project outputs

Despite their first disclosure of design process logic and 3D printing and modelling concepts, each student group successfully redesigned a 3D printable object, transitioning from theory to personalisation. Post-production engaged and motivated students to excel. They received their 3D printed objects at the project's end (Fig.3), taking home their design creations. Tutors highlighted mistakes to their students for future reference. Projects varied from basic redesigns (e.g., adding animal shapes to combs) to "innovative" solutions (e.g., adding hooks to improve clothes pegs or transforming keys into multifunctional cutlery). Many students explored tolerances between different parts, notably in redesigning jars, where they had to model both the body and the cap. Several students personalised object shapes by adding names or parts inspired by animals or fantasy characters. Everyone seemed to have understood the process, and most groups successfully integrated the technical requirements and opportunities in their product design definition and development.



Figure 3. Overview of the 3D printed projects of the redesign activity.

4. Students learning assessment

To assess learning before and after the implementation of the lessons, a Retrospective Pre-test was completed by students. As suggested in the literature, this questionnaire was selected as an effective approach for measuring learning outcomes (Levinson et al., 1990). The questionnaire comprised two sections: the first section focused on evaluating how the lessons were conducted, emphasising the management of content and interaction with the class by the tutors. The second section pertains to learning assessment and involves comparing students' knowledge and understanding of skills and theoretical concepts before and after. All questions and assessment requests were designed to understand the impact of the overall strategy employed in delivering the lessons - encompassing the redesign project, personalised and interactive slides, frontal tutorials, and theoretical lectures. A group of students didn't conduct the final survey due to the lack of internet connection in one classroom for the time being. The total number of respondents to the final stage questionnaire is 66, and nobody reported having ever approached a design project activity or a 3D modelling or 3D printing one. Evaluation points divided as follows in Table 2 (Poor = 1; Fair = 2; Good = 3; Very Good = 4; Excellent = 5).

Table 1. Distribution of answers to final Retrospective Pre-test

Section: 1 / Presenters (Ps)	**1**	**2**	**3**	**4**	**5**	**Avg.**
The Ps covered the important topics of the content area.	0	0	1	19	46	4.68
The Ps covered the topic in sufficient detail.	0	0	0	22	44	4.67
The Ps kept the discussion focused on the topic.	0	1	3	20	42	4.56
The Ps refocused the discussion when it began to wander.	0	1	3	31	25	4.21
The Ps created an atmosphere in which most learners participated.	0	1	16	28	21	4.05
The Ps created an atmosphere in which learners felt free to ask questions.	0	1	2	23	40	4.55
The Ps responded to questions with appropriate/relevant answers.	0	0	2	9	55	4.80
The Ps asked questions which led to lively and relevant discussion.	0	1	19	27	19	3.97
The Ps asked questions which were relevant to the topic objectives.	0	2	7	28	29	4.27
Section: 2 / Learning (Prior / After the session)	**1**	**2**	**3**	**4**	**5**	**Avg.**
PRIOR: My understanding of the subject	36	22	4	2	2	1.67
AFTER: My understanding of the subject	0	0	17	39	10	3.89
PRIOR: My ability to demonstrate comprehension of this subject	41	16	5	2	2	1.61
AFTER: My ability to demonstrate comprehension of this subject	0	0	23	34	9	3.79
PRIOR: My ability to apply concepts to an actual situation in this subject	35	19	8	2	2	1.74
AFTER: My ability to apply concepts to an actual situation in this subject	0	1	24	32	9	3.74

5. Discussion

Most students initially didn't possess previous knowledge and understanding of Design and 3D printing, and - even though not everyone has conducted the questionnaire - tutors have observed that all students successfully achieved the learning objectives, navigating through the steps of redesigning objects and preparing them for 3D printing. They also gained skills in measuring objects, using 3D modelling and slicer software, and materialising their design idea. Referring to the group that successfully conducted the retrospective pre-test, responses showed a significant increase in comprehension after the lectures, with students actively participating in design project exercises. By the end of the course, most of the sample reported a greater understanding of the topics covered than their initial comprehension. In addition, the unusual displacement of the theoretical parts of the course, rich in interactive questions through Wooclap and contemporary meme language, played an important role in catching students' attention and engagement, as enthusiastically reported by students through the lessons.

References

Anzai, Y., & Simon, H. A. (1979). The theory of learning by doing. Psychological Review, 86(2), 124–140. https://doi.org/10.1037/0033-295X.86.2.124

Buehler, E., Easley, W., McDonald, S., Comrie, N., & Hurst, A. (2015). Inclusion and Education: 3D Printing for Integrated Classrooms. Proceedings of the 17th International

ACM SIGACCESS Conference on Computers & Accessibility, 281–290. https://doi.org/10.1145/2700648.2809844

Ford, S., & Minshall, T. (2019). Invited review article: Where and how 3D printing is used in teaching and education. Additive Manufacturing, 25, 131–150. https://doi.org/10.1016/j.addma.2018.10.028

Granjeiro, É. M. (2019). Research-based teaching-learning method: A strategy to motivate and engage students in human physiology classes. Advances in Physiology Education, 43(4), 553–556. https://doi.org/10.1152/advan.00034.2019

Huang, A. Y. Q., Lu, O. H. T., & Yang, S. J. H. (2023). Effects of artificial Intelligence–Enabled personalized recommendations on learners' learning engagement, motivation, and outcomes in a flipped classroom. Computers & Education, 194, 104684. https://doi.org/10.1016/j.compedu.2022.104684

Levinson, W., Gordon, G., & Skeff, K. (1990). Retrospective Versus Actual Pre-Course Self-Assessments. Evaluation & the Health Professions, 13(4), 445–452. https://doi.org/10.1177/016327879001300406

Macpherson, R. C. S., Tamara R. Berman, Kimberli A. (1999). Learning by Doing. In Instructional-design Theories and Models. Routledge.

Marin, J., Brichler, S., Lecuyer, H., Carbonnelle, E., & Lescat, M. (2021). Feedback From Medical and Biology Students on Distance Learning: Focus on a Useful Interactive Software, Wooclap®. Journal of Educational Technology Systems, 50(2), 188–200. https://doi.org/10.1177/00472395211023383

Moreno-Medina, I., Peñas-Garzón, M., Belver, C., & Bedia, J. (2023). Wooclap for improving student achievement and motivation in the Chemical Engineering Degree. Education for Chemical Engineers, 45, 11–18. https://doi.org/10.1016/j.ece.2023.07.003

Pearson, H. A., & Dubé, A. K. (2022). 3D printing as an educational technology: Theoretical perspectives, learning outcomes, and recommendations for practice. Education and Information Technologies, 27(3), 3037–3064. https://doi.org/10.1007/s10639-021-10733-7

Schelly, C., Anzalone, G., Wijnen, B., & Pearce, J. M. (2015). Open-source 3-D printing technologies for education: Bringing additive manufacturing to the classroom. Journal of Visual Languages & Computing, 28, 226–237. https://doi.org/10.1016/j.jvlc.2015.01.004

Song, M. J. (2018). Learning to teach 3D printing in schools: How do teachers in Korea prepare to integrate 3D printing technology into classrooms? Educational Media International, 55(3), 183–198. https://doi.org/10.1080/09523987.2018.1512448

Thompson, P. (2010). Chapter 10—Learning by Doing. In B. H. Hall & N. Rosenberg (A c. Di), Handbook of the Economics of Innovation (Vol. 1, pp. 429–476). North-Holland. https://doi.org/10.1016/S0169-7218(10)01010-5

Trust, T., Maloy, R. W., & Edwards, S. (2018). Learning through Making: Emerging and Expanding Designs for College Classes. TechTrends, 62(1), 19–28. https://doi.org/10.1007/s11528-017-0214-0

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Equipping Instructors to Foster *AI Literacy* in the Higher Education Classroom: Preliminary Results from a Pilot Project

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Abstract

The ever-growing number of new and constantly evolving AI-based (writing) tools poses a major challenge for university teaching, especially in writing classes. While students are increasingly exploring these tools without reflecting their use critically enough, many instructors are unsure how to approach these new tools in their own teaching and whether or how to integrate them into their courses. They are unfamiliar with many of the tools or feel overwhelmed by the abundance of options and the obvious or sometimes perceived expectation to integrate them into their teaching. As part of an award-winning pilot project, a platform was therefore developed to support instructors in teaching basic AI literacy skills, providing curated teaching materials and specially designed workshops. Survey results, ongoing subscriptions to the platform, and its partial integration into a new cross-university project all highlight the strong appreciation and continued relevance of these resources among instructors and higher education experts.

Keywords: *AI literacy; higher education; innovative teaching; teaching materials; workshops; emerging educational technologies.*

1. Introduction

The release of ChatGPT by Open AI in November 2022 and the emergence of many other Large Language Models (LLMs) following in its wake have had a disruptive effect on higher education (Farrelly et al., 2023; Sullivan et al., 2023; Bond et al., 2024), especially in the teaching of communication competencies, including business and academic writing. For both students and educators alike, these tools offer many new possibilities, but at the same time, they have also caused unease. While students increasingly use these tools, they often do so without reflecting them critically enough, which then results in unsatisfactory outcomes (Larson et al., 2024). For higher education teachers, this poses a major challenge, and the central question remains how to deal with generative AI inside and outside the classroom (Walter, 2024).

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In this, instructors are faced with a dilemma. On the one hand, many universities have decided to approach these developments proactively by incorporating *AI literacy* into their curricula as part of a comprehensive and future-oriented education strategy aligned with digital transformation goals (Martin, 2023). According to Long and Magerko (2020), *AI literacy* is defined as a skill set that helps individuals to critically assess AI, interact with it effectively, and use it in everyday life. Furthermore, it includes recognizing AI tools, understanding how they work, knowing their benefits and limitations, understanding AI programming capabilities, and being aware of ethical issues and the role of humans in AI. The idea is therefore to teach students basic *AI literacy* skills and how to engage with AI appropriately (Southworth et al., 2023; Jensen et al., 2024; McDonald et al., 2024) to make them competent "managers of AI" (Cardon et al., 2023).

On the other hand, many lecturers are unfamiliar with most AI tools or feel overwhelmed by the constantly growing range of options and the obvious need or the (perceived) expectation to integrate them into their own teaching. This has also been reflected in the development of various *AI literacy frameworks*, such as UNESCO's *AI Competency Framework for Teachers* (2024). These circumstances gave rise to a pilot project, whose goal was to create a university-wide platform for lecturers with teaching materials for teaching basic *AI literacy* skills. A variety of workshops on different topics were developed to support lecturers in their teaching and to thereby help them tackle the aforementioned challenges.

2. Moodle Platform with Workshops

Over the course of two semesters (08/2023-07/2024), three main workshops A, B, and C were developed. All workshops were made accessible from the beginning to all interested staff members via the university's Moodle course management system. The sections for each workshop contained a "lesson plan" with recommendations for how to teach the workshop in question, complete lesson slides in the form of a PowerPoint presentation, and additional external materials, such as learning videos and useful links. The course page also offered support in the form of a forum for instructors to exchange experiences, the school's regulations and legal factsheets regarding the use of AI (e.g., in assignments), and further reading material. All workshops could be taught individually or in combination due to their modular nature, enabling lecturers to customize and adapt them to their specific needs. They were designed to support the lecturers regardless of their level of knowledge.

Workshop A served as a general introduction into AI tools such as ChatGPT, explaining their capabilities, limitations, and potential applications in higher education while emphasizing academic integrity. It included a short video overview, discussion prompts, and practical exercises where students, under instructor supervision, explored several AI tools in groups and reflected on their advantages and challenges. Workshop B built on the foundation established

in Workshop A by focusing on the use of AI tools for writing tasks such as summarizing and paraphrasing, introducing tools such as QuillBot to demonstrate advanced text modification features. Lecturers guided students in critically evaluating these tools, understanding quality standards, and addressing benefits, potential challenges, and limitations. Finally, Workshop C focused on academic research, specifically on the development of research questions, helping students leverage AI for brainstorming and refining queries. It encouraged a critical assessment of AI-generated research questions in terms of relevance, accuracy, and clarity, fostering a deeper reflection on the role of AI in the research process.

The instructions of each workshop included a brief concluding discussion on the importance of applying human judgement when evaluating and critically assessing AI-generated content. This was essential for ensuring adherence to quality and academic standards and for fostering critical thinking skills.

3. Methods

Prior to the first implementation of the workshops in fall semester 2023, 50 faculty members from different fields within the university were asked in an online survey (Google forms) about their use of AI tools in the classroom to better understand general needs and concerns. Moreover, a focus group of 12 communication lecturers, who had expressed their interest in using the workshops in their teaching in spring semester 2024, was invited for an interview, in which the workshops were presented to the lecturers in detail. The discussion was recorded and focused on the following pre-defined topics: 1. use of AI tools and self-assessment of own competence in using these tools; 2. dealing with AI tools in higher education; and 3. AI tools in the context of the home university. The main statements were transcribed and organized in thematic categories. In addition, a Padlet was made available to the lecturers to collect further feedback. The results of the survey, the discussion, and the feedback provided were then used for the further development of the workshops.[1]

After each implementation of the workshops in fall semester 2023 (version V.1) and spring semester 2024 (improved version V.2), the lecturers who had taught them were asked to participate in a semi-structured, open-ended interview and to complete structured feedback forms in order to detect potential need for changes and adjustments in the teaching materials.

[1] Students were also asked to provide feedback in an anonymous quantitative and qualitative online survey before and after being taught the workshops. Since these results are currently being published elsewhere and the focus of this paper is on higher education instructors, the findings are not discussed here.

4. Results

4.1. Faculty Survey

The results of the faculty survey revealed that while 49% of the lecturers had increased their use of AI in the classroom since the launch of ChatGPT in November 2022, 51% had not. Moreover, when asked about their level of confidence regarding the use of AI tools (1= not at all, 6= very), 60% indicated feelings of insecurity (see Figure 1). At the same time, however, when asked whether they thought it was expected of them to use AI in their teaching (1= not at all, 6= absolutely), 68% had the impression that they were indeed expected to use AI tools in the classroom, 34% of them even stating that they believed they absolutely had to (see Figure 2).

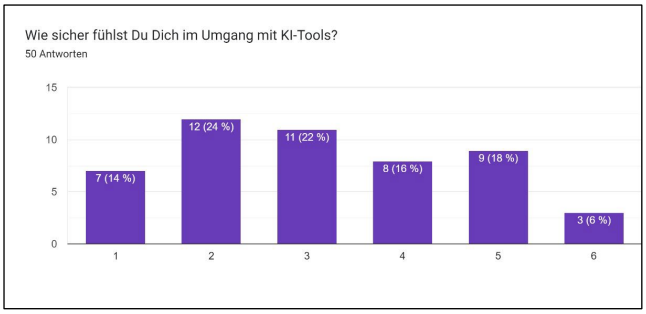


Figure 1. Survey question: "How confident do you feel about using AI tools?" Source: KI in der Hochschullehre (n.d.).

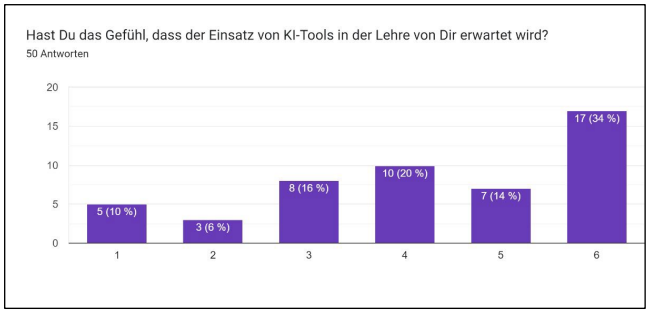


Figure 2. Survey question: "Do you have the impression that you are expected to use AI tools in your teaching?" Source: KI in der Hochschullehre (n.d.).

The faculty members were also asked for their opinion about the extent to which students used AI tools (1= not at all, 6= always). 79% believed that students used them often (23%), very often (52%), or always (4%) (see Figure 3).

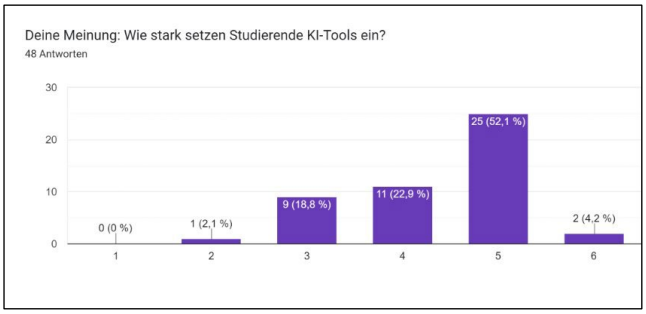


Figure 3. Survey question: "Your opinion: To what extent do students use AI tools?" Source: KI in der Hochschullehre (n.d.).

Yet, 80% believed that students were not or only somewhat skilled in their use of AI tools and did not consider ethical implications enough, with 22% stating that students never did so and 59% stating they did so only rarely.

4.2. Focus Group of Lecturers

The interviewed lecturers described varied use of AI tools, employing different tools for diverse tasks to varying degrees. In teaching, for example, some used AI to create case studies or exam questions. Many were in a "trial and error" phase, partly due to the rapid emergence of new tools becoming available. The discussion revealed varying knowledge levels and attitudes toward AI tools. Some lecturers were highly experienced, while others had limited familiarity. Many expressed uncertainty or concern about the rapid development of AI tools and knowledge gaps regarding university regulations ("what is allowed, what is not allowed"), asking for clear guidelines and specifications from the study directors to ensure a consistent approach across courses. They identified dealing with exams as the biggest challenge, revealing two contrasting views: namely restricting versus incorporating AI use. Some favored designing exams to prevent AI usage to focus on assessing students' knowledge without tool assistance, while also raising concerns about tool reliability. Others suggested integrating AI tools into exams from the outset. The discussion also addressed the values that students should be taught at university in the context of AI, how to best prepare them for their future professions, and lecturers' needs to be able to use and teach AI tools effectively and appropriately.

4.3. Qualitative Interviews: Lecturer's Feedback on Workshops

According to the lecturers who taught the workshops, these were well-organized and structured, effectively encouraging active participation and providing meaningful exchanges among students of all levels through practical demonstrations and hands-on activities. Students reportedly improved their understanding of AI tools and increased confidence in various aspects of business and academic writing, including text structure, the possibilities and challenges of

AI, and issues such as academic integrity and dishonesty. The workshops were particularly impactful for students without prior experience with LLMs; for more experienced students, the focus on academic integrity and institutional guidelines added value. All lecturers agreed that time management was the most significant challenge, as it limited the opportunity for proper discussions and comprehensive execution of tasks. Another challenge was the rapid evolution and market maturity of new AI writing tools, which required adaptations to some workshops.

5. Discussion

The survey completed by faculty teaching staff showed a large discrepancy in terms of knowledge, application, and competence but also attitudes and approaches towards these tools. While half of them saw a benefit or need to increase their use of AI tools in the classroom and had already done so, the other half had not, which might point to reluctance or insecurities with regard to incorporating AI into their teaching. This interpretation was further underscored by the fact that the majority (60%) expressed a lack of confidence about the use of AI technologies. At the same time, an even larger number of the educators (68%) felt pressured to incorporate AI in their teaching, 34% of them even stating that they believed they absolutely had to. This could be interpreted as pointing to a potential dilemma: On the one hand, teachers did see a growing need or expectation to include AI in their teaching – probably also because 79% of them had realized that students were increasingly using AI in their assignments, but in an inept or ethically questionable way. On the other hand, many did not feel adequately equipped to do so.

A similar ambivalence was found in the discussion with the lecturers of the focus group, indicating that they not only had different attitudes towards AI, but also different levels of confidence and competence regarding the use of AI tools. The knowledge advantage that lecturers normally have over students seemed to be softened here for once. This led to uncertainty regarding the didactic approach. In addition, there were few guidelines from the university management in fall 2023 that the lecturers could follow. Hence, what all lecturers agreed on was that the university needed to implement clear guidelines and instructions for both instructors and students to ensure consistency in the context of AI.

The lecturers who taught the workshops reported that the developed workshops were mostly appreciated by their students and worked quite well in their classes; moreover, they resonated well with lecturers across the entire school. The lecturers added that they appreciated the opportunity to stick to certain guidelines and lesson notes, especially at the beginning. This was especially true in the first two semesters (fall semester 2023 and spring semester 2024), when ChatGPT brought the AI writing tools into focus for all students and lectures, and when guidelines from the university management were mostly missing. The teachers' feedback was

useful to realize that, between the first and final versions of the workshops, only time management had to be adjusted for their improvement.

6. Conclusion and Outlook

Cooperating closely with the university's teaching staff over the course of two semesters revealed important needs and challenges on their side. This information was used to continuously develop useful and supporting teaching materials, which were meant to facilitate their teaching of *AI literacy* skills in the classroom. In general, the workshops were very well received and continue to be taught. The project was awarded the university's innovation prize in June 2024, and staff members still ask for access to the materials on the Moodle platform. Therefore, it was suggested by several higher education experts within the university that the workshop materials be published in an Open Educational Resources (OER) repository to make them publicly available. Insights and content from this pilot project will also feed into a new joint initiative by FHNW and the University of Basel, funded by the swissuniversities network. The aim of this project is to strengthen the digital and AI competencies of all university members and to foster a cultural shift by developing tailored frameworks and learning opportunities that support the effective integration of AI in teaching and learning.

7. Limitations

This study is limited as it relies on insights from only a small number of lecturers. Further research could be conducted to analyze the experiences and feedback of a larger group of instructors who have taught the workshops by now. Nevertheless, we have realized the ongoing validity and relevance of our work due to the continuing demand for the workshops.

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References

AI competency framework for teachers. (2024). In *UNESCO eBooks.* https://doi.org/10.54675/zjte2084

Bond, M., Khosravi, H., De Laat, M., Bergdahl, N., Negrea, V., Oxley, E., Pham, P., Chong, S. W. & Siemens, G. (2024). A meta systematic review of artificial intelligence in higher education: a call for increased ethics, collaboration, and rigour. *International Journal of Educational Technology in Higher Education*, *21*(1). https://doi.org/10.1186/s41239-023-00436-z

Cardon, P., Fleischmann, C., Aritz, J., Logemann, M. & Heidewald, J. (2023). The Challenges and Opportunities of AI-Assisted Writing: Developing AI Literacy for the AI Age. *Business and Professional Communication Quarterly*, *86*(3), 257–295. https://doi.org/10.1177/23294906231176517

Farrelly, T. & Baker, N. (2023). Generative Artificial Intelligence: Implications and Considerations for Higher Education Practice. *Education Sciences*, *13*(11), 1109. https://doi.org/10.3390/educsci13111109

Jensen, L. X., Buhl, A., Sharma, A. & Bearman, M. (2024). Generative AI and higher education: a review of claims from the first months of ChatGPT. *Higher Education*. https://doi.org/10.1007/s10734-024-01265-3

KI in der Hochschullehre. (n.d.). Google Docs. https://docs.google.com/forms/d/1gX9P0cqFVGS_rp8JF-YbSoUaBvyRl81FKZroAHfZHXA/edit#responses

Larson, B. Z., Moser, C., Caza, A., Muehlfeld, K., & Colombo, L. A. (2024). Critical thinking in the age of generative AI. *Academy of Management Learning and Education*, *23*(3), 373–378. https://doi.org/10.5465/amle.2024.0338

Long, D. & Magerko, B. (2020). What Is AI Literacy? Competencies and Design Considerations. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (pp. 1-16). Association for Computing Machinery. https://doi.org/10.1145/3313831.3376727

Martin. (2023, October 19). *Education - United Nations Sustainable development*. United Nations Sustainable Development. https://www.un.org/sustainabledevelopment/education/

McDonald, N., Johri, A., Ali, A. & Hingle, A. (2024). Generative Artificial Intelligence in Higher Education: Evidence from an Analysis of Institutional Policies and Guidelines. *arXiv (Cornell University)*. https://doi.org/10.48550/arxiv.2402.01659

Southworth, J., Migliaccio, K., Glover, J., Glover, J., Reed, D., McCarty, C., Brendemuhl, J. & Thomas, A. (2023). Developing a model for AI Across the curriculum: Transforming the higher education landscape via innovation in AI literacy. *Computers and Education Artificial Intelligence*, *4*, 100127. https://doi.org/10.1016/j.caeai.2023.100127

Sullivan, M., Kelly, A. & McLaughlan, P. (2023). ChatGPT in higher education: Considerations for academic integrity and student learning. *Journal of Applied Learning & Teaching*, *6*(1). https://doi.org/10.37074/jalt.2023.6.1.17

Walter, Y. (2024). Embracing the future of Artificial Intelligence in the classroom: the relevance of AI literacy, prompt engineering, and critical thinking in modern education. *International Journal of Educational Technology in Higher Education*, *21*(1). https://doi.org/10.1186/s41239-024-00448-3

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Catalyst Awards for Science Advancement (CASA): Pilot Results

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Abstract
Catalyst Awards for Science Advancement (CASA) are mini-grants designed to promote professional development for graduate students, post-doctoral researchers and early career scientists. Professional development is embedded into CASA in multiple ways: writing the proposal, executing the proposed activities, preparing the final report, and optionally, serving as a CASA peer reviewer. Proposals are solicited semi-annually. Thirty-five projects have been awarded to date, including 16 during Round 1 (Spring 2024) and 19 during Round 2 (Fall 2024). Following submission of their final reports, project leads are invited to complete an anonymous evaluation survey. To date, 27 (or 77%) project leads completed the survey. Pilot evaluation results are strongly positive. On a scale of 1 (negative) to 5 (positive), participant mean responses to 17 quantitative survey items regarding self-efficacy, sense of belonging and agency range from 3.9 to 4.8. Qualitative (open-ended) responses align with the quantitative results. Formative feedback is used to inform program revisions for future solicitations. For more information: www.soest.hawaii.edu/CASA/

Keywords: *Professional Development; Grant writing; Graduate students; Early Career*

1. Introduction

1.1. Rationale & Institutional Context

This pilot program is co-located at two institutions in the United States (U.S.): University of Hawai'i at Mānoa (UH Mānoa), located in Honolulu, Hawai'i, and Washington University at St. Louis (WashU) in St. Louis, Missouri. Both UH Mānoa and WashU have a Carnegie Classification of R1, defined as doctoral-granting universities with very high research activity (American Council on Education, 2025). Only a small portion of research activities at R1 institutions are supported through intramural sources; the vast majority is supported by U.S. federal agencies, such as National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), National Oceanic and Atmospheric Administration (NOAA), National Institute of Health (NIH), Department of Defense (DOD) and

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Department of Energy (DOE). Typically, these federal agencies issue solicitations (requests for proposals), faculty submit proposals, peer reviewers evaluate the scientific merit of the proposals, and (based on that evaluation) funding is either awarded or denied. Thus, the ability to secure extramural funding is a major determinant of a scientist's research productivity. Yet, few graduate programs offer training in grantsmanship (grant writing and/or grant management). And, when such trainings are offered, they are typically optional and often conflict with class or work responsibilities. Thus, attending such training is rarely prioritized by students or their advisors. The result is that many newly minted PhDs have little or no grantsmanship training or experience, which puts them at a significant disadvantage career-wise, particularly if they land at an R1 institution.

1.2. CASA Program & Professional Development

Catalyst Awards for Science Advancement (CASA) offers mini-grants (up to $3000) to promote grantsmanship and other types of professional development among graduate students, post-doctoral researchers and other early career scientists (e.g., university faculty or staff). This program extends to two main groups: (1) UH Mānoa's School of Ocean and Earth Science and Technology (SOEST), which supports research and training in earth, ocean, atmospheric and planetary science; and (2) Interdisciplinary Consortium for Evaluating Volatile Origins (ICE-Five-O), a multi-institutional NASA Solar System Exploration Research Virtual Institute center that researches volatile evolution on airless bodies like the Moon and asteroids. Led from WashU, the ICE-Five-O team also includes researchers from SOEST and other institutions in the U.S. and Canada.

Professional development is embedded into CASA in multiple ways: through writing the proposal, adhering to program requirements, responding to peer reviews, executing the proposed activities, developing and managing the project budget, preparing the final report, and optionally, serving as a CASA peer reviewer. CASA mini-grant proposals are solicited semi-annually, with submission deadlines in May and December, and eligible SOEST and ICE-Five-O students and scientists apply. Prior to the submission deadline, online and in-person information sessions are offered to clarify guidelines and answer questions. These sessions represent the extent of pre-submission training; the vast majority of professional development training unfolds in a series of scaffolded steps following submission (summarized below). At each step of the process, staff are available to support project leads.

1) Peer review panels are convened and panelists are trained in reviewing proposals based on NSF merit review criteria. All persons eligible to serve as a CASA project lead may volunteer to serve as a peer reviewer, provided they are not submitting a proposal during that round of funding. Typically, each panelist is asked to review 4-6 proposals over a two-week period using a template provided. Usually, three panelists are assigned to each proposal, and they write their reviews independently. This serves to increase the quality

and independence of the review process and avoids putting undue pressure on the peer reviewers.

2) Peer reviews are then compiled into a summary review containing two parts: strengths and weaknesses / areas that require clarification, and these reviews are sent to the project lead. Based on this summary, a small number of proposals are selected for or declined funding. However, in most cases, the proposal is considered selectable and the project lead is asked to respond to the review (e.g., provide additional information not included in the original proposal to address weaknesses). The revised proposal is then re-reconsidered for funding. This unusual two-stage review process is intentionally designed to increase the quality of the final proposal submitted and therefore the likelihood of funding, which is anticipated to result in increased self-efficacy. A key result is the vast majority of CASA proposals are funded. The peer review experience also trains the peer reviewers to write stronger proposals in the future.

3) Project leads of successful proposals now begin their project, which are executed over a period of approximately six months. Project periods are February-August (for proposals submitted in December) and July-December (for proposals submitted in May). During this stage, the project lead develops professionally by executing the project activities (e.g., attending a short course, mentoring an undergraduate, organizing an outreach event) and managing the budget.

4) After completing the project, project leads submit a brief report, which includes a synthesis of results, dissemination and whether project goals/objectives were achieved. This requirement is modeled after NSF processes.

1.3. Project Goals and Theory of Change

The overarching goal of the CASA program is to promote professional development for graduate students, post-doctoral researchers and early career scientists. Beyond improved grant-writing skills, anticipated outcomes include increased sense of belonging, self-efficacy and agency, so project leads feel empowered to pursue future, larger grants. Self-efficacy theory states that a person's belief in their own capabilities affects their behavior (Bandura, 1977). Simply put, increased self-efficacy leads to increased motivation, engagement, effort and persistence, which in turn leads to increased competence. Research has shown that a sense of self-efficacy, belonging, and agency positively correlate with academic achievement, retention and career success (e.g., Bandura, 1986; Elliott & Dweck, 2988; Pintrich & DeGroot 1990; Schunk 1983a, 1989a).

CASA invokes two theories of change: scientific management and social cognition (Kezar, 2018). A top-down scientific management approach is utilized through the establishment of a new funding program to incentivize change. A bottom-up social cognition change perspective

is invoked through the individual CASA awards. The project leads are a key part of the change because these individuals are proposing, leading and managing the project activities. Thus, the CASA program provides a framework for top-down and bottom-up theories of change to merge.

2. Methods & Data

2.1. Survey Instrument

Following completion of their project and submission of their final report, project leads are invited to complete an anonymous online survey, which was approved as exempt by the UH Institutional Review Board. This survey contains 24 items, divided for the purpose of this discussion into three sections and takes approximately 5 minutes to complete. Part 1 (3 items) asks for the project lead's academic status and past experience with submitting proposals and being awarded grants. Part 2 (17 items) aims to evaluate whether CASA participation results in increased self-efficacy, sense of belonging, and/or agency among project leads. The first subsection (self-efficacy) presents a list of 11 skill sets. For each, project leads are asked to compare their current level of knowledge/confidence to their pre-CASA level. The second subsection (sense of belonging; 3 survey items) asks project leads to report on any changes in their feelings of connection and happiness at work, as a result of having received a CASA award. The third subsection (agency; 3 survey items) asks project leads to estimate their likelihood of participating in future grant-related opportunities. In Part 2, all survey items are given in the form of statements and survey respondents are asked to indicate their level of agreement with each. Response choices range from Strongly Disagree to Strongly Agree, as well as "Not Applicable". Part 3 (4 items) solicits formative feedback to inform program revision. Through open-ended prompts, project leads are asked to share one thing they liked about being a CASA project lead, one thing they learned, and a suggestion for program improvement. There was also a space provided for optional, additional comments.

2.2. Survey Data & Analysis

Thirty-five CASA projects have been awarded to date, including 16 during Round 1 (Spring 2024) and 19 during Round 2 (Fall 2024). To date, 27 project leads have completed the survey, for a response rate of 77%. Data are summarized below.

Survey Part 1. Academic Status & Prior Grant Experience

The majority (52%) of survey respondents are graduate students; the others are university faculty or staff (37%) and post-doctoral researchers (11%). About one-third (35%) of respondents had submitted at least one proposal prior to CASA, although fewer than one-third (27%) had received at least one successful funding decision.

Survey Part 2. Self Efficacy, Belonging and Agency

For each survey item in Part 2, respondents indicate their agreement or disagreement on a five-point Likert scale. The response choices are then quantified as follows: 1 (Strongly Disagree); 2 (Disagree); 3 (Neither Agree nor Disagree); 4 (Agree); and 5 (Strongly Agree). Responses of "Not Applicable" are neither quantified nor included in the analysis. **Table 1** presents the self-efficacy survey items, along with the mean response and the % agreement (that is, the percentage of respondents who agreed or strongly agreed) to each. Similarly, **Tables 2 and 3** present the survey items on sense of belonging and agency, respectively, along with the mean response and % agreement.

Table 1. Participant Responses to CASA Survey items on Self-Efficacy

Compared to how I felt before I applied for my first CASA mini-grant, I now feel more knowledgeable / confident in ….	**Mean Response[1]**	**% Agree[2]**
Justifying the importance of a project	4.3	89%
Organizing project ideas / activities in writing	4.4	89%
Creating and managing a budget	4.4	93%
Writing a competitive proposal	4.4	93%
Asking colleagues for feedback	4.0	70%
Conversing with funders about my project ideas	4.1	78%
Responding to peer reviews	4.2	85%
Executing project activities that I proposed	4.4	89%
Writing a final report	4.4	93%
My writing abilities, in general	3.9	63%
My scientific abilities, in general	3.9	65%

[1]Mean Response is on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree)
[2]% Agree is the percentage of respondents who selected "Agree" or "Strongly Agree" responses

Table 2. Participant Responses to CASA Survey items on Sense of Belonging

As a result of having been awarded a CASA mini-grant, I now feel …	Mean Response[1]	% Agree[2]
More connected to SOEST peers / colleagues	4.4	85%
More respected by my peers / colleagues	3.9	67%
Happier about my work	4.6	93%

[1]Mean Response is on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree)
[2]% Agree is the percentage of respondents who selected "Agree" or "Strongly Agree" responses

Table 3. Participant Responses to CASA Survey items on Agency

As a result of having been awarded a CASA mini-grant, I am now more likely…	Mean Response[1]	% Agree[2]
To apply for another mini-grant opportunity	4.8	100%
To apply for a larger grant	4.6	89%
To volunteer to serve as a peer reviewer for a grant competition	4.4	85%

[1]Mean Response is on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree)
[2]% Agree is the percentage of respondents who selected "Agree" or "Strongly Agree" responses

Part 3. Formative Feedback

Respondents are invited to provide responses to open-ended prompts to share one thing they liked about being a CASA project lead, one thing they learned, and a suggestion for program improvement. Space is also provided for optional, additional comments. **Table 4** presents a sample of representative responses received regarding what they liked and learned. The suggestions they offered included making successful past proposals available (to serve as examples), increased advertising (to ensure all students are made aware of CASA), an extended project period (to allow more time to spend down the budget), and meetings with other project leads (to foster networking). The optional comments shared were all expressions of gratitude.

3. Discussion & Conclusions

Pilot results were strongly positive. On a scale of 1 to 5, participant mean responses to the 17 quantified Likert scale survey items ranged from 3.9 (Agree) to 4.8 (Strongly Agree) (**Tables 1-3**). We note that all survey items were worded such that agreement is a positive response. Participant agreement rates (the percentage of respondents who agreed or strongly agreed with

Table 4: Sample participant responses to open-ended prompts

Please share one thing you LIKED about being a CASA project lead	Please share one thing you LEARNED from being a CASA project lead
Bringing an idea to fruition. I really appreciated the opportunity to come up with a project, propose it, receive funding, and actually do it!	I learned how to organize an original idea and have a set list of goals.
I liked being the PI of my own project (often not possible as a PhD student).	Everything takes more time than anticipated. All aspects of my proposed work took longer than intended and I didn't account for admin tasks like managing receipts and reimbursement and final reporting.
I was able to help find a way to support a project that I am passionate about	I developed soft skills in facilitating symposiums and workshops, including time management, introducing speakers, designing discussion dynamics, and effectively summarizing discussions.
I liked to be able to run the symposium I applied for. It had great attendance and was very well received by the participants.	I learned the importance of dissemination.
I liked being in charge of communication with the grantors.	I was able to work with managing grant spending and ordering for the first time, which will be very helpful for future endeavors.
I have never applied for a grant before and the process was very straightforward and gave me the confidence to try applying to more small grants.	Budget needs to be more well thought out. I believe we had quite a bit left over. If planned better, we could have been more efficient.
CASA allowed me to work with students on fun and engaging projects, and with the inclusion of a stipend for student support, I was able to support them financially as well as intellectually.	Gained valuable experience in managing a project of this scale, particularly the timing of putting events together.
Being a CASA project lead allowed me to investigate the issues my community partners and I agreed upon without being limited by funding or the priorities of other project leads.	The two-stage review process (being given an opportunity to address questions posed by the reviewers) was really powerful in that it gave me ideas about what I could include in future proposals to make an application/ justification stronger.
Being able to work on collaborations outside my lab bubble and help inspire early career scientists! The CASA team was also great to work with, flexible on changing situations.	I learned new ways to engage students in and outside the lab and found that student success takes many forms.
	I learned the importance of sharing and delegating tasks effectively, ensuring that responsibilities are distributed in a way that supports both teamwork and efficiency.

each survey item) ranged from 63% to 100%, with a mean of 82%. Project leads reported increased mean self-efficacy in all survey items, even those that were not specific to the CASA project, such as their general writing (3.9) and scientific (3.9) abilities (**Table 1)**. They also reported an increased sense of belonging, measured by feelings of connectedness to peers (4.4), being respected by peers (3.9) and happiness at work (4.6) (**Table 2)**. In terms of agency (mean responses 4.4 to 4.8), 89% of respondents reported being more likely to apply for a larger grant, 85% to serve as a peer reviewer, and 100% to apply for another mini-grant opportunity (**Table 3)**. Responses to open-ended comments asking what they liked and learned (**Table 4**) were similarly positive. For example, respondents reported liking the independence and leadership involved in being project lead, the application process, pursuing new (previously unfunded) opportunities, and working with students and community collaborators. They learned how to organize ideas, set goals, create budgets, manage tasks and spending, make a dissemination plan, in addition to specific skills learned from executing the projects themselves. Together, the qualitative and quantitative pilot evaluation results indicate that serving as a CASA project lead positively impacts self-efficacy, sense of belonging and agency, qualities that have been found to correlate with academic achievement, retention and career success.

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References

American Council on Education (2025). Carnegie Classification of Institutions of Higher Education. http://carnegieclassifications.iu.edu/

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84, 191-215.Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice-Hall.

Elliott, E. S., & Dweck, C. S. (1988). Goals: An approach to motivation and achievement. Journal of Personality and Social Psychology, 54, 5-12

Kezar, A. (2018). How colleges change: Understanding, leading, and enacting change. Routledge.

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. Journal of Educational Psychology, 82, 33-40.

Schunk, D. H. (1983a). Ability versus effort attributional feedback: Differential effects on self-efficacy and achievement. Journal of Educational Psychology, 75, 848-856.

Schunk, D. H. (1989a). Self-efficacy and achievement behaviors. Educational Psychology Review, 1, 173-208.

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Do Different Rating Scales in Student Evaluations Bias Perceptions of Teaching Quality?

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Abstract

This study examines how different rating scales in Student Evaluation of Teaching (SET) influence perceived teaching quality and decision-making. In Phase 1, SET data was collected from five university courses, with students randomly assigned to evaluate their instructor using one of two different rating scales per course. In Phase 2, 3,719 online participants completed one of two decision-making tasks based on SET results from Phase 1. Participants were randomly assigned to select a university for their studies or hire a candidate, with ratings derived from varying rating scales. A linear regression analysis shows that differences in standardized scores derived from the usage of different rating scales significantly influence selection outcomes. Additionally, a thematic analysis of open-ended responses reveals that participants relied on percentage-based comparisons, but their choices were adjusted when the distribution of responses was provided. These findings uncover the bias introduced by different rating scales in SET.

Keywords: *SET, student evaluation, rating scales, bias, higher education*

1. Introduction

Management control systems (MCSs) guide organizations in aligning employee behavior with strategic goals (Merchant & Van der Stede, 2007). While extensively studied in corporate settings, their application in higher education remains underexplored. With increasing pressure on universities to ensure quality teaching, Student Evaluations of Teaching (SET) have emerged as a dominant evaluation tool, adopted by 94% of institutions in Germany, Austria, and Switzerland (Guenther & Schmidt, 2015). Despite their widespread use, SETs face criticism for biases and methodological limitations (Boring et al., 2016; Stroebe, 2020). Prior research highlights how rating scales influence psychometric properties such as reliability and validity (Cox, 1980; Schmitt & Stults, 1986). However, little attention has been given to how different response scales alter perceived teaching quality. This study addresses this gap by analyzing how scale variations affect SET results and subsequent decision-making. To investigate, we collected

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SET data from courses at a Western European university, applying different response scales. We then conducted a survey where participants compared evaluation scores presented in hiring and university selection scenarios. Our goal was to understand how participants interpret and compare SET scores derived from different scales. Notably, we intentionally held teaching quality constant by design, altering only the rating scale used for evaluation.

The paper proceeds as follows: Section 2 details our methodology, Section 3 presents results, and Section 4 concludes with implications.

2. Methodology

We conducted a two-phase approach: in Phase 1, we collected real SET data using various rating scales; for Phase 2, we conducted an experimental survey to analyze how participants interpret and compare these SET results in two different decision contexts.

2.1. Phase 1

To obtain real-world SET data, we evaluated five different courses at a Western European university. Each evaluation questionnaire contained the same 19 standardized questions, and students were randomly assigned one of two rating scales tested within a single course. This setup ensured that we could directly compare evaluation results for the same instructor, in the same course, at the same time – isolating the effect of the rating scale itself. Across the five courses, students were exposed to five different scale combinations: 4-point (n=17/34) vs. 7-point (n=17/34), 4-point (n=27/49) vs. 7-point (n=22/49), 4-point (n=22/44) vs. 8-point (n=22/44), 5-point (n=10/27) vs. 7-point (n=17/27), and 4-point (n=13/22) vs. 6-point (n=9/22), resulting in a total of 176 completed evaluations.

2.2. Phase 2

Using this data, we designed an experimental online survey with two decision-making scenarios to test how participants interpret the evaluation scores from Phase 1.

In the first scenario (Figure 1), participants imagined themselves as students choosing a university for their master's program. They were presented with two options, University X and University Y, and informed that both universities were comparable in quality, apart from the alleged evaluations, which entailed the master program evaluation within the two universities. These ratings, allegedly from former students, were taken from our SET dataset in Phase 1, where we assigned two different average scores from the same instructor’s evaluations—each derived from a different rating scale—to the two universities. Participants had to decide which university they would prefer, based solely on these ratings.

In the second scenario (Figure 2), participants imagined themselves as hiring committee members selecting a professor. Two candidates, Candidate A and Candidate B, were described as having identical research backgrounds, with the only differentiating factor being their teaching evaluations. As in the first scenario, we presented the teaching performance of both candidates by extracting averages from our SET dataset in Phase 1. Specifically, each candidate was assigned one of the two averages derived from the evaluation of the same instructor, who was assessed in Phase 1 using two different rating scales. In this scenario, participants were also shown the distribution of scores behind each average. This allowed us to assess how access to additional data influenced decision-making.

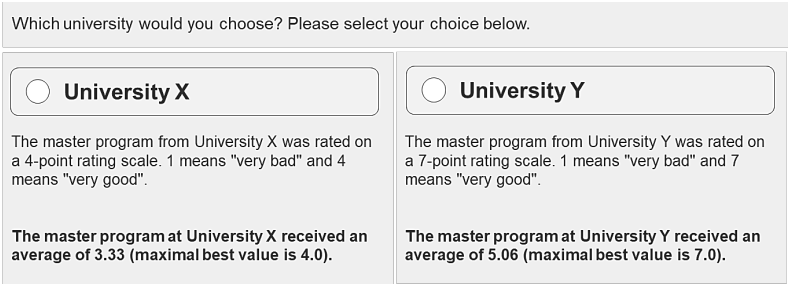


Figure 1. *Decision-making scenario: Selection between University X and University Y based on ratings from different scales. The figure displays the exact interface shown to study participants when they were asked to choose between two universities based solely on master program evaluation scores derived from different rating scales. Source: Authors' Own Study (2024).*

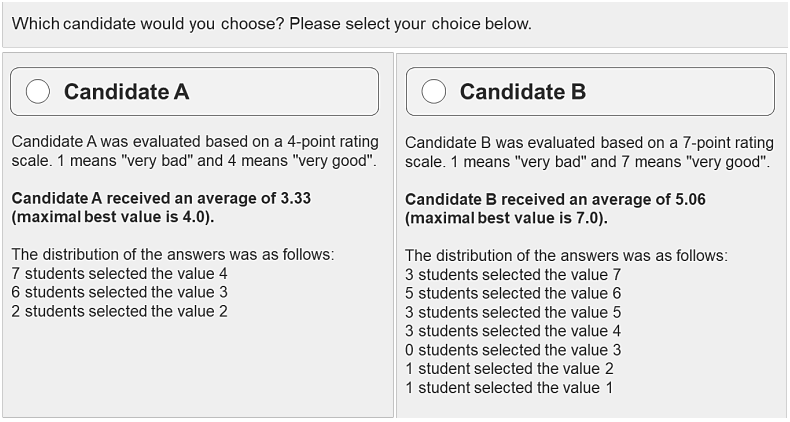


Figure 2. *Decision-making scenario: Selection between Candidate A and Candidate B based on ratings from different scales, including the distribution of responses. The figure displays the exact interface shown to study participants when they were asked to choose between two candidates based solely on teaching evaluation scores derived from different rating scales. Source: Authors' Own Study (2024).*

The survey was conducted via Prolific, a UK-based research platform, with 3,719 participants from Europe. Each participant received a small financial incentive, and the median completion time was 3 to 4 minutes.

To analyze responses, we applied both quantitative and qualitative methods. First, SET scores were standardized into percentages for comparability, and a linear regression model examined the relationship between score differences and voting outcomes. Second, a thematic analysis of 3,719 open-ended responses was conducted following Guest et al.'s (2014) framework to identify key reasoning patterns. This approach enables us to assess how small changes in rating scales impact both SET results and the decisions made based on those results. By combining empirical SET data with a survey experiment, we provide a comprehensive examination of rating scale effects in higher education assessments.

3. Results

3.1. Impact of Rating Scales on SET Scores (Phase 1)

To compare the SET evaluations across different rating scales acquired in Phase 1, we standardized the averages using the following formula, adapted from Preston & Colman (2000):

$$Standardized\ Score = \left\{ \frac{Rating-1}{Max\ Scale\ Value-1} \right\} x\ 100 \quad (1)$$

This transformation converts all SET scores into a 0 - 100% scale, allowing for direct comparisons. For example, one instructor received an average score of 3.80/5, which - when standardized using Formula (1) - became 70.00%. The same instructor, when evaluated using a 7-point scale for the same question, received an average of 6.71/7, which standardized to 95.86%.

The analysis of 19 score comparisons between different rating scales for the same course and instructor revealed notable variations in standardized scores. When applying the standardization formula, we observed differences of up to 25 percentage points. The mean absolute difference across all rating scale comparisons was 7.93 percentage points.

These findings underscore that rating scale selection alone can significantly impact perceived teaching performance, which may in turn influence faculty evaluations, hiring decisions, and institutional policies.

3.2. Survey Experiment Findings (Phase 2)

A total of 3,719 participants completed the survey, making decisions in two scenarios based on SET-derived ratings from Phase 1.

In the first scenario, where participants chose a university based solely on its average student evaluation score, 95% of participants selected the university with the higher standardized percentage rating. This confirms that participants mentally convert different rating scales into a common percentage-based format before making decisions.

In the second scenario, where participants evaluated faculty candidates and were also shown the distribution of scores, 89% of participants selected the candidate with the higher percentage rating – similar to the first scenario. Therefore, the assumption that most of the votes were given to the university/candidate with the highest percentage rate holds true for both scenarios.

3.3. Regression Analysis

A linear regression model was used to examine the relationship between score differences and voting outcomes. Results, based on all data from Phase 2, show a strong positive relationship between the difference in standardized scores and the difference in votes. Specifically, a 1% increase in the standardized score difference resulted in a 4.70% increase in the vote difference ($p < 0.001$). This confirms that the comparison of evaluation results, stemming from different rating scales, systematically influence voting outcomes. Table 1 illustrates this relationship, showing a case where Candidate B received a standardized score that was 25.17% higher than Candidate A (95.17% vs. 70.00%). This difference in standardized scores translated into a 77.08% difference in votes (88.54% vs. 11.46%). The results align with the model's findings, reinforcing the conclusion that differences in evaluation results due to varying rating scales can have a measurable impact on decision-making.

Table 1. Example of How Differences in Standardized Scores Translate into Voting Outcome.
Source: Own elaboration based on Phase 2 data.

	Standardized Score (%)	Standardized Score Difference (%)	Votes	Votes (%)	Vote Difference (%)
Candidate A Score 3.80/5	70.00%	-25.17%	11	11.46%	-77.08%
Candidate B Score 6.71/7	95.17%	+25.17%	85	88.54%	+77.08%

3.4. Thematic Analysis of Open-Ended Responses

We asked all participants an open-ended question about the reasoning behind their choice. Using thematic analysis, we aimed to uncover the multiple factors influencing voting behavior in greater detail. The thematic analysis followed the framework by Guest et al. (2014) and was conducted on a dataset of open-ended responses from a total of 3,719 study participants. This analysis identifies key themes explaining how participants evaluate universities and faculty candidates based on SET scores measured on different scales, with Table 2 presenting the main factors that emerged as influencing their decisions.

In Scenario 1 (University Selection), participants were provided only with average scores. Decision-making in this scenario was driven primarily by quantitative metrics, as participants overwhelmingly preferred higher percentage ratings, top scores, and standardized scores. This suggests a strong reliance on numerical comparisons when no additional context was available. In Scenario 2 (Faculty Hiring), where participants also received score distribution data, decision-making patterns shifted. Participants placed greater emphasis on minimizing negative feedback, often favoring candidates with fewer negative ratings even when their overall average was lower. Additionally, evaluation reliability, as indicated by larger sample sizes, played also a more prominent role in their choices.

Table 2. Identified Decision-Making Themes in the Thematic Analysis. Source: Own elaboration based on responses from 3,719 study participants in Phase 2.

Theme	Description	Scenario
Higher Percentage	Preference for options with a higher percentage rate, indicating quantitative superiority.	1 & 2
Standardized Score	Adjustment of scores to a common standard to compare options across different scales.	1 & 2
Top Score	Preference for options closer to the maximum possible score on its scale.	1 & 2
Large Scale	Preference for evaluations on a larger scale, perceived as more comprehensive.	1 & 2
Distribution More Positive	Preference for options with a higher proportion of positive evaluations.	2
Distribution Less Negative	Preference for options with fewer negative evaluations, minimizing poor outcomes.	2
Sample Size	Preference for options evaluated by a larger number of participants, seen as more reliable.	2

To analyze decision patterns, we categorized universities and faculty candidates into green and red categories based on their difference in standardized scores. The green category included candidates or universities with a positive difference, meaning they received a higher standardized score compared to their counterpart. Conversely, the red category included those with a negative difference, indicating a lower standardized score. In the example from Table 1, Candidate B falls into the green category, having a higher standardized score, while Candidate A is in the red category, with a lower standardized score. This classification allowed for a structured examination of participants' choices and the reasoning behind them. Across both scenarios, the green category options were primarily chosen based on high standardized scores, whereas red category options were selected when participants considered factors such as rating scales, sample size, and negative score distribution. This finding suggests that while score-based comparisons dominate decision-making, the distribution of responses and sample size become equally important once this additional information is provided to decision-makers.

3.5. Excluded Themes

Some participant responses did not fit into the structured decision-making themes presented in Table 2. Several participants relied on intuition, making decisions based on gut feelings rather than systematic comparison. Others provided no clear reasoning, selecting an option arbitrarily without justification. Additionally, some responses were irrelevant or incoherent, making them unsuitable for analysis. While a few participants referenced "better ratings," their criteria for defining "better" were often vague, making systematic categorization difficult.

4. Conclusion

This study examined how variations in rating scales influence Student Evaluations of Teaching (SETs) and the decision-making processes that follow. The findings demonstrate that even when the instructor, course content, and student cohort remain constant, differences in rating scales can lead to notable changes in standardized scores. This suggests that the same teaching performance may be perceived quite differently depending on the scale used. Through a survey experiment, we found that participants predominantly relied on numerical averages when evaluating universities and faculty candidates, often converting scores into percentages and choosing the option with the higher value. However, when additional information such as score distributions was available, participants became more attentive to negative feedback and the reliability of evaluations based on sample size. These patterns illustrate the risks of comparing SETs across different scale formats without proper context. Institutions using SETs for hiring, promotion, or rankings should therefore exercise caution, as scale design alone can influence decision outcomes. This aligns with Rivera and Tilcsik's (2019) findings that subtle differences in rating scales, such as the number of points, can introduce bias—particularly gender-related bias—in teaching evaluations. Future research could address ways to mitigate these effects, for example, through standardized rating scales or by providing contextual explanations with evaluation results. While this study is limited by the number of courses included and the specific range of scale formats tested, it underscores the broader implications of rating scale design. As SETs continue to play a critical role in assessing teaching quality, ensuring their fair and meaningful interpretation remains essential for academic institutions and faculty alike.

References

Boring, A., Ottoboni, K., & Stark, P. (2016). Student evaluations of teaching (mostly) do not measure teaching effectiveness. *ScienceOpen Research*, *2016*, 1–11. https://doi.org/10.14293/s2199-1006.1.sor-edu.aetbzc.v1

Cox, E. P. (1980). The optimal number of response alternatives for a scale: A review. *Journal of Marketing Research*, *17*(4), 407–422. https://doi.org/10.2307/3150495

Guenther, T. W., & Schmidt, U. (2015). Adoption and use of management controls in higher education institutions. In B. R. Martin, D. M. H. Grant, & U. Schmoch (Eds.), *Incentives and performance: Governance of research organizations* (pp. 213–236). Springer. https://doi.org/10.1007/978-3-319-09785-5

Guest, G., MacQueen, K. M., & Namey, E. E. (2012). *Applied thematic analysis*. SAGE Publications. https://doi.org/10.4135/9781483384436

Merchant, K. A., & Van der Stede, W. A. (2007). *Management control systems* (2nd ed.). Pearson Education Limited.

Preston, C. C., & Colman, A. M. (2000). Optimal number of response categories in rating scales: Reliability, validity, discriminating power, and respondent preferences. *Acta Psychologica*, *104*(1), 1–15. https://doi.org/10.1016/S0001-6918(99)00050-5

Rivera, L. A., & Tilcsik, A. (2019). Scaling down inequality: Rating scales, gender bias, and the architecture of evaluation. *American Sociological Review, 84*(2), 248–274. https://doi.org/10.1177/0003122419833601

Schmitt, N., & Stults, D. M. (1986). Methodology review: Analysis of multitrait-multimethod matrices. *Applied Psychological Measurement*, *10*(1), 1–22. https://doi.org/10.1177/014662168601000101

Stroebe, W. (2020). Student evaluations of teaching encourage poor teaching and contribute to grade inflation: A theoretical and empirical analysis. *Basic and Applied Social Psychology*, *42*(4), 276–294. https://doi.org/10.1080/01973533.2020.1756817

Appendix A

1	I regularly attend the course.
2	The learning objectives of the course are clear.
3	The course has a clear structure.
4	The instructor is committed to their teaching.
5	The course provides a learning-conducive atmosphere.
6	The evaluation methods (exams, assignments, etc.) are aligned with the learning objectives.
7	The course enables me to deepen the content independently.
8	The offered activities (readings, group work, excursions, etc.) support my learning.
9	I have the impression that the course prepared me well for the assessment (exam, assignment, etc.).
10	The content is presented in an understandable way.
11	The material is illustrated with examples
12	The requirements are...
13	I actively participate in the course (thinking along, preparing and reviewing, regular attendance, etc.)
14	The videos and interactive case studies helped me to better understand the material.
15	Mother tongue(s)
16	Gender
17	Degree program
18	I am taking this course as part of…
19	For me, this course is…

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Blended Intensive Programme (BIP) - Digital Transition, Law, and International Markets: a case study

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Abstract

The Blended Intensive Programme (BIP), hosted by the Polytechnic of Porto in collaboration with European partner institutions, exemplifies an innovative approach to interdisciplinary education in the context of European higher education transformation. This article examines the programme's design and implementation, combining virtual and onsite methods to address global challenges related to digital transformation, legal frameworks, and international trade. Through a qualitative methodology, incorporating document analysis and participant observation, the study explores how the BIP model successfully integrates diverse pedagogical approaches while fostering cross-cultural collaboration among participants from six European countries. Key outcomes are presented, emphasizing participants' development of intercultural and digital skills, as well as challenges encountered during the programme's implementation, including technical difficulties and time constraints. The findings underscore the significance of the BIP model in promoting internationalization and interdisciplinarity in European higher education, while also suggesting improvements for future iterations such as expanded thematic scope and enhanced IT infrastructure. This case study contributes to ongoing discussions about innovative educational practices in the Erasmus+ framework and offers insights for institutions seeking to implement similar blended learning initiatives.

Keywords: *Blended Intensive Programme; interdisciplinary education; digital transformation; legal frameworks; international trade.*

1. Introduction

Blended Intensive Programmes (BIPs), an initiative under the Erasmus+ framework, combine both virtual and face-to-face components to foster innovative pedagogical practices. These programs are organized by, at least, three Higher Education Institutions from different countries

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participating in Erasmus+, aiming to promote innovative teaching and learning methods. Research literature widely recognizes these programs' potential to enhance educational flexibility and accessibility while developing students' digital literacy and critical thinking skills. Furthermore, blended learning represents the thoughtful integration of face-to-face and online learning experiences, fundamentally redesigning the educational approach to optimize student engagement through the effective combination of both modalities, as conceptualized in Garrison and Vaughan's Community of Inquiry framework.[1] Additionally, blended learning is recognized as an effective strategy for promoting intercultural collaboration, since it facilitates preliminary virtual interactions between participants from diverse cultural backgrounds prior to in-person engagement.[2]

Collaborative learning approaches further enhance academic performance and interpersonal skills, providing students with essential competencies for international collaboration.[3]

The Erasmus+ Programme Guide emphasises innovative teaching methods, including blended learning, stating that *"blended learning enhances flexibility and accessibility in education, combining face-to-face interaction with virtual tools".* [4]

Nevertheless, scholarly discussions about BIPs have predominantly relied upon official Erasmus+ documents and perspectives, rarely incorporating complementary theoretical frameworks or critically examining diverse scholarly viewpoints.

Thus, this article aims to fill this gap by critically examining the structure, methodology, and outcomes of the Blended Intensive Programme conducted by the Polytechnic of Porto, specifically addressing the interconnectedness of digital transformation, law, and international trade within an interdisciplinary educational setting.

The BIP, conducted in October 2024, involved participants from six European countries (Lithuania, Germany, Portugal, Romania, Slovenia and Spain), combining virtual instruction and onsite immersion. Its primary goal was to address pressing global issues by engaging students and academics in challenge-based learning. This paper examines the programme's structure, pedagogical innovations, thematic challenges, and outcomes. It also highlights the BIP as a model for interdisciplinary and internationalised higher education.

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[1] Garrison, D. R., & Vaughan, N. D. (2008). Blended Learning in Higher Education: Framework, Principles, and Guidelines. San Francisco: Jossey-Bass. DOI:10.1002/9781118269558. Publisher: John Wiley & Sons. ISBN: 9780787987701, pp 13-30.

[2] Deardorff, D. K. (2006). Identification and Assessment of Intercultural Competence as a Student Outcome of Internationalization. Journal of Studies in International Education, 10(3), 241-266.

[3] Johnson, D. W., Johnson, R. T., & Smith, K. A. (2014). Cooperative Learning: Improving University Instruction by Basing Practice on Validated Theory. Journal on Excellence in College Teaching, 25(4), 85-118.

[4] European Commission. (2021). Erasmus+ Programme Guide 2021–2027.
Retrieved from: https://erasmus-plus.ec.europa.eu

The study sample consisted of a total of 33 students, 22 of whom were female and 11 male, with an average age of 21. Students from the following universities took part: Vilnius Gediminas Technical University (Lithuania) - 6 participants; Schmalkalden University of Applied Sciences (Germany) - 3; Universidad de León (Spain) - 6; Kauno Kolegija (Lithuania) - 6; Romanian-American University (Romania) - 2; International School for Social and Business Studies (Slovenia) - 3; and Porto Polytechnic School of Technology and Management (Portugal) - 7. With regard to the areas of study of their respective degrees, the participants were divided into: Business and Administration (14), Law (7), Marketing and Advertising (7), Information and Communication Technologies; Social Sciences, Journalism and Information (2) and Economics (1). As for the level of study, 28 students are studying for a bachelor's degree and 5 for a master's degree.

The teaching staff in mobility is characterised by 6 professors, one male and 5 females. They came from universities in Spain (2), Lithuania (2) and Romania (2). In addition, 11 professors from the host institution took part in the activities.

2. The Structure of the Blended Intensive Programme

The BIP unfolded over two distinct phases: a virtual phase (7th–11th October) and an onsite phase in Felgueiras, Portugal (20th–26th October). Each phase contributed uniquely to the programme's objectives.

The virtual phase laid the theoretical groundwork through interactive webinars on topics such as digital governance, trade compliance, and the regulatory impact of emerging technologies. This stage fostered cross-border collaboration by grouping participants into multinational teams, ensuring diverse perspectives and mutual learning. Participants prepared for the onsite phase by engaging with preliminary readings, discussions, and resource-sharing via digital platforms.

The onsite phase focused on practical applications and cultural immersion. Participants engaged in workshops led by academic and industry experts, exploring complex topics such as consumer protection, digital arbitration, and artificial intelligence. In addition to academic activities, visits to cultural and industrial landmarks, such as the city of Guimarães and the "Quinta da Lixa" winery, provided context to discussions on local economic practices and global markets.

This combination of academic depth and cultural engagement exemplified the holistic nature of the BIP. So, we can say that: *"Collaborative programs foster intercultural competence, teamwork, and problem-solving skills among students."* [5]

3. Pedagogical Approach and Methodology

The BIP employed a blended learning model that merged theoretical insights with hands-on problem-solving. This approach leveraged the strengths of virtual and in-person formats, ensuring a robust and multifaceted learning experience.

[5] Deardorff, D. K. (2006). *op. cit.*

A key feature of the programme was its challenge-based methodology. Participants were assigned specific global issues to investigate and propose solutions, fostering a sense of ownership and accountability. These challenges spanned a range of interdisciplinary themes, requiring participants to combine knowledge from law, economics, technology, and social sciences.

There were interactive sessions; lectures on which experts discussed several topics; group projects, giving the opportunity to students from different countries to collaborate on projects; cultural exchange (as we already told) and final presentations, giving the opportunity to each group to present their project at the end of the event.

Assessment criteria were designed to evaluate both individual and group contributions. Participation during sessions accounted for 20% of the assessment, while research depth and collaboration contributed 30%. The remaining 50% was allocated to the quality of final presentations, which included poster displays and oral defences. This comprehensive evaluation framework ensured that participants were rewarded for active engagement, teamwork, and intellectual rigour.

There are several benefits for students: *"Blended learning can enhance student engagement, improve learning outcomes, and provide greater flexibility."*[6]

We also highlight the impact of collaborative learning: *"Participatory and collaborative learning approaches have a positive impact on academic performance and interpersonal skills."*[7]

4. Thematic Challenges

The Blended Intensive Programme was structured around twelve thematic challenges that addressed real-world issues at the intersection of digital transformation, law, and global markets. These challenges served as focal points for research and discussion, requiring participants to draw upon multiple fields and fostering an appreciation for the complexity of global issues. Although diverse, these challenges can be grouped into four major thematic clusters, each contributing to a comprehensive understanding of the digital transition in international contexts.

The first cluster focused on digital trade and economic integration, encompassing challenges such as Digitalisation and International Trade Agreements, Global Trade Compliance, and Digital Taxation in the EU. Participants analysed the modernization of customs, the integration

[6] Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2010). Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies. U.S. Department of Education.
Retrieved from: https://www2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf

[7] Johnson, D. W., Johnson, R. T., & Smith, K. A. (2014),*op. cit.*

of e-commerce into trade policies, and the legal implications of digital services taxes. Teams specifically explored blockchain's role in trade transparency, regulatory technology (RegTech) adoption, and the design of digital services taxes in accordance with OECD initiatives for international cooperation.

A second group addressed regulatory and legal frameworks, including topics like Data Privacy in the Digital Age, Consumer Protection in E-Commerce, and International Arbitration in the Digital Era. Students explored the application of GDPR in cross-border data transfers, AI-assisted arbitration, and mechanisms like online dispute resolution systems, all of which exemplify how digital transformation reshapes traditional legal procedures. Key discussions centered on privacy-enhancing technologies, transparency in digital transactions, and the enforceability of digital arbitration agreements in virtual proceedings.

The third cluster highlighted technological innovation and governance, with challenges such as Artificial Intelligence and Legal Systems, Regulation of Digital Assets and Cryptocurrencies, and Digital Identity and Global Mobility. Participants critically examined emerging regulatory frameworks for AI and blockchain, including the rise of central bank digital currencies (CBDCs) and digital identity solutions based on biometric verification. Important topics included liability in AI-driven decision-making, anti-money laundering measures for cryptocurrencies, and blockchain-based identity verification systems.

Finally, a fourth cluster considered socio-political implications of digitalisation, exploring challenges like Social Media's Role in International Relations, Intellectual Property Rights in the Digital Context, and The EU Digital Single Market. These discussions raised questions about platform governance, IP enforcement in the context of AI-generated content, and the impact of the Digital Services Act on harmonisation across the EU. Teams analyzed strategies for combating disinformation campaigns, digital copyright enforcement, and the implications of geoblocking and platform interoperability within the European context.

By tackling these grouped challenges, participants developed interdisciplinary solutions while engaging with diverse legal, economic, and technological dimensions of digital transformation, demonstrating the programme's commitment to addressing complex global issues through cross-disciplinary collaboration.

5. Outcomes and Reflections

Students reported gaining valuable digital and intercultural skills, and many expressed interest in future collaborations. The staff praised the engagement and creativity of the students, as well as the smooth coordination and cooperation between institutions.

The BIP achieved significant outcomes that underscore its success as an educational initiative.

The programme successfully met its goals, fostering teamwork, innovation, and intercultural exchange. The programme also strengthened ties between partner universities, paving the way for future projects and collaborations.

Students gained new perspectives on sustainability, digital education, and global collaboration. The BIP left a positive impact on all participants, highlighting the power of combining virtual and physical learning experiences.

Academically, it enhanced participants' understanding of critical global trends, equipping them with tools to navigate the legal and economic dimensions of digital transformation. The collaborative nature of the programme encouraged the exchange of ideas, leading to innovative solutions to complex problems.

Culturally, the programme promoted intercultural understanding. Students from diverse backgrounds learned to appreciate different perspectives, an essential skill in today's interconnected world. The onsite phase further enriched this experience by exposing participants to Portuguese culture and its integration into global markets.

However, the programme also highlighted areas for improvement. Time zone differences during the virtual phase occasionally hampered interaction, and some technical issues disrupted digital sessions. Additionally, the intensive onsite schedule left limited time for deeper exploration of certain challenges.

6. Discussion and Implications for Higher Education

The BIP demonstrates the potential of blended programmes to address complex global challenges while fostering academic and cultural growth. By integrating virtual and onsite components, the programme maximised accessibility and inclusivity, allowing participants from diverse locations to engage meaningfully.

This model has broader implications for higher education. First, it highlights the importance of interdisciplinarity in tackling global issues. Legal frameworks, technological advances, and market dynamics are increasingly interconnected, requiring students to adopt holistic approaches. Second, it underscores the value of international collaboration in fostering innovation and mutual understanding.

7. Conclusion and Recommendations

The BIP represents a paradigm shift in higher education, combining academic rigour with real-world relevance. Its success lies in its ability to integrate diverse disciplines, cultures, and pedagogical methods into a cohesive learning experience.

To build on this success, future iterations of the programme should consider expanding its thematic scope to include emerging areas such as environmental law and digital ethics. Enhanced IT infrastructure and extended timelines for onsite activities would also address some of the challenges identified. Furthermore, longitudinal assessments of participants' career trajectories could provide valuable insights into the programme's long-term impact.

By promoting innovation, collaboration, and cultural exchange, the BIP offers a model for preparing students to thrive in an increasingly complex and digitalised world.

We can sumarize with an overarching statement about the importance of programs like BIP: *"Blended learning programs under initiatives like Erasmus+ play a crucial role in fostering international collaboration, developing key skills, and addressing sustainability goals."*[8]

References

Deardorff, D. K. (2006). Identification and Assessment of Intercultural Competence as a Student Outcome of Internationalization. Journal of Studies in International Education, 10(3), 241-266. DOI: 10.1177/1028315306287002. Retrieved from: https://www.mccc.edu/~lyncha/documents/Deardorff-identificationandassessmentofinterculturalcompetenceasanoutcomeofInternationalizat.pdf

European Commission. (2021). Erasmus+ Programme Guide 2021–2027. Retrieved from: https://erasmus-plus.ec.europa.eu

European Commission (2021). Retrieved from: https://wikis.ec.europa.eu/display/NAITDOC/Blended+Intensive+Programmes+in+KA131+Higher+Education+projects

Garrison, D. R., & Vaughan, N. D. (2008). Blended Learning in Higher Education: Framework, Principles, and Guidelines. San Francisco: Jossey-Bass. DOI:10.1002/9781118269558. Publisher: John Wiley & Sons. ISBN: 9780787987701

Johnson, D. W., Johnson, R. T., & Smith, K. A. (2014). Cooperative Learning: Improving University Instruction by Basing Practice on Validated Theory. Journal on Excellence in College Teaching, 25(4), 85-118. Retrieved from: http://static.pseupdate.mior.ca.s3.amazonaws.com/media/links/Cooperative_learn_validated_theory.pdf

Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2010). Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies. U.S. Department of Education. Retrieved from: https://www2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf

[8] European Commission (2021). Retrieved from: https://wikis.ec.europa.eu/display/NAITDOC/Blended+Intensive+Programmes+in+KA131+Higher+Education+projects .

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Personalized learning and how higher education can be unbundled for better instead of worse

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Abstract

Higher education continues to be highlighted for the stresses it is exhibiting under increasing pressures such as globalization, student diversity, information technology, and reduced public funding. Under these stresses, some have identified personalization and the unbundling of the university as either the saviors or the doom of higher education. This paper posits that a middle ground that establishes personalized learning and the unbundling of curriculum for increased transparency, relevance, and effective learning and builds off established learning and instructional theory and stated values is possible. It further discusses the role of such technologies as digital badges and artificial intelligence in supporting the adoption of such principles in higher education.

Keywords: *Personalized learning; digital badges; artificial intelligence; educational change.*

1. Introduction

Higher Education and its limited responsiveness to significant pressures to change has gained increasing attention, including predictions of its inevitable and fast approaching demise (citations). While public funding has shrunk (Bruininks, Keeney, & Thorp, 2010), enrollment has grown as institutions originally tasked with educating the elite 4% of society have been transformed as their models have called for mass education, and now the education of nearly all (Trow, 2007). With societal expectations shifting to the need for educating all citizens, globalization has placed additional pressure as the number of international students has also grown (Altbach, Reisberg, & Rumbley, 2009). Arvanitakis and Hornsy (2016) argue that the mission of higher education should be to develop individuals to be independent and critical thinkers capable of understanding and navigating the complexities and volatility of modern society as problem solvers. Together, these changes have created a significantly more diverse student bodies with different needs and goals and consequently requirements for different

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outcomes, processes and functions at universities. These pressures and needs also have resulted in the increasing complexity of higher education as a system.

This paper argues that while concerns regarding the potential negative impacts of personalization and the unbundling of education are legitimate, so are the visions for the potential benefits of personalization, including the use of disruptive technologies such as artificial intelligence (AI) and digital badges. A middle ground is needed that embraces the needed changes that personalization can bring about, reaping the benefits for learners while at the same time keeping a clear vision of a path forward for higher education that retains its contract for social justice and service and operationalizes steps to prevent the dissolution of classic normative structures and expectations for the system of higher education.

2. Criticisms of Unbundling and Personalization

A significant and valid concern regarding the unbundling of learning processes and roles in higher education is the connection some make with an entrepreneurial approach to education. The rise of neoliberalism and its impact on higher education has led to institutes of higher education (IHE's) adopting practices that assume students attend for reasons of economic self-interest and that the primacy of market-driven economies mean a focus on consumer sovereignty, competitiveness and evaluation based on easily measured performance outcomes and alignment with business practices and entrepreneurial strategies (Olssen & Peters, 2005). In response to the pressures, financial and otherwise described above, one call for reform that has grown out of this movement is the call for unbundling the university.

McCowan (2017) describes four levels of unbundling in higher education: systems, institutions, courses, and academic staff. He specifically points to badges as external assessments of competencies, while arguing that unbundling "signals the end of the programme of study, in which academics curate learning through a process of selection and sequencing of knowledge (p. 738)." Furthermore, he notes the link between personalization for pedagogical purposes but dismisses the theoretical connections to democratizing higher education by allowing students more choice in their goals and means while also conflating personalized learning as solitary learning, resulting in isolation and the demise of the university's role of bringing together diverse individuals and experiences, ultimately concluding: "student learning can be seen to be significantly impacted by the process of unbundling, with the potential gains from personalisation offset by the loss in the relational aspects of learning and opportunities for dialogue and broader experiential learning (p. 744)."

While these concerns are valid, this paper presents principles for personalization while discussing the likewise valid potential benefits of unbundling and personalization through the leveraging of technology, specifically digital badges and AI.

3. Unbundling and Personalizing Learning

A core aspect of the concept of establishing systems of learning that support personalization is the increasing flexibility these systems would provide for what are increasingly complex requirements for learning. \ However, in today's complex world with its diverse problems, the goal of learning necessarily should shift from the ability to reproduce knowledge to instead applying knowledge and skills to different problems in different contexts (Shin, 2014).

A learning system therefore has the need to shift the focus from the teacher to the learning (Kosslyn, Nelson, & Kerry, 2017), supporting more critical and complex thinking in its learners. It therefore follows that if a system is to produce more critical, flexible, and adaptable learners capable of acquiring and applying skills and knowledge to diverse and complex contexts and circumstance, a more personalized and therefore flexible system is needed that can more effectively facilitate this more complex approach to learning (Reigeluth, 1994).

Higher education is facing unprecedented pressures and fundamentally different requirements than in the past, requiring change efforts that address a paradigmatic shift in how IHEs function – systemic change (Watson, et al., 2013). Rather than small adjustments to a system that was never designed to promote the learning of all, among other requirements, systemic change calls for the design of a new system to meet current and future needs through the application of systems thinking and design theory (Watson, et al., 2008). Unbundling can refer to restructuring instructional activities to focus on personalized learning and learning goals rather than time-based structures such as the semester calendar and units based on seat time. Related terms include micro-credentials or micro-courses, but the ultimate goal is creating more flexibility, accessibility, and personalization for learners (Olcott, 2022).

4. Principles of Personalized Learning

As previously discussed, personalization and unbundling in and of themselves need not be seen as embracive of neoliberalist policies but can instead be leveraged to facilitate a transformation of the instructional function of the university to a more learner and learning centered system. The concept of personalized learning is not new, with Keefe (2007) describing a 40 to 50 year history. The United States Department of Education (2010) defined personalization as: instruction that is paced to learning needs, tailored to learning preferences, and adjusted to the specific interests of different learners. In an environment that is fully personalized, the learning objectives and content as well as the method and pace may all vary (so personalization encompasses differentiation and individualization) (p. 12).

The approach to personalized learning we advocate for is based on core learning theories as opposed to being driven by economic factors – in fact, it could be stressed that a truly personalized approach to learning could be less efficient in terms of cost and resources while

being focused instead on increased effectiveness. The learning and motivational theories that underpin personalization of learning include constructivism, self-regulated learning, goal orientation theory, flow theory, and self-determination theory (Watson & Watson, 2016).

Again, while some view personalization as acceding the expertise of instructors to the whims of learners and the personalization instruction as standardized and decontextualized, together these theories establish a set of values that highlight what personalized learning should be for pedagogical reasons, learning that: values developing learners' self-regulation and intrinsic motivation while focus on mastering learning goals rather than comparing learners to each other; prioritizes instruction that is motivating and effective over efficiency; and values instructional methods that are motivating, incorporate social interaction, and support learner choices and goals including in with goal setting, instructional tasks, assessment approaches, and reflection practices (Watson & Watson, 2016).

5. Technology's Role in Personalization

As noted previously, information technology itself has been one of the forces raising pressure on the system of higher education to adjust while also being one significant approach to meeting some of these pressures with online educational offerings growing exponentially and such offerings giving students increased opportunities at education beyond the restrictions of time and place traditionally associated with face-to-face course offerings. Two technologies that have often identified as holding potential for personalization have been AI and digital badges.

AI, while only recently bursting onto the scene for everyday learners and instructors, has a history stretching back decades and implements subcomponents with a record in educational research such as machine learning, learning analytics, and intelligent tutoring (Hardaker & Glenn, 2025). Machine learning allows for the training of a computer on data so that it can such as for large language models (LLMs) which can be used to process natural language for applications such as chat bots (Neumann, et al., 2024). Learning analytics focus on capturing the data produced during educational activities to support analysis and targeted support according to individual student needs; a practice to this point largely applied in online learning environments to limited impact on learning outcomes but retaining great promise with increased understanding (Viberg, et al, 2018).

Beyond more out of reach goals (for the moment) of supporting evaluating and providing feedback to students, AI can significantly support other administrative tasks for instructors, such as personalizing student learning pathways based on interests and background knowledge tracking and reporting student learning, identifying learning or performance gaps and flagging them for instructor follow-up or identifying resources to facilitate addressing the problem. Removing some of the burden of administrative functions in the learning process will free

instructors to spend more time and effort focusing on larger learning outcomes, such as facilitating critical thinking and problem-solving skills rather than merely delivering content.

From a student-centered lens, chatbots can serve as always available intelligent tutors to provide students immediate answers to questions or pose questions or problems to promote further reflection. AI can also support more effective teamwork and communication, helping to select and monitor varied team roles to ensure learners stretch themselves rather than continuing to fill the role they are best at in every project.

With regards to digital badges, the rise of digital badges came from the Mozilla Open Badges platform that was funded by the MacArthur Foundation as an open platform that sought to develop ways for learners to demonstrate their competencies regardless of where they learned them (The Mozilla Foundation, et al., 2012).

Badges function as visual representations of learner competencies and function as a way to demonstration competency outside of typical accreditation of formal learning institutions. Learners demonstrate their competency and earn badges from recognized badge issuers and are then able to show their badges by sharing them on social networking sites and essentially own them. Badges can support learner autonomy and self-regulated learning (Randall, et al., 2013). Badges in education are used to incentivize learning (motivate), identify progress in learning and map out the learning path (signposts), and recognize or credential learning and achievement (Gibson, et al., 2015).

Badges, conversely, support a more personalized, learning-based educational system. Badges can embed instructional resources. They can outline specifically what a learner must do in order to demonstrate competence in a skill or mastery of an area of knowledge. Instructors pre-define what a learner must do to demonstrate competence in order to earn a badge and be credentialed as being able to satisfactorily perform a skill or demonstrate mastery of specific knowledge.

Badges allow a learner the opportunity to earn a badge on day one, if the learner already has the skills the badge is assessing. Badges can support a learner proceeding through a course at their own pace, taking more time if needed or less if they are better prepared. For example, in a course structured with badges, students can see on day one what they must complete to earn their grade in the course. For motivated students, they understand that they can earn the badges as quickly as they are able and free up more time for other coursework later in the semester. For students needing more time, if the course is structured with badges, rather than by week, they can take more time to complete the badges that are particularly challenging to them. This provides the opportunity to have a more personalized, and learner-directed process.

Furthermore, if the instructor sets up the badges with specific assessment guidelines, but broad methods of performance, it allows learners to be creative in how they demonstrate their competence. This allows for learner-ownership of the artifacts they submit to complete the

badge challenges. For example, a communication badge could support challenges associated with persuasive writing, and persuasive speaking. Learners could choose topics they have a personal passion for, and perhaps even expertise in. A letter to the editor arguing for equal protections for LGBT citizens or a video of a speech made on campus arguing for an improved environment for diversity would allow learners to be invested in the products they submit to earn badges.

However, at its most basic level, a course or program broken down into badges forces instructors to break down course learning objectives into detailed performance tasks, defining specifically how they will be assessed, and allows learners to share specific evidence behind why they earned a badge. A grade on a transcript lacks the transparency of associated artifacts. Badges still allow for differentiation between student performance, however. Badges can be granted with distinction, or at an introductory level. By setting up this pathway to different levels or hierarchies of earned badges, students may be motivated to push their learning further.

AI and badges are not the penultimate realization of supporting unbundled and personalized education with technology, however. Previous calls for realizing a system of education that focuses on student learning as opposed to time or sorting of students based on performance emphasized the need for technology to support personalized approaches (Watson, et al., 2008; Watson, et al., 2015). Personalized Integrated Educational Systems would provide the functionality to record student learning, plan for learning, manage instruction for learning, and assess learning in addition to secondary roles such as communication and administration.

6. Conclusion and Implications

The unbundling of the university, at least its curricular functions, through personalization need not sound the death knell of a socially responsible and beneficial system of education that still can fulfill its social contracts and look beyond neo-liberal policies. In fact, when unbundling and personalization are driven by sound pedagogical practices informed by established learning and instructional theories, learning benefits and improved quality can be reasonable outcomes. While the continued growth of technologies such as AI, digital badges, and perhaps one day a fully realized learning management system for personalized learning, such as that envisioned in personalized integrated educational systems (Watson, et al., 2015) will play a significant role in the adoption and effective implementation of such approaches, further cases are needed to support research to examine and refine beneficial implementations of these concepts. What cannot be denied is that the future of higher education will be one of change. It is the contention of the that a vision of progress guided by established theory and values means leveraging technology and reaping the benefits while striving to mitigate potential negatives. The first step in systems design is visioning (Watson, et al., 2008), and we present this paper as one such potential vision of a middle ground to personalization and unbundling.

References

Arvanitakis, J., & Hornsby, D. J. (2016). Are universities redundant? In J. Arvanitakis, & D. J. Hornsby (Eds.). *Universities, the citizen scholar and the future of higher education* (pp. 7–20). London: Palgrave Macmillan.

Gibson, D., Ostashewski, N., Flintoff, K., Grant, S., & Knight, E. (2015). Digital badges in education. *Education and Information Technologies*, *20*(2), 403-410.

Hardaker, G., & Glenn, L. E. (2025). Artificial intelligence for personalized learning: a systematic literature review. *The International Journal of Information and Learning Technology, 42*(1).

Keefe, J. W. (2007). What is Personalization? *Phi Delta Kappan*, (November), 217–224.

Kosslyn, S. M., Nelson, B., & Kerrey, B. (2017). *Building the intentional University: Minerva and the future of higher education*. Cambridge, MA: MIT Press.

McCowan, T. (2017). Higher education, unbundling, and the end of the university as we know it. *Oxford Review of Education*, *43*(6), 733-748.

The Mozilla Foundation, Peer 2 Peer University, & The MacArthur Foundation. (2012). Open Badges for lifelong learning. Retrieved from https://wiki.mozilla.org/images/5/59/OpenBadges-Working-Paper_012312.pdf

Neumann, A. T., Yin, Y., Sowe, S., Decker, S., & Jarke, M. (2024). An LLM-Driven Chatbot in Higher Education for Databases and Information Systems. *IEEE Transactions on Education.*

Olcott Jr, D. (2022). Micro-credentials: A catalyst for strategic reset and change in US higher education. *American Journal of Distance Education*, *36*(1), 19-35.

Olssen, M., & Peters, M. A. (2005). Neoliberalism, higher education and the knowledge economy: From the free market to knowledge capitalism. *Journal of education policy*, *20*(3), 313-345.

Randall, D. L., Harrison, J. B., & West, R. E. (2013). Giving credit where credit is due: Designing open badges for a technology integration course. *TechTrends*, *57*(6), 88-95.

Reigeluth, C. M. (1994). The imperative for systemic change. In C. M. Reigeluth & R. J. Garfinkle (Eds.), *Systemic change in education* (pp. 3-11). Englewood Cliffs, NJ: Educational Technology Publications.

Shin, J. C. (2014). The university as an institution of higher learning: Evolution or devolution? In J. C. Shin, & U. Teichler (Eds.). *The future of the post-massified university at the crossroads* (pp. 13–27). Heidelberg: Springer.

United States Department of Education. (2010). *Transforming American education: Learning powered by technology* [National Educational Technology Plan 2010]. Washington, DC: Office of Educational Technology, U.S. Department of Education.

Viberg, O., Hatakka, M., Bälter, O., & Mavroudi, A. (2018). The current landscape of learning analytics in higher education. *Computers in human behavior*, *89*, 98-110.

Watson, S.L., Watson, W. R., & Reigeluth, C. M. (2008). Systems design for change in education and training. In J.M. Spector, M.D. Merrill, J.J.G. van Merrienboer & M.P. Driscoll (Eds.), *Handbook of research on educational communications and technology* (3rd ed., pp. 692-701). London: Routledge.

Watson, W. R., & Watson, S. L. (2013). Exploding the ivory tower: Systemic change for higher education. *TechTrends*, *57*(5), 42-46.

Watson, W. R., Watson, S. L., & Reigeluth, C. M. (2015). Education 3.0: Breaking the mold with technology. *Interactive Learning Environments, 23*(3), 332-343. DOI: 10.1080/10494820.2013.764322

Watson, W. R., & Watson, S. L. (2016). Personalized instruction. In C.M. Reigeluth & B. Beatty (Eds.), *Instructional-Design Theories and Models* (Vol. 4)(pp. 93-120). New York: Taylor & Francis.

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Integration of Various Active Methodologies in the Training of Industrial Engineers in Master's Degree: Results and Reflections

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Abstract

In the industrial engineering education field, the implementation of active methodologies is a key strategy to improve student learning and participation. This manuscript presents an educational experience developed in a second-year specialisation course in a master's degree in industrial engineering, where different active methodologies have been used to promote deeper and more meaningful learning. During the development of the subject, methods such as the case method, debate, presentations by students, visits to companies, attendance of experts in the classroom and the simulation of participation in a congress have been used. These methodologies have not only allowed students to apply theoretical knowledge in practical contexts, but have also promoted essential skills such as critical thinking, effective communication and teamwork.

Keywords: *Industrial Engineering; Flipped Learning; Case method; Debate; Experts; visits to industries*

1. Introduction

Industrial engineering education has undergone a significant transformation with the incorporation of active learning methodologies. These methodologies seek to involve students more directly and participatively in their learning process. Unlike traditional approaches, where the educator is the main transmitter of knowledge, active methodologies promote student-centred learning, where the student becomes the protagonist of his or her own training.

The use of active methodologies in higher education has been associated with multiple benefits, including the development of critical skills such as analytical thinking, problem solving, effective communication and teamwork (Freeman et al., 2014; Prince, 2004). These methodologies also foster greater knowledge retention and better application of theoretical concepts in practical contexts (Michael, 2006).

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Among the most commonly used active methodologies are the case method, which allows students to analyse and resolve real or simulated situations; debate, which stimulates critical thinking and argumentation; and student presentations, which develop communication skills and information synthesis (Hernández-de-Menéndez et al., 2019). In addition, visits to companies and the attendance of experts in the classroom provide a direct connection with the professional world, enriching the educational experience with up-to-date perspectives and knowledge. The use of active methodologies also allows students to develop and work on transversal competences and on Sustainable Development Goals (SDG).

This manuscript aims to explore the implementation of various active methodologies in a second-year specialisation course in a master's degree in industrial engineering. The aim is for students to apply to real industrial processes what they have learned in previous undergraduate and master's degree subjects, integrating active methodologies, cooperative work, flipped learning, the case method, role-playing, oral presentations and the inclusion of the Sustainable Development Goals in an in-depth manner, encouraging a critical spirit.

2. Methodology

This work was carried out in a subject of the second year of the master's degree in Industrial Engineering, Process Integration and Industrial Chemical Plants, in the speciality of Chemical and Process Engineering. It is a 4.5 ECTS course taught over 15 weeks, in which 10 people were enrolled in the 2024-2025 academic year. Eight of the students were students from the School of Engineering, who had linked the Bachelor's Degree in Industrial Engineering with the Master's Degree. These students had already worked with flipped learning methodology in another subject from the same area (Design of Chemical Processes, (Requies et al., 2024)). The other two people were two Erasmus students from fields other than industrial engineering. The methodologies described in this paper were implemented in the first half of the course, up to week 8. During these 8 weeks we worked with 4 topics: 1-Introduction, 2-Sulphur industries, 3-Sodium and chlorine industries, and 4-Glass industries. The evaluation of this half of the course was divided into two parts: 60 % of the mark was assigned to group or collaborative work and 40 % to an individual minimum test of concepts carried out in class for each topic.

No official course notes were available, in some topics a presentation was used with the minimum knowledge or context of the sector, but most of the content was generated through activities by the students. For each sector studied the students had to produce a summary document of about 8 pages. The class was divided into 3 groups. Each group was in charge of producing one of the topic documents and supervising another one. The deadline for the document was one week after the completion of that unit. One week later, the minimum test of concepts was carried out in class, lasting approximately 30 minutes and consisting of 5 multiple-choice questions and 4 short questions to be developed.

In each subject students worked with basic concepts that they had already acquired in previous subjects of the degree or master's degree and were complemented with information available in official European sectoral documents, BREFs, best available techniques documents, environmental impact assessment, occupational health and safety, etc. In some cases this content was also complemented with a talk in the classroom by an expert, and visits to companies related to the sectors studied in class. Specifically, visits were made to a sulphuric acid production company, a flat glass production company, a steelworks, and a refinery. During the visits to the companies, the students had to ask at least one question to the person in charge who showed us around the facilities. This question was prepared before going on the visit and could be related to the theory seen in class or to doubts that had arisen, and the educator reviewed them before the day of the visit.

Through the different methodologies used, general transversal competences described in the Catalogue of Transversal Competences of the UPV/EHU (UPV/EHU, n.d.) were worked on: Social commitment, critical thinking, and communication and multilingualism. In addition, the Sustainable Development Goals were integrated into the discussions (UPV/EHU, 2019). Discussions were focused on SDG 7 (Affordable and clean energy), SDG 9 (Industry, innovation and infrastructure), SDG 12 (Responsible production and consumption), and SDG 13 (Climate action).

Some of the expected improvements in the teaching-learning process of students in this part of the subject were: I) Improve autonomous development through the use of inverted classroom methodology. II) Develop group work: peer learning, strengthening critical thinking. III) Critical analysis of the integration of the SDGs in processes that may affect the environment in terms of the design and implementation of chemical processes.

3. Results and Discussions

3.1. Opening Session

The course started with an introductory lecture, through an activity focused on the presentation of the subject. The objective was to introduce students to the key issues of the subject and encourage reflection on the importance of various aspects in the chemical industry, such as the environment, safety, economics, occupational hazards and SEVESO accidents. The duration of the activity was approximately 1 hour.

The structure of the activity was as follows:

- Introduction (10 minutes): Introduce yourself and give a brief introduction about the subject. Explain that today's activity will help them to identify the key issues that will be addressed during the course.

- Group formation (5 minutes): Divide students into groups of 2 or 3. Assign each group one topic: environment, safety, economics, occupational hazards, SEVESO accidents.

- Research and Discussion (20 minutes): Each group should discuss and write down the key points related to their assigned topic.

- Group presentation (15 minutes): Each group presents its findings to the rest of the class. Encourage discussion and exchange ideas between the groups.

- Conclusion (10 minutes): Summarise the key points discussed during the activity. Explain how these aspects will be integrated of having a holistic view of the chemical industry.

3.2. Sulphur Industry (flipped learning, expert panel)

This topic was already well known to almost all the students in the class. For 10 minutes the students compile in groups of 2 or 3 what they remembered about this industry. Each group wrote on the blackboard their compilation and then we made a comparison between what was written by each group, correct or clarify what was necessary. The educator checked that all the important content to remember about this industry was there, together with the basic concepts. Then, in the same groups, they had to analyse how the conversion of that process could be improved (15 min), we put it together and ensure minimum concepts (heat exchangers, catalysts, energy production, etc.).

The second session started with a short summary of the sulphuric acid production process, and in groups they had to identify the main environmental problems in this process, where and how to solve them. After 20 minutes of internal discussion, the groups had to share their ideas in about 10 minutes. Then for 20 minutes they had to analyse in groups more general aspects of the process (which Sustainable Development Goals interact, control problems in the process, which points are most critical, handling of substances involved, hazardousness, risk to health and the environment, occupational safety, et.). Concluding this part with another general discussion of about 10 minutes. The session ended with a review by the educator with a closing presentation. This presentation was given to the students as support material.

In the third session, the flipped learning dynamic was used, the students had searched before this session for European BREFFS documents related to sulphur industries, and Environmental Impact Assessments of companies related to the use, extraction or production of sulphur derivatives. The first 10 minutes were used to review what the students had found. Students were assigned what aspect to focus on. They worked individually for this during 15 minutes, and they will present it in the next session for 5 minutes. They had to hand in a 1-sided document on what they are going to present, which the educator reviewed and confirmed that the point of view seemed appropriate. They were told that the presentation will be evaluated on: technical content, synthesis capacity, adjustment to the maximum time limit, visual support of the

presentation, bibliographic sources used and communication skills. In this same session, an Expert Panel session was held, where a person who has been working for 15 years on industrial safety issues and SEVESO legislation on accidents with chemical industries in the Basque Country gave a talk. In this presentation, the expert related the cycle of products generated from raw materials produced in the chemical industry of the Basque Country.

In the fourth session of the Sulphur Industry subject each student made the presentation of the subject that corresponded to him/her. This presentation was assessed and marked. The rest of the students had to take notes on the lectures, correct or add to them as they see fit. Each student must also ask at least one question in one of the presentations. The appropriateness and interest of the question asked was also assessed.

3.3. Sodium and chlorine industries (role playing methodology, puzzle)

This topic was new for all students, the main methodology used was role-playing. In the first session of this topic, it was explained to them how we were going to work on this topic, and the general outline of the sessions and tasks. The educator then gave an introduction to sodium and chlorine industry. In the learning methodology, the students were going to be part of two companies from the sector. In each company there will be different types of engineers. Each student was assigned a company and a role. At the end of this first session, the people from the same company got together and had to construct a basic process diagram in about 30 minutes. Finally, they draw the two flow diagrams on the blackboard and explain them briefly.

In the second session all the roles of the same company met again and had to analyse the types of roles they have. After this analysis they generated a list with the main ideas of their role. Then the people who had the same role got together and reviewed their notes and complemented each other. Each role wrote a list on the board with the main ideas and explained it to the rest of the class. I presented the case they were going to deal with in each company at the congress, where each student will focus on applying their role.

During the third session, the final activity of this topic was explained to the students in detail. Each company was going to attend an industrial congress. In order to attend this congress, they had to hand in an abstract beforehand, as it is done in real congresses. During the third session the students worked on preparing the documentation and the presentation. They could go checking with the educator any doubt they had.

For the fourth session, a poster of the congress was prepared, which was placed at the entrance of the classroom door before the arrival of the students. An identifying sign with their name was prepared for them, just as it is done in real congresses. The students were also integrated into the activity and came dressed for the occasion. Each company had 15 minutes of presentation plus 10 minutes for questions from the audience (the rest of the students). Each student had to

ask a question during the presentation of the other group. The presentation was assessed and marked similarly to the presentation of the previous unit.

3.4. Glass industries (judgement methodology)

In this last topic, the final discussion of what was learnt about glass companies took place through a judgement activity. Each student had to prepare a different topic in the context of the glass industries. During the rest of the first session dedicated to the glass industry, and during the second session, the students were able to work on their specific topic, asking the educator for any doubts about approach or content they might have.

In the third and final session, the judgement activity took place. The students were divided into two groups, being the educator the judge. The trial was set up as a lawsuit between a traditional glass company opposing the construction of a new company that manufactures biodegradable glass, due to economic, labour, safety, environmental and process arguments. One group was the traditional company and the other group represented the biodegradable glass company. The students were told what the timing of the trial would be, so that they could structure their discussion and defence of their arguments. For 15 minutes each group prepared their speech, focusing on the most important points, researching references, and preparing possible witnesses or technical experts (who were represented by students from that group). After this initial preparation time, the tables and chairs were arranged in a trial format, with the educator as the judge. During the first 5 minutes, the defence presented its main arguments, followed by 5 minutes of explanation by the prosecution. They then had 5 minutes to reorganise their arguments, and look for weaknesses on the other side, think about whether they were going to question witnesses or technical experts. The defence then had 5 minutes and the prosecution another 5 minutes. Finally, the educator gave a general verdict of 5 minutes, emphasizing the importance to take into account different aspects before evaluating a new technological approach.

The evaluation of this group activity took into account the following aspects: 1- Presentation of the case. 2- Use of evidence. 3- Interrogations carried out. 4- Role-playing. 5- Final argumentation. The discussions done during the judgment had to be based on technical and scientific evidence, well argued and referenced.

3.5. Discussions

The implementation of all the activities described in the Methodology section required a great deal of effort on the part of the educator, although the final result was very satisfactory. The key to success was that the workload was not excessive for the students, and that this work was rewarded with a high percentage in the assessment. Almost half of the mark was also kept as individual assessment as a way of being able to differentiate what each student had learnt, which

was important to maintain the motivation of all the students to learn and understand, and to avoid students being dragged towards a pass mark because of the work of others.

The size of the group made the work manageable for the educator and the activities very interactive and didactic. This was helped by the fact that the students involved were enthusiastic and participative at all times. Moreover, as this was a second year master's group, the students had a high level of basic knowledge that allowed them to understand and discuss the industrial processes worked on with a certain ease, reaching high levels of understanding and enabling them to reach the process discussion phase, implement innovations, improvements, challenges, interconnect ideas, implement the vision of different roles within the industry, etc.

The visits to the companies were also very motivating for students and educators. The students saw the processes we had been working with in class on a real scale, they were able to talk to the engineers in charge of the processes, ask them questions, operation parameters, curiosities, etc. In addition, it served as a first letter of introduction and behavioural test for a possible interview that they will have to face in the near future, and they could also ask the companies what profiles they need, how to get to work there, what types of work they do, etc. For the educator, these visits were also very interesting from an industrial point of view, but above all it was a very satisfying experience to observe how the students performed in a real environment, how well their questions were received, the good feeling they caused during the visits. All this was a pleasant reward for the great effort made in the preparation of the subject,

The knowledge acquired by the students coming from the industrial engineering degree was high, and this was demonstrated both in the individual tests (with grades of B or A) and in the group or oral tests (with grades of A in most cases). In the case of students from different areas, the two Erasmus students, the level of understanding of the processes achieved was much lower, but sufficient, with a high level of involvement in the subject, in the content and in their classmates, so they also passed the subject.

At the end of the course, students were asked questions to find out their degree of satisfaction with the course and the methodologies used. Several questions were asked regarding the employed methodology. The students indicated that the employed methodology was adequate and helped them understanding the industrial processes, with a negative point of being the time limited. In the questionnaire, 75 % of the students indicate that their ability to interrelate technical concepts with social, environmental and economic aspects after the section of the course tough with active methodologies was high. Those students also think that these methodologies improved their ability to work in a team and collaborate with their colleagues.

4. Conclusions

The educational experience presented in this work was very satisfactory for both the students and the educator involved. As there were only 10 students and it was a specialised subject in the

second year of the Master's degree, it was an ideal context to carry out the subject in a more active way with the students. This helped them to visualise the chemical industry from points of view not previously covered in other undergraduate and Master's degree subjects (safety, job roles, etc.) as well as implementing all the knowledge they had already acquired in the previous 5 years of study.

Using different learning dynamics allowed students to acquire the desired knowledge of the various industries in terms of content. In addition, students achieved a deeper understanding of technical aspects by working on various aspects associated with the process industries, such as the different roles that exist in companies, sustainability through the Sustainable Development Goals, occupational safety, chemical risks, environmental impacts, etc. The involvement achieved by the students also allowed them to work on critical analysis, an in-depth analysis of the material, oral expression and written expression.

This paper has highlighted the benefits and challenges of implementing active methodologies in the training of industrial engineers. Through this application example, it is hoped to contribute to the debate on best practices in engineering education and to offer recommendations for future educational programs.

References

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, *111*(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

Hernández-de-Menéndez, M., Vallejo Guevara, A., Tudón Martínez, J. C., Hernández Alcántara, D., & Morales-Menendez, R. (2019). Active learning in engineering education. A review of fundamentals, best practices and experiences. *International Journal on Interactive Design and Manufacturing*, *13*(3), 909–922. https://doi.org/10.1007/s12008-019-00557-8

Michael, J. (2006). Where's the evidence that active learning works? *American Journal of Physiology - Advances in Physiology Education*, *30*(4), 159–167. https://doi.org/10.1152/advan.00053.2006

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education*, *93*(3), 223–231. https://doi.org/10.1002/j.2168-9830.2004.tb00809.x

Requies, J., Laura Barrio, V., Acha, E., Agirre, I., Viar, N., & Gandarias, I. (2024). Integration of sustainable development goals in the field of process engineering through active learning methodologies. *Education for Chemical Engineers*, *49*, 26–34. https://doi.org/https://doi.org/10.1016/j.ece.2024.08.001

UPV/EHU, U. of the B. C. (n.d.). *Catalogue of Transversal Competences of the UPV/EHU*. http://www.upv.es/visor/media/5db62400-7400-11e8-893e-4310959e86f3/c

UPV/EHU, U. of the B. C. (2019). *EHUagenda 2030 for Sustainable Development*.

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Enhancing Engineering Education through Digital Twins and Interdisciplinary Collaboration

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Abstract

In the current educational environment, the tripartite collaboration between the Department of Industrial Engineering (DIE), the Department of Mechatronics (DIM), and a globally recognized automation company has been fundamental in improving student learning. This project enabled the development of digital twins for the logistics cell, which is currently operated manually. Using the Emulate3D tool, the activities developed in this project aimed to transform this cell into an automated cell with Industry 4.0 elements. The tool facilitated students in creating innovative proposals that enhance their use and improve the teaching methodology. Implemented in the Industrial Automation course, the project not only automated the cell's processes but also enriched the practical and experiential learning of the students, demonstrating the effectiveness of interdisciplinary cooperation in educational settings. Currently, these proposals are being evaluated by DIE professors for future incorporation into courses that use the logistics cell.

Keywords: *Interdisciplinarity, digital twins, collaboration, higher education, educational innovation.*

1. Introduction

In higher education, interdisciplinarity is crucial for preparing students to meet the demands of an increasingly complex and technology-oriented industry (Glänzel & Debackere, 2022; Kolmos et al., 2024). The integration of advanced tools, such as digital twins, exemplifies how interdisciplinary methods can connect theoretical knowledge with practical applications. Digital twins, virtual representations of physical systems, allow students to simulate and analyze real-world scenarios in a safe and controlled environment. Their implementation fosters active

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learning, enhances technical competencies, and promotes collaboration across disciplines, making them an invaluable resource for engineering education (Pathak & Upadhyay, 2024).

However, the adoption of interdisciplinary and technology-oriented approaches faces significant challenges. Educators encounter barriers such as lack of experience with advanced tools, limited resources, and the need for a shared vision among collaborators (Van den Beemt et al., 2020). Addressing these obstacles requires fostering collaboration, continuous professional development, and integrating emerging technologies into the curriculum.

This study addresses two important elements in engineering education reflected in the following research questions: What are the advantages and disadvantages of interdisciplinary collaboration between departments in engineering education? What adjustments are necessary to implement projects using new and unfamiliar technological tools for both teachers and students?

The collaboration took place between the Departments of Industrial Engineering (DIE) and Mechatronics (DIM) and Rockwell Automation, a globally recognized automation company. The tool used was Emulate3D (Emulate 3D, 2024), which allows the creation of digital twins of processes. Mechatronics students developed practical exercise proposals using Emulate3D, which will be applied by industrial engineering students in a logistics cell to enrich their learning activities and advance towards Industry 4.0. These proposals are designed to enhance the academic experience and practical learning of industrial engineering students and are currently being evaluated by the professors of the Department of Industrial Engineering for implementation in courses that use the logistics cell. This collaboration enabled the creation of shared visions and the acquisition of interdisciplinary skills, addressing the research question: How does the use of digital twins' impact practical learning and student motivation in engineering? Digital twins allowed the design of experiences that simulate real situations, thereby improving students' mastery of competencies.

2. Methodology Project Description

The project was conducted in the Industrial Automation course during the sixth semester of the Mechatronics Engineering program. It involved two groups of 16 students each, forming four teams per group. At this stage in their studies, students possess a solid knowledge base in electronics, computing, mechanics, control, and automation. The course spans 120 hours, including 80 hours of core topics and a 40-hour final project based on the challenge-based learning (CBL) technique. In this approach, students propose solutions to real-world problems by researching, analyzing, proposing, and implementing appropriate solutions. This method actively involves students in industrial contexts, with an industry partner collaborating on the challenge, providing valuable experience and preparing them for their professional careers (Leles et al., 2024).

This semester's challenge was the development of digital twins using Emulate 3D software, a platform for modeling and simulating production systems, from assembly lines to logistics networks. Emulate 3D allows users to create a detailed virtual representation of their production environment. The use of this tool was made possible by the support and sponsorship of an automation company that has consistently supported the university. Both students and the course instructor were initially unfamiliar with Emulate 3D, adding an additional layer of learning and adaptation.

At the beginning of 2024, Industrial Engineering professors sought support to automate their logistics cell, which currently operates manually. Their goal was to add technological elements to transform it into a cell with Industry 4.0 features, enhancing its utility and positively impacting student learning.

This problem was presented to Mechatronics Engineering professors, who saw an opportunity to link the course challenge with the logistics cell of Industrial Engineering to create its digital twin. Preliminary meetings were held before the course began, involving engineers from the automation company and professors from DIE and DIM. The objective was to establish a work plan and develop a project proposal achievable within the course's timeframe. The initial scope was limited due to high costs associated with acquiring necessary equipment and materials, as well as the course duration constraints.

The problem defined and presented to the students on the first day of class was: Automate the logistics cell process in the Industrial Engineering laboratory by implementing a digital twin using Emulate 3D® software from Rockwell Automation. The goal was to improve efficiency and present economically viable proposals, including a budget table for the Industrial Engineering department to consider for implementation.

2.1. Course Framework and Initial Challenge Presentation

The challenge was presented on the first day of the course, along with deliverables and evaluation methodology. To maintain a formal atmosphere, the engineer from the automation company and the professor from the Department of Industrial Engineering were invited to the presentation. An overview of the automation company was provided, followed by the students' first contact with the logistics cell through a practical exercise to identify problems and potential solutions. They were given an activity manual to understand how to submit their practice proposals. During the challenge development, the engineer from the automation company provided training sessions on the software. The professor from DIE offered guidance on using the logistics cell, while the professor from DIM coordinated the challenge development and taught the course.

The course strictly follows the curriculum, with the challenge playing a fundamental role. The total evaluation is divided into two sections: the course itself (60% of the final evaluation)

includes exams, practical laboratory exercises, and quizzes; the challenge (40% of the evaluation) has two key evaluation points, at the middle and end of the course.

Due to inexperience with the software, the last laboratory practice was sacrificed to help students complete the challenge. This highlights the main challenge of this technique: accurately measuring the time required for both the course and the challenge. The nature of the challenge and lack of experience with the tool complicated time estimation, necessitating adjustments to meet industry partner requirements.

2.2. Final Project Assessment: Digital Twin Solutions

On the last day of classes, the eight final projects were presented in the presence of the industrial training partner, professors from both departments, and invited professors to evaluate the work. The requirements for the final deliveries were:

1. Problem Identification and Improvement Proposals: Based on knowledge acquired during practical sessions in the logistics cell, students identified a problem and made two improvement proposals:

   Low-Budget Proposal: Solutions that do not involve significant costs, utilizing and reorganizing existing materials within the Industrial Engineering laboratory space.

   New Elements Proposal: Solutions that include acquiring new elements or desirable products for a manufacturing laboratory with Industry 4.0 elements.

2. Integration of Existing Elements: Incorporate resources already available in the logistics cell for the new production and distribution process proposal.
3. Selection of Appropriate Equipment: Choose components that meet the specific requirements of the simulated process.
4. Technologies Used: Employ specialized software (Emulate 3D), communication modes, and technology to simulate, program, and visualize the entire process.

While taking this course, students also take the Flexible Manufacturing course, which is why all proposals in the second category included industrial robots. Additionally, students were required to provide the costs of the equipment used and reference websites where the equipment could be purchased. Another requirement was to develop a practical user guide for Industrial Engineering students to follow their proposed work.

The projects ranged from identifying bottlenecks in a production line, measuring delay times in raw material handling and manufacturing, to automotive transmission assembly projects, seeking to optimize processes and obtain performance metrics for production lines. Students applied knowledge acquired in the logistics cell to identify bottlenecks and optimize production processes, using digital twins to simulate and evaluate their proposals in a safe environment.

3. Project-specific examples

3.1. Automated 3D Printing Farm

The "Automated 3D Printing Farm" project uses 3D printers (3DP) to enhance student interaction with the production process, emphasizing data collection and generation in Industry 4.0. 3DP technology, increasingly adopted in educational institutions, enhances teaching and learning across disciplines by allowing students to design and create solutions for real-world problems, improving their visual and technological literacy (To, Al Mahmud, & Ranscombe, 2024). Integrating additive manufacturing (AM) and 3DP in engineering education fosters essential skills such as CAD modeling, problem-solving, critical thinking, and teamwork, promoting creativity, innovation, and multidisciplinary collaboration (Tripathi et al., 2024).

In the project, 3D printers serve as adaptable production machines in the logistics cell, enabling students to create and customize designs, thus combining manual work with automated activities. For example, students can compare creating paper shirts in origami with 3D printing to evaluate the impact on their learning.

A new laboratory practice involves using 3D printers to produce T-shirts of different sizes and storage boxes, aiming to maximize production speed and quality. Students collect data to predict the time required to produce 1000 T-shirts for a client. The price of a 3D printer is approximately 215 US dollars, and the filament package costs 25 dollars, making this an attractive investment for the laboratory.

3.2. Use of Virtual Reality in PCB Assembly Training

According to Scorgie et al. (2024), one of the significant advantages of the digital twin is that, supported by Virtual Reality (VR) tools, it allows for direct operator training without the need to read a manual or halt production. This proposal is based on VR, which has revolutionized various industries by offering immersive and realistic experiences that surpass traditional methods. Safety training, crucial for preventing workplace accidents, has traditionally relied on passive methods such as videos and manuals, which can be less effective. With the transition to Industry 4.0, digital technology, including VR, is increasingly used to enhance safety training, providing a more interactive and engaging learning experience.

This project focuses on the production subprocess of printed circuit boards (PCB) assembly and soldering. The objectives are to test the immersive experience of VR in recreating a PCB assembly process and facilitate learning with VR tools. For the proposed practice in the Logistics Laboratory, the digital twin of the logistics cell created in Emulate3D software is provided. This model illustrates how an operator, using VR, assembles PCBs with soldering technology. The exercise, tested and handled by a professor during the final course evaluation, involves the user taking PCBs from the storage system and placing them in the through-hole

component assembler, following instructions in the immersive VR environment. This activity requires augmented reality glasses; the Oculus Quest 2 was used, costing $485. Additionally, Emulate3D software is necessary for developing virtual environments, raising the initial investment cost.

3.3. General Comments

The skills developed through these projects, including CAD modeling, problem-solving, critical thinking, and teamwork, are highly applicable to future learning and industry. Students gained hands-on experience with advanced manufacturing and digital technologies, preparing them for careers in fields that require technical proficiency and innovative thinking. The projects demonstrated significant improvements in student motivation and understanding complex industrial concepts. The use of digital twins and virtual reality created engaging and immersive learning environments, which enhanced students' practical and technical skills. These findings highlight the effectiveness of integrating advanced technologies in engineering education and their potential to improve learning outcomes.



Figure 1. Professor using Virtual Reality tool for PCB assembly training exercise

4. Current challenges and plans

Lack of Experience with Software: The inexperience of both students and the professor with Emulate 3D software led to adjustments in planning, including the elimination of a laboratory practice focused on advanced simulation techniques. This can negatively impact the learning of other course content and hinder the project's completion. To address this, additional training sessions and workshops on Emulate 3D are recommended to build proficiency and confidence in using the software. Providing access to online tutorials and resources can also help bridge the knowledge gap.

Challenges in Time Management: The methodology highlights the difficulty in accurately measuring the time required to complete both the course and the challenge. This can result in

excessive workloads for students and limit the time available for other important course activities. To avoid sacrificing content, it is proposed to add greater flexibility to the schedule, with contingency times or additional sessions if students require more support to solve their challenge. Implementing a more detailed project timeline and regular progress check-ins can help manage time more effectively.

Dependence on External Resources and Budget Constraints**:** Implementing the digital twin and automating the logistics cell requires financial and material resources, such as specialized software, hardware, and training materials, which can be challenging to secure. This limitation restricts the project's scope and may result in some elements remaining theoretical without practical implementation. Nevertheless, the Department of Industrial Engineering has shown interest in the 3D Printing project and has recently acquired 3D printers to support this initiative. To mitigate this limitation, seeking additional funding sources and partnerships with industry could be beneficial.

Key Findings: The project demonstrated significant improvements in student motivation and understanding of complex industrial concepts. The use of digital twins and virtual reality created engaging and immersive learning environments, which enhanced students' practical and technical skills. These findings highlight the effectiveness of interdisciplinary collaboration and the integration of advanced technologies in engineering education.

5. Conclusions

This work has addressed the importance of interdisciplinarity and industry collaboration to enhance teaching in the field of Engineering. By utilizing digital twins and virtual reality, the project created active and safe learning environments that allowed students to develop practical and technical skills while facing real-world challenges. Projects such as the automated 3D printing farm and the modeling of processes in virtual reality proved effective in enhancing student motivation and their understanding of complex industrial concepts.

Additionally, the work highlights the need to address limitations related to software inexperience and time management. Future projects should incorporate additional training sessions and detailed planning to optimize outcomes. The collaboration between the Departments of Industrial Engineering and Mechatronics, supported by Rockwell Automation, has been fundamental to the success of these initiatives.

In future work, it is anticipated that the Department of Industrial Engineering (DIE) will acquire the necessary devices to implement the 3D printing farm proposal and other advanced project ideas. This will allow for a more comprehensive evaluation of the project's impact and strengthen the alliance between academia and industry to design authentic and relevant learning experiences. The integration of advanced technologies such as digital twins and virtual reality

not only elevates student training but also prepares future engineers to address the multifaceted challenges of modern industry.

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References

Emulate 3D. (2024). Emulate 3D - Digital twin software for industrial automation. Retrieved November 11, 2024, from https://www.emulate3d.com/

Glänzel, W., & Debackere, K. (2022). Various aspects of interdisciplinarity in research and how to quantify and measure those. Scientometrics, 127, 5551-5569. https://doi.org/10.1007/s11192-021-04133-4

Kolmos, A., Holgaard, J. E., Routhe, H. W., Winther, M., & Bertel, L. (2024). Interdisciplinary project types in engineering education. European Journal of Engineering Education, 49(2), 257-282. https://doi.org/10.1080/03043797.2023.2267476

Leles, A., Zaina, L., & Cardoso, J. R. (2024). Challenge-based learning for competency development in engineering education, a prisma-based systematic literature review. IEEE Transactions on Education, 67(5), 746-757. https://doi.org/10.1109/TE.2024.3417908

Pathak, R. K., & Upadhyay, P. (2024). Integration of digital twins technologies in education for experiential learning: Benefits and challenges. International Research Journal of Advanced Engineering Hub, 2(03), 442-449. https://doi.org/10.47392/IRJAEH.2024.0064

Scorgie, D., Feng, Z., Paes, D., Parisi, F., Yiu, T. W., & Lovreglio, R. (2024). Virtual reality for safety training: A systematic literature review and meta-analysis. Safety Science, 171, 106372. https://doi.org/10.1016/j.ssci.2023.106372

To, T. T., Al Mahmud, A., & Ranscombe, C. (2024). A framework for integrating additive manufacturing into engineering education: Perspectives of students and educators. European Journal of Engineering Education, 1-22. https://doi.org/10.1080/03043797.2024.2358368

Tripathi, N., Hietala, H., Xu, Y., & Liyanage, R. (2024). Stakeholders collaborations, challenges and emerging concepts in digital twin ecosystems. Information and Software Technology, 159, 107424. https://doi.org/10.1016/j.infsof.2024.107424

Van den Beemt, A., MacLeod, M., Van der Veen, J., Van de Ven, A., Van Baalen, S., Klaassen, R., & Boon, M. (2020). Interdisciplinary engineering education: A review of vision, teaching, and support. Journal of Engineering Education, 109(3), 508-555.

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Integrating Sustainability into Data Science Education: A Framework for Fostering Social and Environmental Commitment

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Abstract

This paper explores the integration of sustainability into business education, specifically within the context of the 'Fundamentals of Business Organization' course in the Data Science Degree at UPV. By analyzing the current state of sustainability education and its alignment with the institution's strategic goals, we propose the introduction of a new practical activity designed to foster Social and Environmental Commitment among students. This activity, which integrates the Pattern Categorization Framework, aims to engage students in real-world challenges, focusing on SDG 12: Responsible Production and Consumption. Through this initiative, students will not only deepen their understanding of business strategies and operations but also develop key soft skills related to ethical decision-making, sustainability, and responsibility. The paper highlights the importance of equipping future professionals with the tools and knowledge needed to design and manage business systems that contribute to long-term social, environmental, and economic sustainability.

Keywords: *Data Science; Sustainable Development Goals; Business practices.*

1. Introduction

In the face of pressing global challenges such as climate change and social inequality, universities are increasingly recognized as key agents in shaping professionals capable of driving sustainable development (Raimo et al., 2024). The Universitat Politècnica de València (UPV, Spain) has responded to this call by embedding the United Nations' Sustainable Development Goals (SDGs) into its strategic framework. This institutional commitment promotes an educational model that extends beyond technical proficiency, fostering social and environmental responsibility among students (Boni et al., 2019).

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Within this context, the course Fundamentals of Business Organization (FOE), part of the Bachelor's Degree in Data Science Engineering, has emerged as a strategic platform for integrating sustainability into engineering education. Introduced in the 2021/2022 academic year, the degree program equips graduates to lead data analysis projects across diverse fields, including industry, by training them to design, manage, and communicate data-driven solutions for process optimization and decision-making.

FOE is taught in the first semester of the first year and is coordinated by the Business Management Department (DOE) at UPV. Positioned early in the curriculum, the course provides students with foundational knowledge of business management to guide their professional development. It introduces key concepts in organizational theory, strategic management, human capital, market dynamics, and core functional areas such as finance, operations, and marketing.

Beyond technical and managerial knowledge, FOE aims to develop critical soft skills, as outlined in the current Teaching Guide (Diego et al., 2025). These include innovation and creativity, teamwork and leadership, and effective communication, which are essential competencies for addressing complex societal and professional challenges.

Given the pivotal role of data infrastructures in enabling knowledge sharing, innovation, and informed decision-making, there is an urgent need to embed sustainability principles into data-related education. A well-designed, equitable data system can create long-term value aligned with environmental, social, and economic goals. Integrating sustainability alongside current soft skills and technical education ensures that future data scientists are equipped not only to manage information, but to do so ethically and responsibly.

The FOE course, situated at the intersection of education and industry, offers an ideal context for developing sustainability capabilities. In this paper, we propose integrating the recently developed Pattern Categorization Framework (Rosa et al., 2024) into FOE's practical sessions to engage students in real-world, problem-based learning focused on Sustainable Development Goal (SDG) 12: Responsible Production and Consumption (Johnston, 2016).

This study aims to explore how the integration of this sustainability-oriented framework impacts students' learning experiences and contributes to the development of social and environmental commitment as a core soft skill. Specifically, it addresses the following research question: How do students perceive and engage with sustainability-focused, problem-based activities within the FOE course?

2. A broader perspective

While engineers can act sustainably on an individual level by reducing personal consumption, recycling, choosing less polluting transportation options, or collaborating with NGOs; the

greatest impact engineers have on society and the environment stems from their professional work (Sánchez-Carracedo et al., 2020). Given the rapid pace of technological change, Data Science engineers play a crucial role in driving sustainable innovation. By leveraging data analytics, machine learning, and artificial intelligence, they can optimize resource use, enhance energy efficiency, and develop predictive models to mitigate environmental and societal risks. Their expertise enables informed decision-making, fostering sustainable practices across industries and contributing to the broader transition toward a circular and responsible economy.

Incorporating the Social and Environmental Commitment soft skill means acting with ethics and professional responsibility when facing social, environmental, and economic challenges, all while being guided by democratic principles, values, and the Sustainable Development Goals (SDGs). To foster this, we propose a learning process centered around student involvement, in collaboration with their professors and peers, where they are encouraged to act as societal game-changers.

To integrate the concept of sustainability into students' work, a new classroom activity is introduced. The primary objective is to raise awareness of key sustainability competencies: systems thinking, futures thinking, values thinking, strategic thinking, and interpersonal competencies (Redman et al., 2021). In particular, this new activity will focus on Sustainable Development Goal (SDG) 12: Responsible Production and Consumption, highlighting the role of companies in promoting sustainable practices. Additionally, young people represent a significant consumer group, and the evolution of their consumption patterns will greatly influence the sustainability trajectory of the companies they will lead in the future. This activity aims to empower students to become change agents equipped with the knowledge, resources, motivation, and courage to take transformative action for sustainable development.

2.1. The pattern categorization framework

To support students in understanding the complex decisions required for sustainable development and to inspire them to drive transformative changes in both them and society, it is essential to first clarify key concepts.

At the forefront, sustainability competency is closely linked to the broader concept of sustainable development (Sánchez-Carracedo et al., 2020). Sustainable development is fundamentally rooted in the definition proposed by the Brundtland Commission (Brundtland, 1987): “the ability to meet present needs without compromising the ability of future generations to meet their own needs,” emphasizing intergenerational justice.

Both the Brundtland Commission and the United Nations Sustainable Development Goals (SDGs) (Johnston, 2016) identify three foundational pillars of sustainable development: social equity, environmental protection, and economic growth. To uphold the principle of

intergenerational sustainability justice outlined by the Brundtland Commission, these pillars must be systematically integrated into higher education curricula.

On the other hand, the value chain studied in this course as a sequence of activities that facilitate the movement of a product or service from production to consumption (Porter, M., 1985), traditionally operates within a linear economic model characterized by the take, make, dispose paradigm. In contrast, the circular economy model promotes a continuous cycle of resource preservation and regeneration, aiming to optimize resource utilization and minimize waste (Ellen MacArthur Foundation, 2015).

While the circular economy is often illustrated through visual representations such as the Ellen MacArthur Foundation's butterfly diagram (Ellen MacArthur Foundation, 2015), we propose an alternative conceptual framework, the funnel metaphor, to address certain limitations (see Fig. 1). This metaphor acknowledges two key aspects: first, that not all waste generated along a value chain can be indefinitely reintroduced; and second, that resource flows can be exchanged between different value chains, a process that can be just as valuable for circular economy objectives as recirculating resources within a single value chain. Thus, the funnel metaphor offers a more nuanced representation of the current economy (Rosa et al., 2024).

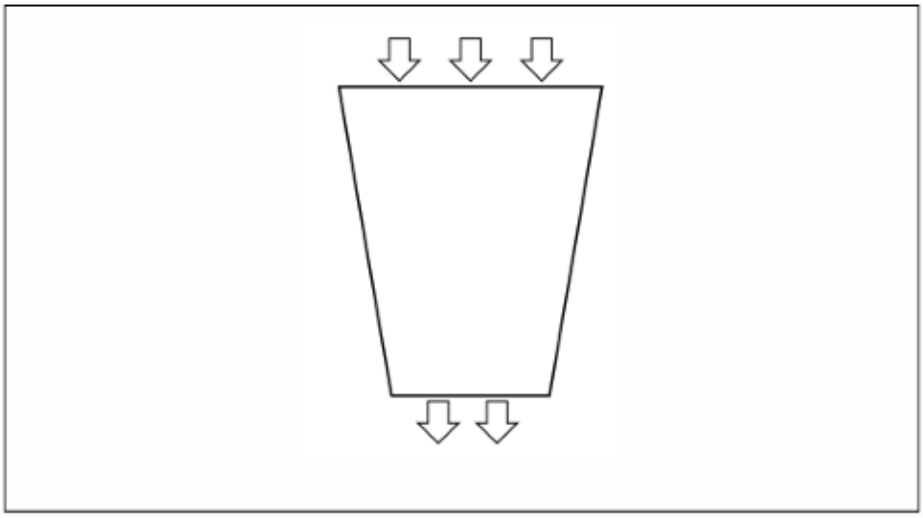


Figure 1. The funnel metaphor. Source: Author's elaboration.

Following this, a pattern categorization is introduced as a continuous journey toward circularity rather than a fixed, attainable state devoid of material and energy. This perspective aligns with a dynamic and evolving approach to sustainability. To illustrate this concept, a three-step configuration of the funnel metaphor is adopted (see Fig. 2), highlighting the progressive nature of circularity and the interconnected strategies required for its implementation. First, the

optimization of resources entails reducing the reliance on raw materials and non-renewable energy, enhancing efficiency, and minimizing waste. Second, the preservation of product value involves slowing the flow of resources by extending product lifespan through strategies such as reuse, repair, remanufacturing, and refurbishment. And finally, the interconnection of multiple funnels which emphasis the importance of collaborative networks where resources are recycled and repurposed across value chains to enhance circularity

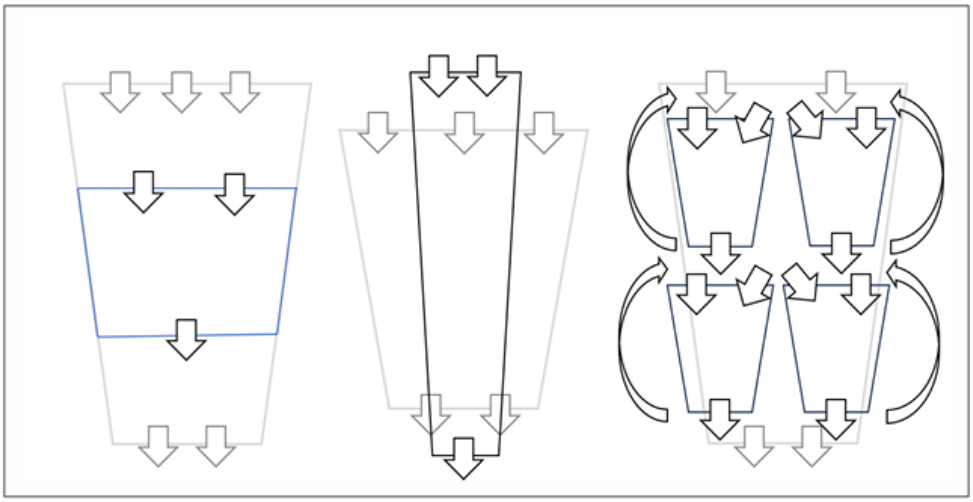


Figure 2. The pattern categorization: (1)optimization, (2) preservation and (3)cycling resources. Source: Author's elaboration.

2.2. Adapting the pattern categorization framework in the classroom

Each academic year, the FOE course is delivered in two main groups: one taught in Spanish with approximately 65 students, and the other in English with around 65 students. The Spanish-based class primarily consists of students who have recently completed secondary education in Spain. In contrast, the English-based group often includes Erasmus students, many of whom are in the final years of their degree programs and choose FOE as one of the English-taught courses available. Given this composition, we believe it is advantageous to initially implement the framework with the English-based group. These students typically bring more academic experience and diverse perspectives from various higher education institutions across Europe, which may enrich classroom discussions and facilitate the adoption of sustainability-focused, problem-based learning approaches.

Before engaging in this new activity, students in the English-based group will have already been organized into small teams of five members during the practical sessions. Each group will have selected a company to analyze and will have completed several assignments to examine the company's mission, vision, and values. Specifically, students will have applied strategic tools

such as PESTEL and Porter's Five Forces to identify key variables affecting the company, as well as the factors influencing industry rivalry and the company's bargaining power over suppliers and customers. Furthermore, they will have conducted an internal analysis using Porter's Value Chain framework to describe the company's value creation process, highlighting its strengths and weaknesses. This analysis will be complemented by a SWOT analysis, which will explore the opportunities and threats posed by the external environment.

These analyses will have equipped students to assess the company's strategy using additional strategic tools, such as the BCG Matrix and Porter's Business Strategies. To conclude this part of the project, students will have also analyzed the company's organizational structure, information systems, and financial situation, alongside its marketing and commercial strategy (Font, L., 2012).

In the new sustainability-focused activity, students will begin by illustrating the funnel metaphor for their selected companies. They will map out the flow of resources; materials, energy, and labor, used throughout the value chain. These diagrams will show how products pass through different stages of the life cycle, from production and distribution to use and disposal.

Next, students will engage with the pattern categorization framework and develop sustainability initiatives based on one or more of the three identified patterns. For each initiative, they will describe its key attributes using the pattern concept card proposed by the authors (Rosa et al., 2024). These attributes such as value creation, target, focus, and technology, represent crucial dimensions that bridge academic research and industrial practice. The pattern card serves as a structured tool for designing and analyzing sustainability and circularity strategies, recognizing the multifaceted nature of business innovation for sustainability.

The FOE course includes ten practical sessions, two of which are currently dedicated to team presentations. We propose a revised allocation: seven sessions for the existing activities (six for teamwork and one for presentations), and three sessions for the new activity. These final three sessions will be structured as follows; (1) first session focused on learning key sustainability concepts, (2) second session for hands-on experimentation using the framework and (3) third and final session for students to present their sustainability initiatives to their peers.

3. Conclusion

Data Science engineers have the potential to drive sustainable innovation by applying data-driven insights to environmental, social, and economic challenges. In alignment with the UPV's strategic focus on sustainability, this paper proposes the integration of a sustainability-focused, problem-based activity into the FOE course, leveraging the Pattern Categorization Framework.

This activity is designed to actively engage students in analyzing real-world business practices through the lens of SDG 12: Responsible Production and Consumption. By incorporating tools

that structure their analysis and stimulate critical thinking, the activity aims to enhance students' understanding of sustainability in a business context and foster their Social and Environmental skills.

The forthcoming implementation of this activity will explore how students perceive and engage with these sustainability-centered challenges. Specifically, it will examine their motivation, participation, and reflections as they navigate ethical, environmental, and strategic dimensions of business decisions. The anticipated outcome is a deeper connection between course content and real-world sustainability issues, equipping students with the skills and mindset needed to become proactive contributors to a more sustainable economy.

References

Boni, A., Belda-Miquel, S., Calabuig-Tormo, C., Millán-Franco, M. A., & Talón-Villacañas, A. (2019). Adaptando los ODS a lo Local mediante la Educación para el Desarrollo. La Experiencia de la Estrategia de la Ciudad de Valencia. Revista Internacional de Educación Para La Justicia Social, 8(1), 117. https://doi.org/10.15366/riejs2019.8.1.007

Brundtland, G. H. (1987). Our common future—Call for action. Environmental conservation, 14(4), 291-294.

Diego, F., Simón, M. G., Pechuán, F. G., Montesa, I., Campos, B., Laudon, K. C., & Price, J. (2025). Teaching Guide. https://www.upv.es/titulaciones/GCD/menu_1023060c.html

Ellen MacArthur Foundation. (2015). Circular Economy Report - Delivering The Circular Economy. March. Delivering the circular economy: a toolkit for policymakers

Font, L. R. (2012).Fundamentos de organización de empresas (FOE). Editorial Universitat Politècnica de València

Johnston, R. B. (2016). The 2030 Agenda for sustainable development. United Nations, 12–14. https://doi.org/10.1201/b20466-7

Porter, M. E., & Millar, V. E. (1985). How information gives you competitive advantage. Development, February, 6033–6044.

Raimo, N., Nicolò, G., L'Abate, V., & Vitolla, F. (2024). Analyzing the factors affecting university contributions to achieving the sustainable development goals in European Union countries. Sustainable Development, February, 6033–6044. https://doi.org/10.1002/sd.3013

Redman, A., Wiek, A., & Barth, M. (2021). Current practice of assessing students' sustainability competencies: a review of tools. Sustainability Science, 16(1), 117–135. https://doi.org/10.1007/s11625-020-00855-1

Rosa, E., Sofia, E., & Ismael, L. (2024). Towards Sustainable Business : Leading Change From The Bottom Up. Working Papers on Operations Management https://doi.org/10.4995/wpom.21587

Sánchez-Carracedo, F., López, D., Martín, C., Vidal, E., Cabré, J., & Climent, J. (2020). The sustainability matrix: A tool for integrating and assessing sustainability in the bachelor and master theses of engineering degrees. Sustainability (Switzerland), 12(14), 1–23. https://doi.org/10.3390/su12145755

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Fostering Democratic Attitude within Engineering Education

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Abstract

According to the education ideal advocated by Wilhelm von Humboldt, education should be a holistic process to develop the whole human being and should not be narrowed toward job training. For example, in democratic societies, education should be directed to fostering a democratic mindset of students to strengthen pluralistic democracy. It is always possible to introduce a general course into a study program that deals with democratic education from a theoretical point of view. But by introducing such a course, the time spent on technical subjects will be reduced. The other major disadvantage of such solutions is that democratic education is seen to be separated from technical education. But in the contrary, democracy should be included in the whole life as a general way of thinking and cooperation between individuals. Therefore, ideas and lecture experiences are presented in this article on how democratic education can be integrated into all engineering subjects as an elementary educational design concept. Students should be led toward a general democratic attitude by practical application. To achieve this, democratic learning environments can be established in all types of courses like lectures, seminars, and labs. This includes, for example, the design of exercises, the presentation of the theoretical content, and the interaction between professors and students as well as the interaction between the students themselves as induced by the teaching activities. Also in exams, elements to promote democratic thinking are possible: Exams should be not directed to learning only content but toward understanding, creativity, and problem-solving competence. They should include, where possible, the fact that correct technical solutions are not unique but that a multiverse of solutions exists, with each solution featuring various strengths and weaknesses. This not only sensitizes the students for the need for (e.g. socially or environmentally) responsible technical design choices but also allows them to find optimized solutions for the engineering challenges at hand. In sum, lecturers should be aware that a democratic learning environment is a demanding process, as students must be taken as serious partners in a joint learning process and surprises are to be expected.

Keywords: *Engineering Education; Democratic Education.*

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1. Introduction, Motivation, and Research Question

According to the education ideal advocated by Wilhelm von Humboldt, education should be a holistic process to develop the whole human being and should not be narrowed toward the job training. Universities should embody this ideal and educate students to become holistically mature personalities.

On the other side, a report from Freedom House (2024) states that global freedom declined for the 18th consecutive year in 2023, and an extensive deterioration of political rights and civil liberties is seen. But there are many people all over the world who work to defend and expand freedom. Not only large initiatives with broad media coverage promote democracy, but also many small measures in everyday life. The logical consequence is that all democratically minded people can promote democracy in their everyday lives through small actions.

Education plays a central role in promoting human rights, democracy, and the rule of law (Council of Europe, 2010). Learners should gain knowledge, skills, and understanding to develop a democratic attitude. They should be empowered to exercise and defend their democratic rights and play an active part in democratic life.

The authors are of the opinion that professors should not only teach the subject content that is documented in the module handbook of the curriculum. Students should also be prepared for life in a democratic society by communicating these values in a democratic atmosphere.

The research question therefore is:

How can students be encouraged toward a democratic attitude
due to didactic settings in engineering lectures and lab courses?

Section II lists exemplary previous research. The authors describe their implementations in lectures and lab courses to foster democracy in engineering education in Section III. Section IV gives a summary and conclusion.

2. Previous Research

There are diverse approaches to include holistic learning approaches in an engineering curriculum.

“Democracy and Education” by John Dewey (1916) is seen as one of the first books that deals systematically with the aspects of a democratic education. He describes the democratic ideal as more than only a form of government but a way of living, and the aims in education how to go toward this ideal.

An early article about the connection between engineering education and democracy is written by Doherty (1937). He advocates a broader focus on engineering education to enable young

people to participate in democratic processes. The suggestion is to change the curriculum to less technical subjects and more general subjects. However, there are no ideas on how to integrate democratic education into existing programs.

A very extensive literature review is given by Sant (2019) that examines democratic education. Eight different academic movements are analyzed, which are pro or against democratic education for different reasons. Extensive analysis and discussions are given for all identified movements. Three different educational policies are summarized: Education for democracy; education within democracy; and education through democracy.

Brown, Flick, and Williamson (2005) suggest developing curricula further to develop the social and human capital of students to increase their performance in their later life and raise productivity. Democratic education in this context is utilized to increase the social and human capital of students but not as an ethical value itself.

An integrated course model is developed by Catalano (2004) to educate about peace, democracy, and sustainable development. In the face of the Iraq war, the author proposes a model that educates toward peace with us, other people, and the planet. These goals are connected to a democratic culture with participation in societal affairs, a sense of responsibility, and solidarity. Many educational goals are listed but no real ideas are given to integrate these goals into the limited time frame of an engineering curriculum without losing other goals.

The literature review from Hamad, Hasanain, Abdulwahed, and Al-Ammari (2013) about ethics in engineering education shows that a democratic form of information exchange is a part of ethical engineering skills.

Helland (2023) describes aspects of democratic education in ten international teachers' curricula. A very thorough analysis is of the democratic aspects of curricula. Two main aspects of democratic education are given: Pupils should be prepared for democratic citizenship. Universities themselves should be democratic spaces.

Generic skills of graduates are described by Kamsah (2004). It is stated that democratic approaches are more effective than indoctrinal approaches in the classroom to teach generic skills. Democratic teaching is here a measure to increase the learning effect, not to foster democratic behavior itself.

A democratic classroom environment was established by Palpanadan and Ahmad (2018) and the improvement of communication skills was tested. The difference in communication between democratic and non-democratic classroom environments is emphasized. Democratic education is not seen as a value in itself but a vehicle to increase the communication skills of students.

Wegerif (2022) emphasizes that dialogue instead of democracy should be promoted when teaching children. The author argues with a narrow concept of democracy and focuses on the

aspect of voting. But it is obvious that a democratic atmosphere is a prerequisite for an open dialogue, which is strongly emphasized by the author as the ideal of education.

Jónsson and Rodriguez (2021) developed seven democratic competencies based on the definitions by the Council of Europe. However, they show no idea how to implement these competencies into practical teaching.

In sum, some research has been done about democratic education, only a few exemplary articles are cited here. It is seen that most research is done on theoretical aspects of democratic education. Not much research can be found about practical implementations, especially in engineering courses. The authors therefore decided to write about their own experiences of promoting a democratic atmosphere in engineering education.

3. Aspects of Democratic Education in Engineering Education

The authors consider it important that democratic ideas are not only taught in specific courses about democracy but that they are an integrated part of every course. Therefore, they have incorporated the ideas presented here into their own engineering courses as good as possible.

3.1. General Ideas

Democratic learning is a lifelong learning process to create a mindset. This can't be done during one specific course and verified by exam questions. Students and professors are partners during this process, and can learn together and from each other. This whole process starts with a democratic mindset of the professor and the wish to pass on this democratic attitude to the students. He or she should be willing to give up some control of the lecture to the students and accept students as equal partners in this learning process. Students can have a say in the content (as long as this does not compromise the overall aim of the course) and how it is taught. This also implies that the professor has to act as transparently and comprehensibly as possible for the students. There are clear rules that apply to everyone, both the students and professor, just like in a constitutional democracy. Justified criticism from students is valuable in two ways. It provides the impetus to learn from it and to develop oneself further. It also shows that students are allowed to criticize, which is only possible in an open and democratic atmosphere.

Open and respectful discussions are one of the basic prerequisites for a democratic atmosphere and can only flourish in an appropriate setting. It is important to create a culture of discussion. Students should be taken seriously with their opinions and problems. They should be encouraged to engage in discussions, and everyone should be invited to do so. This is especially true for shy and reserved students. These discussions are encouraging for students to reflect on their work and behavior. Discussions do not always have to be harmonious; they can also be controversial. However, they should always be respectful toward the other person. This often

makes these discussions particularly valuable, as opposing ideas can be exchanged and new ideas can be generated. When moderating such discussions, it is important to point out this value and encourage the students to communicate with each other. In this way, students learn to engage with other ideas, to think about their ideas more carefully, and to formulate more clearly. They learn to accept other opinions, to value them, and to accept them if they are better than their own ideas. In discussions that are based on facts, students learn how to deal critically with fake news and untrue statements.

It is essential to teach students the importance of individuality and diversity and to encourage them to think about these topics by themselves. To reach this goal, it is helpful if students get intellectual impulses and are encouraged by the professor to look beyond their own horizons.

Students should be responsible for themselves to learn or not to learn. The professor should not force them to learn but should provide support and encouragement. Students should be allowed to make their own decisions and make their own mistakes. This encourages students to take responsibility for their own lives and shows them that they have to make their own decisions and live with them. This is a similar situation in a democracy, where the people make the decisions and then must deal with the consequences.

A democratic society does not function if all members only look selfishly at their interests. It is necessary that people also have the welfare of the community in mind and are committed to it. This attitude can be promoted through group work and projects in teams. Students learn that there is added value for everyone if they work as a team to achieve common goals.

The above ideas are not intended to be implemented in a separate course but can be integrated into all courses of an engineering degree program. Compared to concepts in which democracy education is outsourced to separate courses, the time for teaching technical content is not reduced here. As a result, there is no need to cut back on the amount of technical content on a degree program. The other major disadvantage of separate democratic courses in the curriculum is that democratic education is seen to be separated from technical education. But in the contrary, democracy should be included in the whole life as a general way of thinking and cooperation between individuals.

The authors are of the opinion that it is important to let students experience the freedom of democracy. This freedom is only limited by the freedom of other persons who think differently. Students should not be educated to accept everything that is said by authorities but to think critically and make their own decisions. This is how democratically responsible citizens are educated.

Democratic education should not be political education. It should not deal with political topics, neither from a philosophical point of view nor concerning day-to-day politics. Different political opinions should not play a role during study as long as they are based on democratic values.

Should political discussions arise, they should be ended. These are possible topics for private discussions, but they have no place in the professional setting of an engineering education curriculum.

3.2. Lectures

Lectures lay the theoretical foundations of all subjects and present exemplary applications. These can be designed in different ways. In the lecturer-centered variant, knowledge is told by the professor and students are educated to listen passively to what the professor says. In student-centered lectures, students are educated to be active individuals who question and discuss topics. Active participation of all individuals is an important prerequisite for education toward a democratic attitude.

There are many possibilities to design participative lectures. Voting systems are an interesting option to help implement this goal. One application of these systems is the control of the learned knowledge. However, they can also be used to carry out secret and equal democratic elections, allowing students to express their opinions and even influence the course of the lecture.

Democracy is a constant process of discussion, which can be very exhausting. This also applies to a lecture in a democratic environment. Students discuss and question certain aspects and topics. You may also be questioned in your role as a professor. Lecturers should welcome discussions, criticism and dissenting opinions. This should be promoted by encouraging and thanking students for their participation. Overall, this makes the lecture more educational for everyone involved.

Exams are not only for defining grades, but they influence the whole learning process during the course as students prepare their minds for the exam. Closed questions, the extreme form are multiple choice questions, promote students who are good at memorizing given topics without their own creative thinking. Open questions in a competence-oriented exam promote students' solution competence and critical thinking which are also important for critical citizens in a democratic society. Exams should include, where possible, the fact that correct technical solutions are not unique but that a multiverse of solutions exists, with each solution featuring various strengths and weaknesses. In this way, democratic education can be promoted by giving appropriate exams that encourage critical and open thinking, which is important in a democratic society.

3.3. Practical Courses

Practical courses are used to deepen theoretical knowledge by applying it to practical challenges. In principle, practical courses can be predefined where students carry out given tasks to achieve an already known experimental result. On the other side, practical courses can have open topics where students can find their own creative solutions to solve a given challenge.

Students should work in teams, organize themselves, plan their work, and take responsibility for their success or failure. Professors act as coaches without taking students responsibility for their projects. Democratic decision-making and teamwork should be promoted by professors.

Students should be encouraged to work on topics with practical relevance, if possible for society. Examples are developing aids for handicapped people or ideas on how to help underprivileged persons. This work can strengthen social and therefore also democratic behavior.

The assignment of practical courses could be done in this way that students' efforts to develop the team, foster discussions and democratic team structures give positive grading points additionally to the points that give a working technical solution.

4. Summary and Conclusion

The authors are of the opinion that the type of teaching has an influence on the development of a democratic mindset in students. For this reason, numerous suggestions have been developed in this article to promote democratic thinking through a suitable atmosphere in lectures and practical courses. Over the years, the authors have changed their lectures and lab courses based on their experiences with students to create an atmosphere that encourages reflection and discussion.

It is very difficult to test democratic behavior in tests or evaluations. A democratic mindset evolves over a long time due to many influencing factors. A lecture or lab course has only a small influence on building such a mindset. During the lectures with a democratic setup, the authors see increased openness to ideas, group discussions, and responsibility for their own learning and the group. These are indications that democratic atmospheres in lectures and lab courses have positive impacts on the democratic behavior of students.

This process of creating a democratic atmosphere during teaching is not finished but is a continuous learning process in which professors and students explore new paths together.

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References

Brown, S., Flick, L., & Williamson, K. (2005). Social capital in engineering education. *IEEE Frontiers in Education 35th Annual Conference*.

Catalano, G. (2004). A peace paradigm for engineering education: A dissenter's view. *ASEE Annual Conference*, Salt Lake City, Utah. doi:10.18260/1-2--12873

Council of Europe. (2010). *Council of Europe Charter on Education for Democratic Citizenship and Human Rights Education: Recommendation Cm/Rec (2010)*, 7. Council of Europe.

Dewey, J. (1916). *Democracy and education*. Wikisource.

Doherty, R. E. (1937). Engineering education and democracy. *Electrical Engineering*, 56(9):1073–1076.

Freedom House. (2024). *Freedoms Denied as the World Enters a Consequential Year of Elections*. Retrieved November 21, 2024, from https://freedomhouse.org/article/freedoms-deniedworld-enters-consequential-year-elections.

Hamad, J. A., Hasanain, M., Abdulwahed, M., & Al-Ammari, R. (2013). Ethics in engineering education: A Literature Review. *IEEE Frontiers in Education Conference*, 1554–1560.

Helland, K. (2023). Discourses of democratic education in the preparation of teachers for international contexts: an analysis of curriculum documents. *Nordic Journal of Comparative and International Education (NJCIE)*, 7(1).

Jónsson, Ó. P., & Rodriguez, A. G. (2021). Educating democracy: Competences for a democratic culture. *Education, citizenship and social justice*, 16(1), 62–77.

Kamsah, M. Z. (2004). Developing generic skills in classroom environment: Engineering student's perspective. *Conference On Engineering Education*, 14–15.

Palpanadan, S. T., & Ahmad, I. (2018). Democratic classroom and student communication skills development of mechanical engineering education. *Technology*, 9(12):803–811.

Sant, E. (2019). Democratic education: A theoretical review (2006–2017). *Review of Educational Research*, 89(5):655–696.

Wegerif, R. (2022). Beyond democracy: Education as design for dialogue. In *Liberal Democratic Education: A paradigm in crisis*, 157–179. Brill mentis.

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Integrating personal and professional development in higher education: history, implementation and future directions

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Abstract

This paper explores the integration of personal and professional development within higher education. Using the case of Artevelde University of Applied Sciences, we describe how personal and professional development can be addressed in a dedicated course. The course aims to equip students with essential skills for a rapidly changing world, emphasizing self-awareness, self-management, and adaptability. Initially designed to support first-year students in their transition to higher education, the course has evolved to address the needs of students throughout their academic journey and beyond, including career guidance post-graduation. The paper outlines two main approaches to course implementation: competency development and identity development. By examining these approaches, the paper highlights the importance of a holistic educational framework that prepares students for lifelong learning and professional success. The conclusion reflects on the continued relevance of integrating personal and professional development in higher education curricula and suggests areas for further enhancement.

Keywords: *Professional development; career development; student support.*

1. Introduction

Allocating space for personal and professional development in the curricula is becoming more important in higher education, equipping students with essential skills for a rapidly changing world. Beyond academic knowledge, soft skills such as self-awareness, self-management, and adaptability are critical for navigating complex careers and societal challenges. By focusing on these aspects, institutions not only prepare students for lifelong learning and employability but also foster resilience, ethical thinking, and active citizenship. This holistic approach ensures that students are better prepared to thrive both professionally and personally.

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At Artevelde University of Applied Sciences, guiding students in their personal and professional development is embedded within a dedicated course across all programs. The course serves as a basic form of student support, fully embedded in the curriculum.

The course consists of a series of structured interventions, including individual coaching sessions, group workshops, digital reflection assignments, and portfolio development. Each academic year builds on the previous one, with increasing complexity and autonomy. For instance, in year one, students complete a self-assessment and discuss it with a mentor, while in the final year, they develop a personal development plan aligned with their career goals.

This paper explores how this course has evolved over the years. Additionally, we discuss how individual programs shape the course, as they are granted autonomy to design and implement it in ways that align with their specific contexts. Two main approaches can be observed across our programs. We conclude with some final reflections.

2. History

The scope of the personal and professional development course has evolved significantly over the past decade. The course was first introduced in 2013, primarily targeting first-year students to support their transition into higher education. It was positioned in the first semester or academic year and aimed to help students adjust to academic life by encouraging reflection on their role as learners, increasing motivation, offering remedial support (e.g. for academic language or study skills), and providing tailored academic advice and progress monitoring.

Between 2014 and 2017, several pilot programs explored different formats and intensities. These were monitored through student feedback and performance indicators such as credit acquisition and dropout rates. Based on positive results, the course was gradually extended to second- and third-year students. This extension acknowledged that personal and professional development does not end after the first year but continues throughout the academic journey. In this phase, students are encouraged to reflect on their progress in acquiring discipline-specific competencies and learning outcomes, fostering a deeper understanding of their development within their chosen professional field.

From 2018 onwards, the further development of the course was explicitly guided by the framework of Kariene Mittendorff (2014), which distinguishes three overlapping domains of student development: academic progress, professional development, and career identity. This model offered a conceptual foundation and a shared language for programme teams across disciplines. It helped move the course beyond fragmented interventions towards a coherent, longitudinal learning line in which identity formation and skill development are intertwined.

In 2021, the course was enriched with explicit components related to career guidance and lifelong learning, reflecting broader institutional ambitions to prepare students for sustainable

careers in a rapidly changing labour market. These additions were informed by input from alumni, work-field partners, and educational research. The resulting course structure addresses the evolving needs of students throughout their studies and supports them in developing a sense of ownership over their personal and professional trajectories.

3. Implementation

The three scopes of the personal and professional development course are present in all associate degree and bachelor degree programs. However, the way in which programs shape the course varies significantly. While all programs operate within a shared institutional framework, they were also granted autonomy to translate the course into their own educational context, aligned with their disciplinary focus, pedagogical vision, and student needs.

As a result, two distinct but complementary approaches emerged over time. Some programs chose to focus primarily on the development of concrete competencies needed for academic success, professional performance, and career readiness — what we refer to as the competency-based approach. Other programs placed stronger emphasis on supporting students in exploring their values, motivations, and professional aspirations — which led to the identity-based approach.

The emergence of these two approaches reflects the diversity in how programs interpret personal and professional development. It also highlights the flexibility of the overarching framework, which allows for contextualised implementation while maintaining shared developmental goals.

Below, we elaborate on these two approaches for each of the three scopes of the course.

3.1. Competency-based approach

3.1.1. What are my skills as a student?

Successful students need strong learning competencies, which encompass organizational skills, listening and note-taking skills, study skills, and exam skills (Dijkstra, 2015). These competencies are particularly crucial in the first year to foster academic and social integration, a strong predictor of study success (Christie, Munro, & Fisher, 2004; Tinto, 1993). However, learning competencies remain important throughout a student’s academic career, including in tasks such as writing a bachelor's thesis and presenting a portfolio.

To develop students' academic learning skills, several activities are implemented in the first year. These include interactive workshops on time management and efficient study strategies, peer-assisted learning groups, and guided note-taking during lectures. Students are also invited to complete a digital self-assessment tool that maps their strengths and weaknesses in academic

integration. Based on the results, students set goals in a learning contract which is monitored by their mentor. In later years, activities evolve toward more autonomous learning tasks such as study planning for bachelor's theses and giving peer feedback on academic writing.

3.1.2. What are my skills as a practitioner in profession X?

Students are regularly encouraged to reflect on their progress in acquiring program-specific competencies and professional skills. These reflections are integrated into the curriculum, linked to specific learning activities such as clinical practice for occupational therapy students, management exercises for office managers, and research projects for social work students. To facilitate this reflection, students use a portfolio tool.

Learning activities are supported by structured reflection prompts that help students link practice to theory. For example, during internships in occupational therapy, students reflect on concrete patient interactions using the online portfolio system Medbook, widely used in Flemish higher education, which supports students in tracking their development and gathering evidence across learning domains. In business programs, students analyse their role within team assignments through guided self-evaluations and peer feedback forms. Reflection is often scaffolded through rubrics and one-on-one coaching conversations that guide students in recognising growth and setting personal goals.

3.1.3. What are my skills as a professional?

As students progress in their studies, they become more engaged in career planning. Developing career competencies is crucial for long-term employability. We focus on five key career competencies (Kuijpers, 2006): reflection on qualities, reflection on motivation, work exploration, career control, and networking.

These competencies are emphasized in the final study phase as an extension of internship experiences, helping students in their transition to the job market. They are addressed through targeted interventions. Students participate in career orientation sessions, mock job interviews, and CV writing workshops. They also engage in labour market research where they explore job vacancies and compare these with their own profile. In some programs, students conduct informational interviews with professionals in their field. Networking skills are developed by inviting alumni or professionals for speed mentoring sessions. These activities are designed to strengthen career control and awareness.

3.2. Identity-based approach

3.2.1. Who am I as a student?

This question revolves around discovering one's student identity. Students explore their learning preferences: how, when, and why they learn. They also compare their learning strategies to those of their peers.

Developing a student identity is essential for sustainable, lifelong learning (Ruijters, 2021). Once students understand their learning identity, they can seek appropriate learning contexts. For instance, those who learn best through discussion might benefit from joining an intervision group, while those who prefer research-based learning might gain from attending academic conferences.

To help students explore their student identity, several reflective and interactive methods are used. Early in the curriculum, students create a "learning biography" in which they reflect on their past learning experiences, learning preferences, and habits. This is followed by small-group dialogues where students share their learning stories and discover the diversity of learning identities among peers. Another recurring activity is the learning journal, where students reflect after exams or group assignments on what worked well and what didn't — not only in terms of outcome but also in terms of personal style and motivation.

3.2.2. Who am I as a practitioner in profession X?

This question focuses on professional identity formation. Students explore their motivations for choosing a profession, engage with the professional community, and identify which aspects of the profession energize them. For example, social work students may discover a preference for policy work over direct client engagement.

Understanding one's professional identity is critical, especially in an era where professions are becoming more fluid due to specialization and interdisciplinary influences (Ruijters, 2021). Our course helps students navigate these shifts by offering structured reflection opportunities.

Professional identity formation is supported through creative and reflective assignments that allow students to explore how they see themselves in their future field. In communication programs, for example, students are invited to develop a personal branding portfolio, where they reflect on their core values, communication style, and how they wish to position themselves within the media or corporate landscape. This includes writing a personal mission statement, designing a visual identity, and analysing role models within the field. In healthcare education, such as nursing, students participate in guided discussions about their vision on care and ethics, often based on real clinical scenarios, which helps them articulate what kind of professional they aspire to be. These activities support a deeper understanding of one's evolving role and encourage students to develop a distinctive and authentic professional presence.

3.2.3. Who am I as a professional?

In a rapidly evolving labour market, students must continuously define their career identity. It is not just about acquiring skills but also about understanding how one's professional self fits within broader industry changes, societal challenges and personal aspirations. Our curriculum fosters this awareness through mentorship, practical experiences, and structured reflection, preparing students for adaptive career growth.

To support this, students are encouraged to engage in activities that connect their current development with future possibilities. For instance, in communication programs, they take part in a "career narrative" workshop where they reflect on key learning moments and translate them into a personal story that guides future choices. In healthcare programs, students formulate a "vision of care" statement, describing their role in the future of the profession and how they intend to continue growing through new challenges and further education.

These reflections are often accompanied by future-oriented exercises such as the "future self letter," in which students imagine themselves five years after graduation, highlighting not only career ambitions but also learning goals and values they wish to preserve. The exercise invites students to see themselves as evolving professionals who take ownership of their learning path beyond graduation. In doing so, students begin to internalise lifelong learning not as a policy ambition, but as a personal commitment to staying relevant, inspired, and resilient in their professional journey.

4. Future developments

In the future, we aim to further strengthen the identity-based approach across all programs. Encouraging students to integrate their academic, professional, and career identities can lead to greater confidence and adaptability. As education continues to evolve, institutions must remain proactive in embedding these developmental aspects into their curricula, ensuring that graduates are not only skilled but also self-aware and prepared for lifelong learning.

Beyond fostering competencies and identity development, we also aim to integrate a focus on mental well-being into our work with students. Supporting mental well-being not only enhances academic success but also contributes to long-term career development. This includes building resilience, managing stress, and developing mental health literacy. We consider this focus valuable for students at all stages of their academic journey, from first-year entrants to final-year students preparing for graduation and beyond.

Future research should explore the long-term impact of personal and professional development courses on graduates' careers. Conducting longitudinal studies can provide valuable insights into how these courses influence employability, job satisfaction, and career progression. By

continuously refining our programs based on empirical evidence, we can ensure their sustained relevance and effectiveness.

5. Final reflections

Our three scopes of personal and professional development — academic progress, professional development, and career guidance — address the evolving needs of students throughout their academic journey.

We encourage other higher education institutions to integrate personal and professional development into their curricula, ideally within a dedicated course. To maximize its impact, we recommend allowing program-specific adjustments so that faculties can tailor the course to their own discipline. These adjustments can pertain to the competency level versus the identity level, but also to the scope of the course in terms of number of credit points, the link with other learning outcomes, or the tools and materials used to support reflection and self-regulation.

Additionally, fostering collaboration between faculty, academic advisors, and external partners can enhance students' preparation for the job market. By promoting both competency and identity development, institutions can equip students more effectively for lifelong learning and career growth.

References

Christie, H., Munro, M., & Fisher, T. (2004). Leaving university early: Exploring the differences between continuing and non-continuing students. *Studies in Higher Education*, 29(5), 617-636. https://doi.org/10.1080/0307507042000261580

Dijkstra, P. (2015). Effectiever leren met leerstrategieën. *Boom test uitgevers*.

Kuijpers, M., Scheerens, J., & Schyns, B. (2006). Career competencies for career success. *Career Development Quarterly*, 55, 168-178. https://doi.org/ 10.1002/j.2161-0045.2006.tb00011.x

Mittendorff, K., & Kienhuis, M. (2014). Bouwstenen voor SLB: Van visie naar praktijk. *OnderwijsInnovatie*.

Ruijters, M. (2021). Manifest voor de beroepsidentiteit. Over de achterkant van gepersonaliseerd leren in professionele bacheloropleidingen en graduaatsopleidingen [Manifest]. *The Good Work Company*.

Tinto, V. (1993). Leaving College: Rethinking the Causes and Cures of Student Attrition (2nd ed.). *University of Chicago Press*.

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The effectiveness of online peer-feedback for group interaction and assessment quality in a high-enrolment and culturally diverse undergraduate topic

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Abstract

In higher education, the cognitive, behavioural and motivational benefits of peer feedback have been realised. Previously, we reported enhanced group interaction and assessment quality following online peer feedback in a small, undergraduate cohort (Emery, 2024). In this study, we applied key components from theoretical feedback models to online (FeedbackFruits) activities to verify peer feedback outcomes in a high-enrolment, culturally diverse, undergraduate topic. Students actively participated (range 88.8-97.4%) in five online peer feedback tasks, with feedback value ranked as 'high' for peer-to-peer (58.7%) and group-to-group (62.0%) processes. Group-to-group feedback significantly ($p<0.01$) improved poster format (3.79 vs 4.61), referencing (3.25 vs 4.40) and topic coverage (3.88 vs 4.70) between draft and final submissions. Similarly, mean peer evaluation scores significantly ($p<0.05$) improved for information sharing (3.86 vs 3.93) and discussion skills (3.86 vs 3.91%) post-feedback. This study highlights the importance of understanding learner characteristics and technologies in optimising feedback practice in real-world settings.

Keywords: *Feedback; peer; assessment; quality; student characteristics.*

1. Introduction

Online peer feedback refers to technology-facilitated interactions enabling students to submit their work and exchange feedback with their peers through online platforms, without restrictions on time or location (Gao *et al*., 2024).

In higher education, the shift to digital learning environments combined with the expansion of available online tools (e.g. FeedbackFruits, Articulate, Expertiza, Peergrade, Blackboard, Google Docs) has led to a substantial evidence-base describing the benefits of online peer

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feedback for students and educators (Kerman *et al*., 2024). For students, online peer feedback guides learner-centered strategies that improve cognitive (e.g. knowledge, analysis, comprehension), behavioural (e.g. communication, engagement, teamwork) and affective (e.g. motivation, self-regulation, confidence) outcomes (Simonsmeier *et al*., 2020). For academics, online learning tools facilitate the implementation of customised feedback processes with comprehensive auditing and evaluation. These tools have become essential for improving feedback quality and efficiency, particularly in larger cohorts (Alshenafi, 2017).

However, the application of online peer feedback is not without challenges. Learner disengagement due to asynchronous communication, misunderstandings of online tone (Noroozi & Mulder, 2017), low quality feedback associated with anonymous, non-specific commentary (Topping, 2017) and task complexity related to student experience in giving feedback (Er *et al*., 2021) have been commonly reported.

Attempts to optimise online peer feedback processes have been partially addressed by the identification of key feedback components (Gao *et al*., 2024; Kerman *et al*., 2024) and theoretical models (Panadero & Lipnevich, 2022; Wu & Schunn, 2023). However, the adoption of optimised peer feedback into educational practice relies on a further understanding of how individual student characteristics and learning environments impact peer feedback engagement and learning outcomes. Previously, we reported enhanced group interaction and assessment quality following online peer feedback in a small, undergraduate cohort (Emery, 2024). The aim of this study was to verify the effectiveness of optimised online peer feedback on assessment quality and peer interaction in a high-enrolment, culturally diverse, undergraduate topic.

2. Methods

2.1. Study cohort and demographics

Undergraduate 3rd year Bachelor of Medical Science and 2nd year Bachelor of Clinical Science students enrolled at Flinders University, Australia in Semester 2 of 2024 were eligible for the study. Student demographic data was accessed using the University's Intelligence Portal.

2.2. Group Assessment

The assessment consisted of a group research project, produced over 8 weeks. Submission comprised a poster and 3-minute video presentation. Randomly allocated groups (30) of 3-4 students, researched an infectious disease point-of-care test/device. The connectivity, analytical performance and equipment specifications were evaluated against 'ideal' benchmarking criteria described by Land *et al*. (2019). The assessment formed 15% of the topic grade; 4% (group),

6% (individual) and 5% feedback. Final grades were moderated in accordance with the University's assessment policy.

2.3. Assessment Feedback

Assessment feedback comprised four activities in FeedbackFruits: 1) peer-to-peer assessment of draft poster (0.5%), 2) peer-to-peer assessment of final poster (0.5%), 3) group-to-group assessment of draft poster (0.5%) and 4) group-to-group assessment of final poster (0.5%). The student evaluation of feedback (3%) was designed as a Canvas quiz.

2.3.1 Feedback Fruits Rubrics

Analytic assessment rubrics for FeedbackFruits designed by topic academics in 2023 were utilised in this study. The focus of the peer-to-peer feedback was group interaction (Table 1).

Table 1. Indicative* Peer-to-Peer Feedback Rubric in FeedbackFruits

Interaction	Beginning (1)	Emerging (2)	Proficient (3)	Experienced (4)
Sharing information	No information shared	Minimal	Moderate	Maximal
Discussion Skills	No participation	Occasionally spoke when encouraged	Contributed most of the time	Consistently contributed
Listening Skills	Did not listen, acted autonomously	Occasionally listened	Listened most of the time	Actively listened to incorporate ideas
Task Completion	No task completion	Completed some assigned tasks	Completed most assigned tasks	Completed all assigned tasks

**Truncated peer responses shown. Numerical evaluation scores (1), (2), (3) or (4) were used for data analysis.*

The focus of the group-to-group feedback was topic coverage and formatting (Table 2).

Table 2. Indicative* Group-to-Group Feedback Rubric in FeedbackFruits

Poster Criteria	Beginning (1)	Emerging (2)	Proficient (3)	Experienced (4)	Highly Experienced (5)
Topic Coverage	Insufficient	Variable	Satisfactory	Complete	Advanced
Collaboration	Limited	Emerging	Satisfactory	Effective	Outstanding
Referencing	Limited	Inconsistent	Satisfactory	Complete	Precise

**Truncated poster criteria shown. Broadly, topic coverage refers to: evidence-based information, evaluation completeness and assessment cohesion. Collaboration refers to: poster unformity and integrated information. Referencing refers to: correct reference format used and list completeness. Numerical evaluation scores (1), (2), (3), (4) or (5) were used for data analysis.*

2.3.2 Student Evaluation of Feedback

Students evaluated feedback received following the final poster submission using an online Canvas quiz (Table 3). Open text commentary was reviewed by academics.

Table 3. Indicative* Evaluation of Feedback Rubric in Canvas quiz

Feedback Evaluation Category	Response Type
Peer-to-peer and group-to-group feedback value	Low/Medium/High
Assessment changes made to own group poster	Open text
Interaction changes made with own group	Open text
Feedback preference	Anonymous/Identified
Changes made to the poster your group reviewed^	Open text

**Truncated feedback evaluation categories shown. ^New question for this study.*

2.4 Student Feedback Process

Students accessed feedback rubrics using an individualised access number and password. Academics educated students in safe learning environments, trusted peer relationships and provided with guidance on the use of FeedbackFruits and Canvas.

2.5 Data Extraction and Analysis

Deidentified data was extracted from Canvas for analysis. Numerical rankings were applied to peer-to-peer (Table 1) and group-to-group (Table 2) feedback responses to generate draft and final poster evaluation scores, which were analysed using two-sided paired t-tests.

2.7 Ethics and Funding

This University's Human Research Ethics Committee approved the study (#HEL-6549-9). Students could 'opt-out' from FeedbackFruits via email and completed online consent for the evaluation quiz. The study received no funding.

3. Results

3.1 Student Demographics and participation

In this study, the number of students (n=116), proportion of international students (32% non-Australian citizens) and proportion of students who spoke non-English languages at home (44%) were high. Most (79%) students were 20-24 years, female (58%) and none identified as Aboriginal or Torres Strait Islander. Student feedback participation rates were high, irrespective of assessment stage or activity type (Table 4).

Table 4. Student Feedback Participation Rate

Poster Stage	Feedback type	Percentage (%) of students (n=116)
Draft	Group-to-group	96.5
Draft	Peer-to-peer	95.7
Final	Group-to-group	97.4
Final	Peer-to-peer	88.8
Post-final	Evaluation Quiz	93.9

3.2 Impact of Peer-to-Peer Feedback

Mean peer evaluation scores significantly ($p<0.05$) improved for information sharing (3.86 vs 3.93) and discussion skills (3.86 vs 3.91) at final assessment (from draft) but were not significantly different for task completion (3.94 vs 3.96; $p=0.21$) or listening skills (3.94 vs. 3.94; $p=0.44$) (Figure 1).

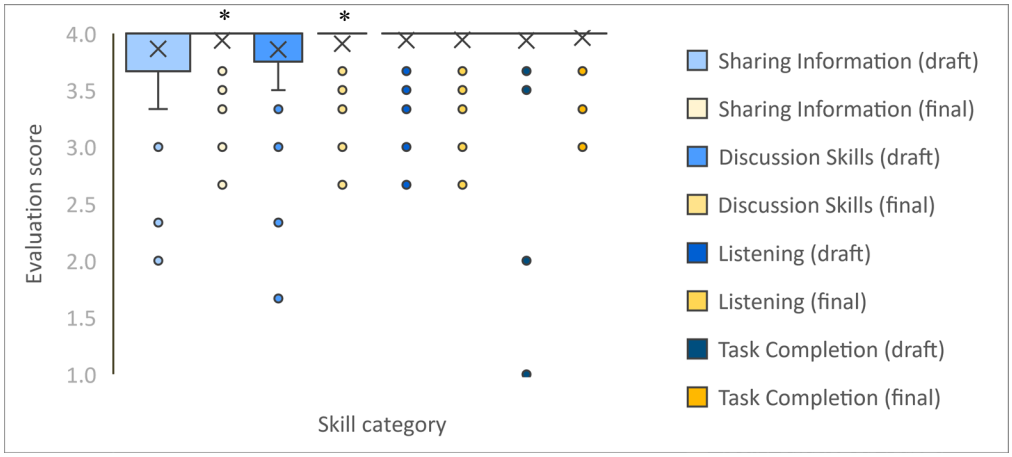


Figure 1: Box plot of evaluation scores by category; sharing information, discussion skills, listening or task completion for draft and final poster submission. Within each box, mean (cross) evaluation scores are shown. Boxes extend from the 25th to the 75th percentile; vertical extending lines denote the minimum values within 1.5 interquartile range of the 25th percentile of each peer group; outliers (dots) represent evaluation scores outside of range of adjacent values. Significant ($p<0.05$) differences between paired (draft and final) mean evaluation scores are denoted by an asterix (*).

3.3 Impact of Group-to-Group Feedback

Mean group evaluation scores significantly ($p<0.01$) improved for topic coverage (3.88 vs. 4.70), formatting (3.79 vs. 4.61) and referencing (3.25 vs. 4.40) at final assessment (from draft) (Figure 2).

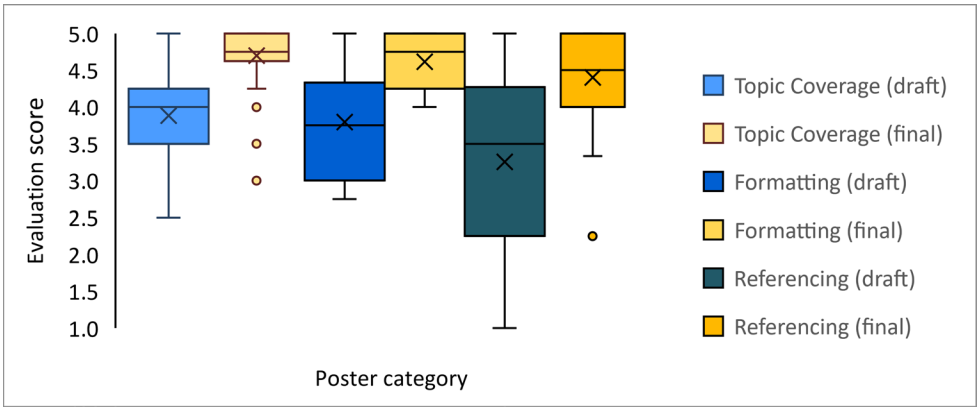


Figure 2: Box plot of evaluation scores by poster category; topic coverage, formatting or referencing for draft and final poster submission. Within each box, mean (cross) and median (horizontal black line) evaluation scores are shown. Boxes extend from the 25th to the 75th percentile; vertical extending lines denote the minimum (lower) or maximum (upper) values within 1.5 interquartile range of the 25th or 75th percentile of each group, respectively; outliers (dots) represent evaluation scores outside of range of adjacent values. Significant ($p<0.05$) differences between paired (draft and final) mean evaluation scores are denoted by an asterix (*).

3.4 Student Evaluation of Feedback

3.4.1 Value of Feedback

Peer-to-peer feedback value was ranked 'high' by 58.7% (n=54), 'medium' by 26.1% (n=24) and 'low' by 15.2% (n=14) of students. The group-to-group feedback value was considered 'high' by 62.0% (n=57) or 'medium' by 33.7% (n=31) of students, with less than 10% (4.4%, n=4) rating the activity value as 'low'.

3.5.2 Assessment Changes Made

Students most frequently reported changing the uniformity of the poster (91.9%, n=79) due to the feedback received. Post-feedback, referencing and topic coverage changes were only reported by 40.7% (n=35) and 37.2% (n=32) students, respectively.

3.5.3 Feedback Preference

Most students (79.3%, n=73) preferred anonymous feedback. Only 19 students requested identified feedback. There were 24 students that either did not respond or did not consent for this question.

3.5.4 Changes made to the poster your group reviewed

Students most frequently reported changes to the uniformity of the poster their group had reviewed (91%, n=67) due to the feedback their group provided. There were 25 students who misinterpreted this question.

4. Discussion

In theory, the effective implementation of online feedback in higher education requires consideration of influential factors categorised in four domains: student characteristics (demographics, academic background, psychological), environment (learning platform, setting), learning processes (content, feedback design) and learning (cognitive, behavioral, affective) outcomes (Kerman *et al*., 2024). Contributing to a gap in real-world educational practice, this study utilised the key steps of evidence-based conceptual frameworks and the authors prior FeedbackFruits expertise (Emery, 2024) to verify the effectiveness of online peer feedback activities in a large and culturally diverse student cohort. This included: a) gaining insight into the student's demographic and academic backgrounds b) talking to the students regarding their pre-existing knowledge, skills and attitudes toward peer feedback during face-to-face workshops before the study commenced, c) offering comprehensive training and education in the delivery and receipt of safe and effective feedback, d) using anonymous feedback (indicated as preferable by students), d) simplifying FeedbackFruits instructional presentations to the class and f) increasing the assessment duration to maximise the time students had to make changes to the assessment based on the feedback they received.

Whilst the student demographic data showed that the cohort of this study comprised of students with individual characteristics that may have influenced feedback literacy and experience (i.e. young, scientific/medical background, international and bi-lingual/multi-lingual), the student participation in all feedback activities was high and approximately 60% of students ranked the value of the peer-to-peer or group-to-group feedback they received as 'high'. Whilst it is acknowledged that some students may have participated in feedback activities only to improve their topic mark, the tasks in this study were designed such that significant time and effort for completion (4.5 hours over 3 sessions) was required and the marks allocated were minimal.

The authors prior experience to the topic learning environment, good understanding of the learning platform and rapid access to technical support assisted the feedback task clarity and workflow for students. This enabled changes within FeedbackFruits associated with software updates to be quickly rectified and highlights the importance of regularly pre-testing assessment rubrics prior to activation in an online environment.

In this study the group-to-group feedback resulted in significant mean evaluation score improvement for topic coverage, formatting and referencing, indicating the feedback received enhanced overall assessment quality. However, when individual student comments were

evaluated by academics, most students reported or observed aesthetic (i.e. poster uniformity) rather than content-related (i.e. topic coverage) changes based on the group-to-group feedback received. This suggests further improvement to the feedback rubric design and content in future studies could be beneficial to guide student responses to the feedback they received.

Peer-to-peer feedback significantly improved discussion skills and sharing information, but high baseline evaluation scores prevented statistically significant differences being observed for listening and task completion. Despite this study limitation, students reported that the positive peer-to-peer feedback they received motivated them to improve or maintain high-level group interactions. One student commented "*I participated more in group discussions as well as listened to other's thoughts and ideas and tried to ensure that I completed my work in a timely manner.*" Another student reflected "*Fortunately, our group worked well and as a result received glowing peer-feedback. Throughout the rest of this task, we strived to maintain these good relationships throughout all group interactions. This included effective communication and respect for all team members.*"

5. Conclusion

Online peer feedback improved assessment quality and group interaction in this study, demonstrating the importance of optimising peer feedback in real-world educational practice through a sound understanding of individual student characteristics and learning environments.

References

Ashenafi, M. M. (2017). Peer-assessment in higher education–twenty-first century practices, challenges and the way forward. *Assessment & Evaluation in Higher Education*, 42(2), 226-251.

Emery, K., Shephard. M., Matthews, S. (2024). Using online peer feedback tools to improve undergraduate group interaction and assessment quality. In: *10th International Conference on Higher Education Advances (HEAd'24).* Valencia, 18-21 June 2024.

Er, E., Dimitriadis, Y., & Gašević, D. (2021). A collaborative learning approach to dialogic peer feedback: a theoretical framework. *Assessment & Evaluation in Higher Education*, 46(4), 586-600.

Gao, X., Noroozi, O., Gulikers, J., Biemans, H. J., & Banihashem, S. K. (2024). A systematic review of the key components of online peer feedback practices in higher education. *Educational Research Review*, 42, 100588.

Kerman, N. T., Banihashem, S. K., Karami, M., Er, E., Van Ginkel, S., & Noroozi, O. (2024). Online peer feedback in higher education: A synthesis of the literature. *Education and Information Technologies*, 29(1), 763-813.

Land, K. J., Boeras, D. I., Chen, X. S., Ramsay, A. R., & Peeling, R. W. (2019). REASSURED diagnostics to inform disease control strategies, strengthen health systems and improve patient outcomes. *Nature microbiology*, 4(1), 46-54.

Noroozi, O., & Mulder, M. (2017). Design and evaluation of a digital module with guided peer feedback for student learning biotechnology and molecular life sciences, attitudinal change, and satisfaction. *Biochemistry and Molecular Biology Education*, 45(1), 31-39.

Panadero, E., & Lipnevich, A. A. (2022). A review of feedback models and typologies: Towards an integrative model of feedback elements. *Educational Research Review*, 35, 100416.

Simonsmeier, B. A., Peiffer, H., Flaig, M., & Schneider, M. (2020). Peer feedback improves students' academic self-concept in higher education. *Research in Higher Education*, 61, 706-724.

Topping, K. (2017). Peer assessment: Learning by judging and discussing the work of other learners. *Interdisciplinary Education and Psychology*, 1(1), 1-17.

Wu, Y., & Schunn, C. D. (2023). Passive, active, and constructive engagement with peer feedback: A revised model of learning from peer feedback. *Contemporary Educational Psychology*, 73, 102160.

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Addressing Burnout Among University Faculty with Mindfulness Practices and Activities: Preliminary Study

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Abstract

Workplace burnout, a growing concern in academic contexts, negatively affects student outcomes, teacher satisfaction, and teaching quality, often leading to disengagement and attrition. Recent research highlights mindfulness practices as an effective tool to mitigate burnout. This preliminary study involved eight full-time university faculty members participating in a one-month mindfulness program addressing burnout-related experiences using library-provided mindfulness activities. Participants completed pre- and post-program surveys assessing six aspects of burnout: exhaustion, cynicism, detachment, ineffectiveness, lack of accomplishment, and stress/anxiety. Data was analyzed using the Wilcoxon sign-rank test, revealing statistically significant differences between pre- and post- program survey scores in feelings of lack of accomplishment. While improvements in post- program survey scores were noted in all burnout aspects, statistical significance could not be determined. The study's findings suggest mindfulness practices can positively impact faculty's experience of aspects of burnout, and support the need for a larger-scale study to further validate them.

Keywords: *Burnout; faculty; higher education; mindfulness; mindfulness practices; university.*

1. Introduction

The need to address burnout has emerged as a persistent topic in the scholarly literature as a response to the many reports of increased burnout among higher educators. Burnout is a serious global problem that affects both the mental and physical health of employees and the effectiveness of organizations (Constantino et al., 2013). Maslach and Leiter (2017, p. 37) define burnout as "an overwhelming exhaustion, feelings of cynicism and detachment from the job, and a sense of ineffectiveness and lack of accomplishment". Although burnout in the workplace

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has received considerable attention over the years (e.g. Waddell et. al., 2023), only recently has burnout research focused on academic burnout (e.g., Becker, et al., 2020; Hagerman et. al, 2023). Educational professions are associated with providing effective academic support to learners, thus becoming emotionally demanding and overwhelming for teachers and lecturers. Studies have shown that academic burnout syndrome negatively impacts student outcomes and teaching quality, and can lead to dissatisfaction, disengagement, and intentional teacher attrition (Huberman and Vandenberghe, 2006). Academic burnout also negatively impacts student-teacher interpersonal relationships (Yoon, 2002) and leads to a decline in academic motivation and self-efficacy. In these cases, burnout is viewed as a consequence of increased demands and stress in an academic environment. It is also regarded as a result of individual personality characteristics and environmental factors (Kourea et al., 2023). Overall, studies have found the leading role of the environment over the individual as a leading factor in the occurrence of this phenomenon.

Mindfulness, viewed as awareness and non-judgmental acceptance of experiences in each moment, is accepted as an effective tool against professional stress and burnout – excessive thinking, anxiety, tension, fear, anger, and the tendency to avoid, suppress, or over-engage with thoughts and feelings that lead to distress (Kabat-Zinn, 1990, 2021; Ergas & Hadar, 2019). A growing body of scholarly literature suggests mindfulness practices and activities as a successful approach in addressing burnout (Luken & Sammons, 2016; Janssen et al., 2018; Marie & Cook-Cottone, 2022; Waddell et al., 2023). Mindfulness practices have been found to be associated with higher levels of life satisfaction and vitality, self-esteem, autonomy, personal competence, and positive affect (Brown & Ryan, 2003), better personality (Giluk, 2009), empathy (Dekeyser et al., 2008), as well as with reducing job stress and burnout (Luken & Sammons, 2016; Goodman et al., 2019). This in turn raises the question of how and to what extent mindfulness practices and techniques, which are proven effective in dealing with life challenges, can be applied in academia with the aim of preventing and reducing the experience of burnout among higher educators. There is no consistency in the implementation of programs related to mindfulness practices across the United States, Canada, or among different countries in Europe. Some programs aimed at increasing mindfulness among teachers and academics have shown promising results. Specifically, Maria Napoli introduced a pilot program for mindfulness training among teachers (Napoli, 2004). She trained them in specific techniques such as: conscious breathing; body scanning; awareness of movements; focus on the senses; feedback. As a result of the program, participants reported significant improvements in their teaching approaches and personal lives. Educators declared that they use the acquired mindfulness techniques to focus students on key ideas; to manage conflicts in the classroom and reduce test anxiety; and apply mindfulness techniques in their personal lives, which helps them maintain balance and reduce stress. In other words, the program can be considered as a prevention of burnout.

A systematic review by Emerson et al. (2017) presented narrative synthesis of 12 quantitative and qualitative studies on the topic of mindfulness among teachers in England, the USA and Canada. Some studies used mindfulness-based interventions to reduce stress or burnout and showed a positive effect on teachers' emotional regulation and their perceived effectiveness, while reducing professional stress. The review discussed possible implications for educational practices and future research, emphasizing the importance of stress reduction approaches and their potential role in improving educators' well-being and the quality of education in general.

A comprehensive in-depth review by Ergas & Hadar (2019) of 447 articles, published 2002 - 2017, on the topic of mindfulness in education outlined that while mindfulness in education was a significant and important topic, it was still in its early stages of development. The review confirmed the importance of mindfulness practices among teachers for enhancing social-emotional competencies, physical and mental well-being, and enhanced cognitive functioning. It also provided new direction on the topic by highlighting the potential of mindfulness as a transformative factor for education.

A systematic review on mindfulness approaches for addressing burnout in higher education settings by Baker and Karadjova-Kozhuharova (2024) was focusing on research articles (2018-2024) in relation to educators. This review confirmed mindfulness practices and activities for addressing burnout as follows: meditation, mindful eating & dieting, breathing techniques, gratitude practices & reflection, and relaxation through mindful movement & yoga. Almost all studies outlined positive impact from addressing burnout with mindfulness practices and activities. The results of the review also revealed that more research is needed to reinforce the evidence for positive effects of mindfulness approaches in addressing burnout in higher education settings in relation to educators.

Overall, research increasingly emphasizes the need to develop and implement more comprehensive training programs for the prevention and management of academic burnout, however, the creation of comprehensive programs addressing all aspects of burnout by assuring flexibility through the availability of a variety of mindfulness practices and activities is necessary to be effective in a long run. This preliminary study explores the effectiveness of such a program provided by the Brain Booth Initiative at the University Libraries.

2. Hypothesis

Participants will report positive improvements in their experience of aspects of burnout as a result of engagement with self-guided mindfulness practices and activities.

2.1. Null Hypothesis

For the purpose of data analysis, the null hypothesis states that participants will report no change in their experience of aspects of burnout as a result of engaging with mindfulness practices and activities.

3. Methodology

The methodology included a quantitative approach using pre- and post-program Qualtrics surveys, administered to evaluate the effects of a 1-month experiential program, and based on engagement with mindfulness practices and activities offered through the Brain Booth Initiative.. The Brain Booth, located at the University Libraries, is an experiential space to learn about the mind-body connection, reduce stress, and optimize academic performance. The second part of the study will include a focus group with participants to further explore the results of the program. This paper reports on the findings of the first part of the sequential mixed-methods study.

Participants in the study were full-time faculty at Georgia Southern University. Participants were invited to participate in a 1-month program during which they were invited to visit the Brain Booth two times per week at times convenient for them and engage with Brain Booth activities for approximately 15 minutes per visit. Additionally, they were invited to engage for approximately 15 minutes, during their personal time and at a location of their choice outside of the workplace, with a preferred activity or one described in the Brain Booth Tip of the Week.

The recruitment email described the study's purpose, listed potential benefits of participation, and described the time commitment and expectations for participation in the study. The email included a link to a pre-program survey. To participate, recipients clicked the link, reviewed and digitally signed an informed consent, and completed a six-question survey in which they rated their level of experience of six aspects of burnout on a 1-5 Likert scale with 1 representing "None" and 5 "Extreme". The six aspects included exhaustion, cynicism, detachment, sense of ineffectiveness, sense of lack of accomplishment, and stress/anxiety. These aspects are derived from components included in Maslach and Leiter's (2017, p. 37) description of burnout. The researchers then reached out to respondents (n=8) to schedule a 1-hour orientation session at the Brain Booth.

One of the researchers was present at the Brain Booth during each orientation to introduce participants to the space, demonstrate the mindfulness activities available to choose from, and provide an overview of the benefits of engaging in brief, low-impact mindfulness practices, as outlined in the literature. Following their orientation, participants self-managed their engagement with mindfulness activities and practices at the Brain Booth, or a location of their choice outside of it.

After the 1-month study period, participants completed a post-program survey which asked them to assess their experience of aspects of burnout using the same six Likert-scale questions used in the pre-program survey.

A participant focus group interview will be conducted in the near future as a second part of this study. The qualitative data collected during the focus group will provide more information about which activities participants preferred, how closely they were able to follow the study's requirements, and how each participant's engagement with mindfulness practices and activities affected their experiences of different aspects of burnout.

3.1. Data Collection and Analysis

The pre- and post-program surveys were built in Qualtrics and included six Likert-scale questions designed to measure the level of each participants' experience of aspects of burnout. The scale ranged *1. None*, *2. Minor*, *3. Moderate*, *4. Major*, and *5. Extreme*. Each participant was emailed the questionnaire to respond to both before and after completing the 1-month program.

Survey responses were analyzed in SPSS using a Wilcoxon sign-rank test. This test was used because the data was not normally distributed, as shown by Shapiro-Wilk test results. The null hypothesis assumed no improvement between pre- and post-program survey responses. Participant responses were tested at a 0.05 confidence level to determine if reported improvements in each aspect of burnout were statistically significant. Improvements were evidenced by negative mean differences between pre- and post-program survey responses.

4. Results

The results of the study indicated a positive effect of engagement with mindfulness practices and activities on faculty members' experiences with six aspects of burnout. Table 1 collects results from the Wilcoxon sign-rank test including mean values, standard deviation, test statistic (w), average response differential, and significance (p) for participant responses to the pre- and post-program surveys. Mean ratings of post-program survey responses showed overall improvement in all six aspects of burnout. However, results of the Wilcoxon sign-rank test indicated statistically significant improvements in only one aspect: lack of accomplishment. While the average differential between pre- and post-program survey ratings in exhaustion, cynicism, detachment, ineffectiveness, and stress/anxiety also showed improvement over pre-program survey ratings, the results of the Wilcoxon sign-rank test did not indicate those changes as statistically significant.

Exhaustion received the highest pre-program survey rating in severity of experience across the sample. Lack of accomplishment at work received the lowest pre-program survey rating, but the

results of the Wilcoxon sign-rank test found the changes between pre- and post- program survey responses to be statistically significant. The average differential between pre- and post-program survey ratings indicated that sense of detachment and stress/anxiety were the most-improved aspect of burnout experienced by faculty, but the results of the Wilcoxon sign-rank test did not find those changes to be statistically significant.

Table 1. Wilcoxon Sign-Rank Test Results.

Aspect	Pre-Test Mean	Pre-Test S.D.	Post-Test Mean	Post-Test S.D.	W	Avg. Diff.	p
Exhaustion	3.8	0.89	2.9	0.83	2.5	-0.9	0.084
Cynicism	3.4	0.92	2.6	0.52	1.5	-0.8	0.098
Detachment	2.9	0.83	1.9	0.64	3.0	-1.00	0.054
Ineffectiveness	2.5	0.53	1.9	0.35	0.0	-0.6	0.059
Lack of Accomplishment	2.4	0.5	1.6	0.5	0.0	-0.8	0.034
Stress/Anxiety	3.6	0.9	2.6	0.7	4.0	-1.00	0.086

5. Discussion

The study's findings show that brief, low-impact mindfulness practices and activities such as those available at the University Libraries Brain Booth alleviate faculty members' experience of workplace burnout. The participants in this study experienced benefits such as increased energy and focus, reduced ruminative thinking and stress, enhanced patience and satisfaction with work, and improved overall well-being. These findings show promising outcomes with the designed approach at academic settings and are corresponding to similar results in other fields, such as nursing (Hagerman et al. 2023; Montanari et al., 2019). The benefits of this study to society include the contribution of valuable data in support of a growing body of research focused on the benefits of mindfulness practices in the workplace.

5.1. Limitations

Since this is a preliminary study to help with finalizing the research design for a full study, a small sample size (n=8) was accepted. However, the small sample size limits the reliability of detecting statistical significance in participant responses. The chance that outliers (e.g. a participant's memory of prior responses, significant changes in workplace or life circumstances, etc.) influenced how pre- and post-program survey responses were reported is also increased due to the small sample size. A larger sample size would have afforded the use of a parametric test of greater statistical power to achieve more reliable results.

6. Conclusion

Burnout has been identified and remains a significant obstacle to productivity in the workplace. This preliminary study addresses the continuing need for mindfulness training programs to address burnout in academic settings through the lens of a library service: the Brain Booth. The findings indicate that a full study with a larger sample size is needed to substantiate the positive results. The next step for the researchers will be to conduct the second part of this preliminary sequential study, namely, the focus group with participants to be able to explain further the results, and be able to adjust the research design as needed to conduct a full study on the topic with a much higher number of participants. The overall goal of this multi-step research project is to design, develop and implement a flexible program that will successfully address burnout with mindfulness practices and activities, and will be replicable in any higher education setting.

References

Baker, R. L., & Karadjova-Kozhuharova, K. G. (2024). Mindfulness approaches for addressing burnout in higher education settings: A systematic literature review. *EDULEARN24 Proceedings*, 4327-4333. https://doi.org/10.21125/edulearn.2024.1082

Becker, M., Bartalotta, A., Morton, M., Helminen, E., Clawson, A., & Felver, J. (2020). The effects of mindfulness-based stress reduction in the higher education workplace: A pilot study. *Journal of Integrated Social Sciences, 10*(1), 136-154. https://www.jiss.org/documents/volume_10/JISS%202020%2010(1)%20136-154%20Mindfulness.pdf

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, *84*(4), 822. https://doi.org/10.1037/0022-3514.84.4.822

Constantino, P., de Souza, E. R., de Assis, S. G., & Correia, B. S. C. (2012). Burnout aspects of physical and mental health conditions. In Bährer-Kohler, S. (Ed.), *Burnout for experts: Prevention in the context of living and working* (pp. 89-98). Springer. https://doi.org/10.1007/978-1-4614-4391-9_6

Dekeyser, M., Raes, F., Leijssen, M., Leysen, S., & Dewulf, D. (2008). Mindfulness skills and interpersonal behaviour. *Personality and Individual Differences*, *44*(5), 1235-1245.https://doi.org/10.1016/j.paid.2007.11.018

Emerson, L. M., Leyland, A., Hudson, K., Rowse, G., Hanley, P., & Hugh-Jones, S. (2017). Teaching mindfulness to teachers: A systematic review and narrative synthesis. *Mindfulness*, *8*, 1136-1149. https://doi.org/10.1007/s12671-017-0691-4

Ergas, O., & Hadar, L. L. (2019). Mindfulness in and as education: A map of a developing academic discourse from 2002 to 2017. *Review of Education*, *7*(3), 757-797. https://doi.org/10.1002/rev3.3169

Goodman, V., Wardrope, B., Myers, S., Cohen, S., McCorquodale, L., & Kinsella, E. A. (2019). Mindfulness and human occupation: A scoping review. *Scandinavian journal of occupational therapy*, *26*(3), 157-170. https://doi.org/10.1080/11038128.2018.1483422

Hagerman, L., Manankil-Rankin, L. & Schwind, J. K. (2023). A narrative inquiry into the experiences of nursing faculty engaging in mindful practices. *International Journal of Teaching and Learning in Higher Education*, *35*(1), 151–157. https://www.isetl.org/ijtlhe/pdf/IJTLHE4438.pdf

Huberman, A. M., & Vandenberghe, R. (2006). Understanding and Preventing Teacher Burnout. *New York: Cambridge University Press*.

Janssen, M., Heerkens, Y., Kuijer, W., van der Heijden, B., & Engels, J. (2018). Effects of mindfulness-based stress reduction on employees' mental health: A systematic review, *PLoS ONE, 13*(1), 1–37. https://doi.org/10.1371/journal.pone.0191332.

Kabat-Zinn, J. (1990). *Full catastrophe living: How to cope with stress, pain and illness using mindfulness meditation*. New York: NY: Bantam Dell.

Kabat-Zinn, J. (2021). The liberative potential of mindfulness. *Mindfulness*, *12*(6), 1555-1563. https://doi.org/10.1007/s12671-021-01608-6

Kourea, L., Papanastasiou, E. C., Diaconescu, L. V., & Popa-Velea, O. (2023). Academic burnout in psychology and health-allied sciences: the BENDiT-EU program for students and staff in higher education. *Frontiers in Psychology, 14*, 1239001. https://doi.org/10.3389/fpsyg.2023.1239001

Luken, M., & Sammons, A. (2016). Systematic review of mindfulness practice for reducing job burnout. *The American Journal of Occupational Therapy*, *70*(2), 7002250020p1-7002250020p10. https://doi.org/10.5014/ajot.2016.016956

Marie, K. S. T.-S. & Cook-Cottone, C. (2022). Mindful self-care to manage the effects of trauma, burnout, and compassion fatigue in educators. In L.L. Douglass (Ed.), *Trauma in adult and higher education: Conversations and critical reflections* (pp. 129-147). Charlotte, NC: Information Age Publishing.

Maslach, C. & Leiter, M. P. (2017). Understanding burnout: New models. In C. L. Cooper & J. C. Quick (Eds.), *The handbook of stress and health: A guide to research and practice* (pp. 36–56). Wiley Blackwell. https://doi.org/10.1002/9781118993811.ch3

Montanari, K. M., Bowe, C. L., Chesak, S. S., & Cutshall, S. M. (2019). Mindfulness: Assessing the Feasibility of a Pilot Intervention to Reduce Stress and Burnout. *Journal of Holistic Nursing*, *37*(2), 175–188. https://doi.org/10.1177/0898010118793465

Napoli, M. (2004). Mindfulness training for teachers: A pilot program. *Complementary Health Practice Review*, *9*(1), 31-42. https://doi.org/10.1177/1076167503253435

Waddell, A., Kunstler, B., Lennox, A., Pattuwage, L., Grundy, E. A. C, Tsering, D., Olivier, P. & Bragge, P. (2023). How effective are interventions in optimizing workplace mental health and well-being? A scoping review of reviews and evidence map, *Scandinavian Journal of Work, Environment and Health*, *49*(4), 235–248.

Yoon, J. S. (2002). Teacher Characteristics as Predictors of Teacher-Student Relationships: Stress, Negative Affect, and Self-Efficacy. Social Behavior and Personality, 30, 485-493. https://doi.org/10.2224/sbp.2002.30.5.485

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Psychological wellbeing and programme-related meaningfulness in undergraduate STEM programmes in an Irish University

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Abstract

Psychological wellbeing (PWB) of students impacts their success. The purpose of the current study was to compare the PWB of third- and fourth-year students of two Irish STEM undergraduate programmes. The Ryff 42-item PWB questionnaire was employed, along with asking, for example, how meaningful students found their programme of study and whether they felt they could approach their department lecturers. There were significant differences between the two programmes for Personal growth and Self-acceptance. There was also a significant difference in PWB scores between those whose programme was their first choice at university and those whose programme was not. Results of the current study indicate that mindfulness of students' personal growth is essential, that being offered one's first choice of university programme of study is likely to play a significant role in PWB throughout one's programme of study and that ensuring students' positive perception of approachability of lecturers is important.

Keywords: *STEM; Undergraduates; Psychological Wellbeing; Meaningfulness.*

1. Introduction

It has previously been reported that a student's success needs attitudes, behaviours and psychological processes that lead to engagement, thriving (Schreiner, 2010), hope (Kibby, 2015), and flourishing (Keyes & Haidt, 2003). One multidimensional approach to wellbeing involves integrating different theories of individual development and adaptive functioning. The 42-item Psychological Wellbeing (PWB) Scale conceptualisation measures six aspects of wellbeing and happiness: autonomy, environmental mastery, personal growth, positive relations with others, purpose in life, and self-acceptance (Ryff *et al*., 2007; adapted from Ryff, 1989). Results of a study on the reliability of the 42-point Ryff scale (among other-sized Ryff scales) have suggested that the Ryff scales are overall reliable, including across age groups (Shryock &

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Meeks, 2018). This scale has been used as a baseline for measuring the efficacy of interventions to improve psychological wellbeing (van Dierendonck & Lam, 2023).

The new study investigates the PWB of third- and fourth-year undergraduate students in two accredited Science, Technology, Engineering and Maths (STEM) programmes attending the same university department, the former leading to a qualification with a non-protected professional title and delivered completely within the department; the latter leading to a professional qualification with a protected title, also being a joint programme with a neighbouring university. Core (profession-specific) programme modules were taught in the studied university department by state-registered members of the profession who were also fulltime lecturers.

2. Methodology

Programme participants – The study was conducted with third- and fourth-year undergraduate degree students attending two programmes at the Department of Biological Sciences, namely the BSc Hons in Nutrition and Health Science (NHS) and the BSc Hons in Biomedical Science (BMS) at the researchers' university. Participants were those in attendance at a given lecture for their programme. All four groups were surveyed within the same week. A total of 77 (65.8% of enrolments) and 53 (94.6% of enrolments) students completed the survey from each of the two programmes. For the participating NHS students, the gender mix was Female 64/77 (83.1%); Male 13/77 (16.9%). A total of 96% of students were aged between 18 and 25 years of age (the remaining 4% indicated that they were >25y). For BMS students the gender mix was Female 37/53 (69.8%); Male 15/53 (28.3%) and one who classified themselves as Other (1.9%). All students were aged between 18 and 25 years of age. For the NHS students, the programme was the first choice for 24/77 (31.2%), second choice for 31/77 (40.2%), third choice for 18/77 (23.4%) and fourth or greater for 4/77 (5.2%). For the BMS students the programme was the first choice for 30/53 (56.6%), second choice for 17/53 (32.1%), third choice for 5/53 (9.4%) and fourth or greater choice for 1/53 (1.9%) of students.

Questionnaire – Anonymised students were presented with a hard-copy of the 42-item Ryff PWB questionnaire (Ryff *et al*, 2007, incorporating a seven-point Likert scale), together with an additional set of six question that asked the participant's gender, age-group, whether the programme of study was the first, second or other choice of the student, whether the programme added meaningfulness to the student's life (testing for student's perception of their programme), whether self-worth was connected to academic performance and whether the student felt that they could approach their MTU lecturers as needed (feelings of security).

Ethics - The study was conducted according to the Declaration of Helsinki (64th WMA General Assembly, Fortaleza, Brazil, October 2013). Ethical approval was granted by the University Ethics committee (No: RECL-20-001-A).

2.1. Analysis of Results

Excel (version 2412) was used for data entry and analysis. The 42-item Ryff PWB questionnaire was scored according to its instructions, i.e. the Likert scale individual student results were scored according to instructions, added as a total for that cohort. Scores were calculated for autonomy, environmental mastery, personal growth, positive relations with others, purpose in life, and self-acceptance (and the total score for each individual was also calculated). Cohorts were split according to programme and whether it was the first, second or other preference for the student. Note that the mean and the standard deviations were calculated for each measure within each programme, along with noting the lowest and highest individual scores for each measure within the cohorts of NHS and BMS students. Results were statistically analysed and reported using the Welch's unpaired t-test (Welch, 1947) in preference to the Student's unpaired t-test to accommodate any non-normal distribution of data, although it could be noted that the Student's unpaired t-test gave equivalent results when checked.

3. Results

Using the 42-point score (Ryff) for determination of six measures of PWB among third- and fourth-year NHS and BMS students, the following results were compiled, as shown in Table 1.

Table 1. Analysis of the 42-point Ryff scale applied to the combined third- and fourth-year students for each of two undergraduate BSc (honours) science programmes

Student cohort*	Autonomy	Environ. mastery	Personal growth	Positive relations with others	Purpose in life	Self-acceptance
NHS 3+4 (n=77) Mean	**0.5921**	**0.6668**	**0.7798**	**0.7864**	**0.7403**	**0.6295**
NHS 3+4 (n=77) SD^	0.1470	0.1231	0.0905	0.1257	0.1430	0.1609
NHS range	0.2245-0.9388	0.3061-0.9592	0.5714-0.9796	0.1257-1	0.1430-1	0.1609-0.9796
BMS 3+4 (n=53) Mean	**0.6276**	**0.6446**	**0.8471**	**0.8009**	**0.7570**	**0.70080**
BMS 3+4 (n=53) SD	0.15578	0.1637	0.1210	0.1305	0.1635	0.1607
BMS 3+4 Range	0.2653-0.8980	0.2653-0.9388	0.5102-1	0.4286-1	0.2857-1	0.1633-0.9592

*NHS = BSc Hons in Nutrition and Health Science; BMS = BSc Hons in Biomedical Science; ^SD = standard deviation

There were no statistically significant differences for autonomy, environmental mastery, positive relations with others or purpose in life between the programmes but there was a significant difference between the programmes for personal growth ($p<.001$) and self-acceptance ($p< .01$), whereby BMS students scored higher in both cases. When overall (combined) scores for all six measures of PWB were used to test for significant difference between the two programmes, there was no significant difference found ($p=.1$). An investigation of whether there was a significant difference in overall individual scores of the 42-point Ryff scale for PWB those in both programmes who achieved their first choice of programme compared to those for whom it was second or subsequent choice showed a significant difference in total scores ($p=.01$), with the students for whom their programme of study was their first choice scoring higher for PWB.

The combined individual Ryff scores were investigated for all participants for whom their programme of study was their first choice versus those for whom the programme was their second choice and they showed that there was also a significant difference ($p<0.05$), again with the former scoring higher than the latter. When investigating the difference in each of the six aspects of PWB between those for whom their programme was their first choice versus those for whom it was not, for autonomy and environmental mastery there was no significant difference; for personal growth there was a significant difference ($p<.001$); for positive relations with others there was no significant difference; purpose in life showed a significant difference ($p<. 05$) and for self-acceptance there was no significant difference.

The majority of students felt that self-worth was connected to academic performance either very strongly, somewhat strongly, or slightly. NHS students indicated that this was the case for 58/77, or 75.3%. BMS students indicated this to be the case for 44/53, or 83%. While fewer NHS students indicated that academic performance was linked to self-worth than BMS students, the NHS students indicated a greater strength of feeling, however. A further analysis showed that most students also stated their programme of study added meaningfulness to their lives. NHS students gave a total of 66/77 (85.7%). BMS students gave a total of 46/53 (86.8%) but the difference was not significant.

For both programmes 9% of students felt that their self-worth was connected to their academic performance but did not feel that their academic programme of study added meaningfulness to their lives. An analysis of the data to determine the proportion of students for whom their programme of study added meaningfulness to their lives but for whom their self-worth was not connected to academic performance showed this to be acknowledged for 19.5% of NHS students and 13.2% of BMS students. An analysis of whether students felt that they could approach an MTU lecturer if they felt the need showed that 68.8% of NHS students felt this to be the case, similarly to BMS students, at 69.8%.

4. Discussion

Wellbeing has been stated to be important for university students as it has direct associations with mental illness and academic outcomes, in addition to having intrinsic value (du Toit *et al,* 2022). Furthermore, van Dierenderonck & Lam (2022) have shown that psychological eudaemonic well-being or happiness can be enhanced by targeted intervention programmes. The current study sought to investigate levels of eudaemonia among students in two STEM undergraduate programmes, investigating whether students differed between programmes and whether accepting their first or subsequent choice of programme affected PWB two to three years later while undertaking the programme. The programme for which the students enrolled was the first choice for only 41.5% of students in the current study – for NHS students it was the first choice for 31.2% of students, whereas it was first choice for 56.6% of BMS students.

It should be noted that the NHS programme, while training students to be nutritionists at graduation does not have as great an emphasis on vocational training as the biomedical science programme, which has mandatory professional or state body accreditation, needed to allow graduates of the programme to practise as medical scientists in Ireland. The current study, which tested for autonomy, environmental mastery, personal growth, positive relations with others, purpose in life and self-acceptance showed that there was a statistically significant difference between students of the two programmes only for personal growth and for self-acceptance, with BMS students scoring higher. The higher scores for personal growth among the BMS students may possibly be explained by having module-based emphasis and training on continuous professional development, whereby BMS students (unlike NHS students) are, for example, mandatorily required to engage with reflective practice as undergraduates.

While acknowledging the relatively small sample size of BMS students when testing for a significant difference between the personal growth scores for BMS students for whom Biomedical Science was their first choice (n=30) and those for whom it was not (n=23), no significant difference was observed for the two groups (p=>.5). Previous studies (Patanapu *et al*, 2018; Robitschek *et al*, 2012) have shown that those with well-developed personal growth initiatives are more likely to present with enhanced coping skills, deal with life challenges in a proactive manner, and to respond proactively to change compared to those with poorly developed personal growth initiatives. This may in turn explain why the higher self-acceptance scores were found among BMS than NHS students, accompanying the higher personal growth scores. It is difficult to ascertain whether being on a joint programme affected the BMS students and this would require a separate study.

The results for the six aspects of PWB were compared for these two groups with a study of college students spanning different-discipline programmes in central India (Sharma & Sharma, 2018) that used the same Ryff 42-item scale. Autonomy scores among the Irish students were lower than those of the Indian students and environmental mastery scores were very similar in

both studies. Personal growth scores were much higher in both programmes for the Irish students than for the Indian students, as were positive relations and purpose in life. Self-acceptance was considerably lower among the NHS students than the Indian students, which were in turn lower than the BMS students. One explanation for the comparatively low scores for autonomy in the current study may be that both programmes are highly prescribed with a strong emphasis on continuous assessment and laboratory and other report writing, both of which activities require a high level of compliance for the student to be successful in their degree studies.

Bell and Brooks (2017), in the UK, have found that teaching and course organisation were the most important predictors of overall student satisfaction, resources being found to be rated far less important. According to Bell (2021), a study has shown that students particularly emphasised staff approachability, empathy, sensitivity and caring. In the current study, which asked whether students felt able to approach their MTU lecturers as needed, 69 and 70% of NHS and BMS students, respectively, felt that they could approach their lecturers. There is room for improvement in these cases, however, whereby the importance of staff approachability could be emphasised at department- and university-level.

In the current study, the overall PWB of the respondents of the programmes showed that a student attending the Department of Biological Sciences is more likely to have a lower PWB score in the latter half of their degree programme if they have entered a degree programme that was not their first choice. A German study (Berlingieri *et al*, 2023) has reported that students who enrol in their preferred field show a higher identification with their field of study, report a higher satisfaction with their studies and spend four hours more per week studying two to three years after university entry. A greater level of course promotion and career guidance may be needed by the department in the current study of its programme for students preparing for entry to tertiary education. However, further study is required to determine the motivation of students for the choices they made of their preferred programmes at university, including geographical location.

The limitations of the study included that only 65.8% of the students enrolled on the NHS programme were surveyed, that the total survey population size was 130 participants and that the study was conducted at one time point only.

5. Conclusion

The results of this current study are important as they indicate that mindfulness of students' personal growth is essential, that being offered one's first choice of university programme of study is likely to play a significant role in PWB throughout one's programme of study, and that ensuring students' positive perception of the approachability of lecturers is something that might be considered. The findings of this work are transferable and can be considered for the wellbeing

of students on other programmes of study. Finally, the results of this study suggest the need for a follow-up study as part of a continuous improvement initiative.

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References

Bell, A.R.; Brooks, C. (2017). What Makes Students Satisfied? A Discussion and Analysis of the UK's National Student Survey. *Journal of Further and Higher Education* 42 (8): 1118–1142. https://doi.org/10.1080/0309877X.2017.1349886

Bell, K. (2021). Increasing undergraduate student satisfaction in Higher Education: the importance of relational pedagogy. *Journal of Further and Higher Education*, 46(4), 490–503. https://doi.org/10.1080/0309877X.2021.1985980

Berlingieri, F.; Diegmann, A. Sprietsma, M. (2023) Preferred field of study and academic performance. *Economics of Education Review* 95:102409. https://api.semanticscholar.org/CorpusID:250438367

du Toit, A.; Thomson, R.; Page, A. (2022). A systematic review and meta-analysis of longitudinal studies of the antecedents and consequences of wellbeing among university students. *International Journal of Wellbeing*, 12(2), 163-206. https://doi.org/10.5502/ijw.v12i2.1897

Keyes, C.; Haidt, J. (2003). Flourishing: Positive psychology and the life well-lived. Washington, DC: American Psychological Association. https://psycnet.apa.org/doi/10.1037/10594-000

Kibby, M. (2015). Applying 'hope theory' to first year learning: A practice report. *International Journal of the First Year in Higher Education*, 6(1), 147–153. https://doi.org/10.5204/intjfyhe.v6i1.248

Patanapu, S. K.; Doshi, D.; Kulkarni, S.; Reddy, P.; Adepu, S.; Reddy, S. (2018). Does academic performance influence personal growth initiative? An institutional-based study among undergraduate dental students. Journal of education and health promotion, 7, 83. https://doi.org/10.4103/jehp.jehp_204_17

Robitschek, C.; Ashton, M. W.; Spering, C. C.; Geiger, N.; Byers, D.; Schotts, G. C.; Thoen, M. A. (2012). Development and psychometric evaluation of the Personal Growth Initiative Scale-II. Journal of counseling psychology, 59(2), 274–287. https://doi.org/10.1037/a0027310Ryff, C. D. (1989). Happiness is everything, or is it? Explorations on the meaning of psychological well-being. *Journal of Personality and Social Psychology*, 57, 1069-1081.

Ryff, C. D.; Almeida, D. M.; Ayanian, J. S.; Carr, D. S.; Cleary, P. D.; Coe, C.; Williams, D. (2007). National Survey of Midlife Development in the United States (MIDUS II), 2004-2006: Documentation of the Psychosocial Constructs and Composite Variables in MIDUS II

Project 1. Ann Arbor, MI: Inter-university Consortium for Political and Social Research. http://dx.doi.org/10.3886/ICPSR04652

Schreiner, L. (2010). Thriving in community. *About Campus*, 15(4), 2–11. https://doi.org/10.1002/abc.20029

Sharma, A; Sharma R. Internet addiction and psychological well-being among college students: A cross-sectional study from Central India. *Journal of Family Medical Primary Care*. 2018 Jan-Feb;7(1):147-151. https://api.semanticscholar.org/CorpusID:49275068

Shryock, S; Meeks, S. Internal consistency and factorial validity of the 42-item psychological well-being scales. *Innovation in Aging*, Volume 2, Issue suppl_1, November 2018, Pages 690–691. https://doi.org/10.1093/geroni/igy023.2568

van Dierendonck, D.; Lam, H. (2023). Interventions to enhance eudaemonic psychological well-being: A meta-analytic review with Ryff's Scales of Psychological Well-being. *Applied Psychology: Health and Well-Being*, 15(2), 594–610. https://doi.org/10.1111/aphw.12398

Welch, B. L. (1947). The generalization of "Student's" problem when several different population variances are involved. *Biometrika*. 34 (1–2): 28–35. https://doi.org/10.1093/biomet/34.1-2.28

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In situ Clinical Simulations in Primary Care applied to emergency training: advanced results of a mixed methods study

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Abstract

This study explores the effectiveness of in situ simulation (SIM) methodologies in Primary Care, focusing on knowledge retention, professional satisfaction, and confidence. It aims to assess SIM's impact on non-clinical skills, such as communication, leadership, and teamwork, and its applicability across various professional profiles. The research utilizes the Kirkpatrick Evaluation Model to evaluate SIM's effectiveness and feasibility within Primary Care settings, particularly in Acute Myocardial Infarction (AMI) and Stroke Code training. Results indicate significant improvements in technical and interpersonal skills, with 88.4% of participants reporting enhanced expertise and 83.5% noting better leadership abilities. Qualitative findings highlight increased team coordination, confidence, and improved clinical practice transferability. Despite some resistance to workplace observations, participants viewed in situ simulations positively, advocating for their extension beyond emergency scenarios. These findings support SIM's integration into Primary Care continuing education, suggesting its potential in optimizing both technical and non-technical competencies.

Keywords: *Clinical Simulation; Continous training; Primary Care.*

1. Introduction

1.1. What are clinical simulations (SIM)?

The continuous updating of knowledge and skills is a fundamental pillar in the practice of Primary Care (PC). This enables professionals to maintain appropriate management of prevalent pathologies and ensure an efficient response to urgent, albeit infrequent, but severe clinical situations, such as acute myocardial infarction (AMI) and cerebrovascular accident (CVA). In Catalonia, annual training in the action protocols for AMI and CVA, known as the IAM Code

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and Stroke Code respectively, is a mandatory requirement within the Healthcare Quality Standards for all PC healthcare professionals. This training is usually provided by healthcare professionals, either in person through theoretical sessions or through online training platforms.

The relationship between teaching methodology and the long-term retention of skills is a fundamental concept in pedagogy. Edgar Dale's learning pyramid posits that the effectiveness of knowledge acquisition is intrinsically linked to the role assumed by the student during the learning process (Dale et al., n.d.). Maximum assimilation is achieved through the simulation of real-world scenarios or, optimally, through practical execution in an authentic context. Consequently, the fidelity of the learning methodology to the real-world situation is positively correlated with the degree of knowledge retention.

According to the Center for Medical Simulation, simulation (SIM) is defined as the creation of an environment or scenario that allows individuals to experience a representation of a real-world event. This is done for the purpose of practicing skills, acquiring knowledge, conducting assessments and tests, or understanding the functioning of biological or human systems. SIM is presented as an innovative response to the current needs in health science education. Its primary objective is for both students and professionals in the field to develop and refine essential competencies, such as clinical, communication, and teamwork skills.

Clinical simulation is conceived as a structured process comprising three distinct phases: the initial briefing session, the development of the simulated scenario, and the feedback session.

In the initial briefing session, learning objectives are established, the simulation environment is described, and roles are assigned to participants. A safe learning environment is fostered, and the confidentiality of information is guaranteed.

During the development of the simulated scenario, participants interact with simulated patients, who have been designed to replicate the characteristics of a real patient with the highest possible fidelity. Participants assume their professional roles and act as they would in an authentic clinical situation, while the rest of the group observes the development of the simulation.

The feedback session is a fundamental stage of the process. It takes place in a separate space from the simulation environment. In this phase, participants reflect on their performance, analyze their actions, and consider the influence of their cognitive processes, psychomotor skills, and emotional states on their decision-making and behavior. The primary objective of this session is to identify areas for improvement and optimize future clinical performance.

Ultimately, the experiential learning acquired through simulation is transferred to daily clinical practice through the modification of behaviors and attitudes, which translates into a continuous improvement of the quality of patient care.

1.2. Current use of Clinical Simulations.

Clinical simulation, as a pedagogical tool, has experienced a growing adoption in both undergraduate (Fitch, 2007; Seybert et al., 2008) and postgraduate training, with a special emphasis on the field of medical emergencies, whether of an in-hospital or out-of-hospital nature (Martin et al., n.d.). The scientific literature provides evidence of favorable results associated with its implementation, including an increase in student satisfaction (4), greater self-confidence in the management of diverse clinical scenarios (Theilen et al., 2013; van Schaik et al., 2011), an improvement in long-term knowledge retention (Houben et al., 2011), a greater transfer of learning to the real clinical context (Sánchez et al., 2013), an optimization of patient safety (Abdulmohsen H, 2010; Lavelle et al., 2017; Wang et al., 2019), and a strengthening of communication and teamwork skills (Garden et al., 2010; Patterson et al., 2013).

While the use of clinical simulations is a common practice in the teaching of Basic Life Support with Automated External Defibrillation (BLS+AED), a lack of a structured and clearly defined methodology is frequently identified. However, the potential of simulation transcends this specific area, encompassing other domains of medical emergencies (codes for Acute Myocardial Infarction [AMI] and stroke, convulsive crises, hypoglycemia, among others), as well as the management of patients with chronic pathologies, home care, and the development of communication skills in the healthcare setting.

1.3. In situ clinical simulations.

On-site simulation, defined as that which takes place in the usual physical and professional context, stands as a pedagogical strategy with the potential to optimize learning, particularly in the development of essential competencies such as effective communication and collaborative work. This training modality facilitates the identification of deficiencies in the application of clinical protocols that, otherwise, could remain hidden until their manifestation in real patient care situations. In this sense, Motola et al. (2013) suggest that on-site simulation represents a pragmatic alternative for those institutions that do not have a dedicated simulation center, and that its implementation can contribute to improving the safety and reliability of care processes, particularly in areas of high complexity or in environments subjected to high care pressure, especially when applied to the training of interdisciplinary teams (Cook et al., 2013; Kurup et al., n.d.; Riley et al., 2010; Sørensen et al., 2017).

Despite the advantages offered by on-site simulation in terms of organizing training activities, by avoiding the displacement of professionals to an external center and the consequent interruptions in regular care activity, there are certain limitations related to its feasibility. The main one is the need to have the emergency service available for the development of these training activities, a requirement that cannot always be met due to the demands of caring for critically ill patients.

1.4. How SIMs are evaluated.

The Kirkpatrick Model, a cornerstone in evaluating the efficacy of both formal and informal training programs, proposes a four-level framework. According to the updated 2019 version (Kirkpatrick & Kirkpatrick, n.d.), the first level focuses on measuring participant reactions, assessing their satisfaction, interest, and perceived value of the training. The second level evaluates the acquisition of knowledge, employing tools such as pre- and post-tests, as well as direct observations. The third level concentrates on behavioral changes, determining whether the learning has translated into new practices or skills. Lastly, the fourth level analyzes the long-term impact of the training, evaluating outcomes in practice, such as improvements in patient safety or quality of care. According to Liao and Hsu (2019), the results of the third level are a robust predictor of the final outcomes, which, due to their complex nature, are often more difficult to quantify.

1.5. Justification of the study

Empirical evidence substantiates the efficacy of simulation (SIM) methodologies in enhancing both technical and non-technical skills acquisition among healthcare professionals. However, the literature on the application of SIM within the context of Primary Care, particularly within the actual clinical setting (in situ), remains relatively limited.

This study seeks to address several key questions surrounding the implementation of SIM in Primary Care:

1. Does SIM effectively facilitate long-term knowledge retention and enhance professional satisfaction and confidence?
2. What is the level of professional acceptance for SIM-based training methodologies?
3. Does the effectiveness of SIM vary across different professional profiles, or is it universally applicable?
4. What other areas within the scope of Primary Care practice can benefit from the integration of SIM-based training?
5. Is it feasible to seamlessly integrate SIM-based training into the routine workflow of healthcare professionals, with the ultimate goal of transitioning all continuing education activities towards this modality?

To address these critical inquiries, this research project aims to evaluate the effectiveness of SIM methodologies in the Primary Care setting, utilizing the Kirkpatrick Evaluation Model as a framework, while concurrently assessing the feasibility of implementing such methodologies within the existing Primary Care infrastructure.

2. Hypothesis

The implementation of in situ simulation methodologies within the context of Acute Myocardial Infarction (AMI) and Stroke Code training in the Primary Care setting demonstrates feasibility and effectively enhances both clinical and non-clinical competencies among Primary Care professionals.

3. Objectives.

3.1. General objective.

To assess the effectiveness and viability of a training program in IAM Code and Stroke Code based on the SIM in situ methodology.

3.2. Specific objectives.

- Analyze the improvement in non-clinical skills: communication, leadership, and teamwork.
- Examine the improvement in knowledge retention over time through this methodology.
- Analyze how the acquired learning results in changes in the clinical practice of professionals and in teamwork.
- Evaluate the satisfaction level of professionals regarding the use of this methodology.
- Assess the feasibility of implementing this training methodology in the Primary Care training program (interference in the daily activities of the center and necessary resources).

4. Methodology

4.1. Type of study.

Implementation study using mixed methods.

- Quantitative study in the form of an analytical observational study based on a pre-post questionnaire with a comparison group, evaluating both technical and non-technical skills, as well as the Simulation-Based Training Quality Assurance Tool (SBT-QA10), which analyzes the simulation experience from the learner's perspective.
- Qualitative study based on the principles of Grounded Theory, involving:
    - Focus groups with healthcare and non-healthcare professionals.
    - Observations during the development of the training activity.

4.2. Determinations

A comprehensive analysis will be conducted of: pre- and post-intervention questionnaires, SBT-QA10 results administered after each training session, transcripts of focus group data, and observations made during simulations.

4.3. Statistical analysis

4.3.1. Quantitative data

To compare and objectify the differences in results obtained before and after the intervention, the paired t-test were used for continuous data, and the McNemar test were applied if variables were binary.

4.3.2. Qualitative data

To generate an in-depth understanding of the phenomenon under investigation and address the research question, we have adopted Grounded Theory as the primary analytical framework. This approach facilitates the inductive generation of a theory of change that underpins the intervention, enabling the identification of critical barriers and facilitators to its successful implementation. By prioritizing the emergent perspectives of study participants, Grounded Theory allows for a data-driven exploration of the intervention's dynamics, minimizing the influence of pre-existing assumptions held by the research team.

5. Results

5.1. Quantitative study

A total of 207 professionals answered the survey, of which 84% were women, 47% aged between 31 and 50, 39% over 50 and 14% under 30. By occupation, 24% were specialists in family medicine, 29% were nurses, 22% administrative staff and the rest other professional profiles.

A majority of the participants (88.4%) reported that the methodology enhanced their technical expertise, while 83.51% perceived improvements in their interpersonal and leadership competencies. Furthermore, 90.72% believed that the methodology facilitated sustained knowledge acquisition, and a similar proportion (90.11%) reported increased self-efficacy in managing similar critical situations.

There is a significant improvement in pre- and post-intervention confidence ($p<0,001$), serenity ($p<0,001$) and a perception of having improved their training ($p<0,001$). In summary, 84.3% recommended using this methodology in future training activities (see Table 1).

Table 1. Results of the quantitative analysis.

N: 95. 88% women. 55% between 31 and 50 years old. 27% phisicians, 22% nurses, 18% administrative support		
88,4% Improve theoretical knowledge	87,3% Improve non-technical skills	92,7% Improve long-term learning
Improve confidence pre-post (p=0,028)	Improve serenity (p=0,05)	Perception of agree with this methodology (p=0,012)
84.3% recommend on-site SIM for future training.		

5.2. Qualitative study

Four focus groups were carried out, with a total of 38 interviewees, among whom there were 13 family doctors and 14 nurses, while the rest were other types of professionals, such as nursing assistants, administrators and psychologists.

All of the interviewees expressed their satisfaction with this training methodology, since it was more fun, dynamic and active, and required greater involvement on the part of the professional.

In the various group interviews conducted, the utility of clinical simulations to enhance the acquisition of theoretical knowledge and the learning of non-technical skills has been repeatedly emphasized. Among these, improvements in team coordination and leadership in emergency situations have been highlighted, which foster improved group cohesion. At the individual level, numerous interviewees have emphasized improvements in the serenity and confidence with which they approach these types of situations thanks to the use of this methodology, emphasizing that the learning has been effectively transferred to real clinical practice in the days following the training activity (see Figure 1).

Regarding the implementation of clinical simulations in the professional's own workplace (in situ), in most cases it has been considered a very positive aspect because it allows for improved knowledge of the different team members and their roles in emergency care, as well as optimizing internal protocols by identifying errors. In addition, it is widely considered that conducting training in the usual work environment improves the confidence with which the training activity is approached, a key aspect to maximize learning. Despite this, some professionals have stated that feeling observed by their own colleagues is a barrier for them. To overcome that difficulty, there are different strategies, such as allowing familiarization with the simulation environment and equipment, prior practice without observation and focus on learning, without judgment.

The professionals expressed the opinion that this methodology should be extended to other clinical situations, not only in the field of emergencies (anaphylaxis or management of aggressive psychiatric patients), but also other situations specific to a Primary Care consultation (management of chronic diseases, mental disorders, communication skills...).

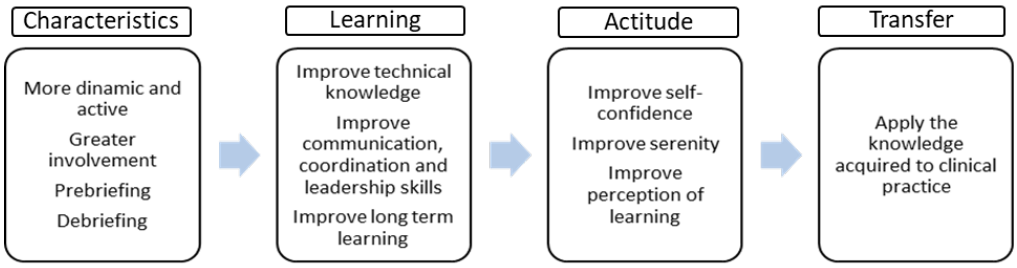


Figure 1. Results of the qualitative analysis.

6. Discussion

This study's findings corroborate the existing evidence supporting the efficacy of in situ simulations as a pedagogical tool in primary care. By simulating real-world clinical scenarios within the actual workplace, we have successfully identified and addressed gaps in professional competencies, thereby facilitating continuous improvement in clinical practice. Our results align with previous research (Sahin-Bayindir & Buzlu, 2022) highlighting the role of in situ simulations in developing both technical and non-technical skills, as well as fostering collaborative teamwork among healthcare professionals.

Moreover, our findings are consistent with those of Kyrkjebø et al. (2006), who underscore the importance of in situ simulations in optimizing care processes and facilitating the transfer of learning to clinical practice, ultimately enhancing patient safety, efficiency of care processes, and professional satisfaction (see Table 2).

It is important to note that these results were observed in the field of primary care, where existing scientific evidence on this training methodology is limited. Furthermore, its implementation was evaluated in a real-world setting, i.e., incorporating the activity into the daily routine of a health center, so that the results of the analysis regarding usefulness, acceptance and feasibility are close to reality. Strategies to overcome the limitations of our research include augmenting the number of participants, designing a more detailed knowledge evaluation questionnaire, or conducting a longer-term analysis (6 or 12 months). Our study supports the use of in situ clinical simulations in continuing education in Primary Care, not only in the field of emergencies but probably also in other training areas.

7. Conclusions

In situ clinical simulations applied to primary care emergency training (AMI code, Stroke code, and CPR) have demonstrated improvements in both knowledge and teamwork skills among healthcare professionals. This methodology holds promise for enhancing continuing education across a broader range of clinical areas.

Table 2. Key points of the investigation. Benefits of SIM in situ.

Identify gaps in professional competencies.
Facilitate continuous improvement in clinical practice.
Develop technical and non-technical skills.
Foster collaborative teamwork.
Transfer of learning to clinical practice.
Enhance patient safety, efficiency of care processes and professionals' satisfaction.

References

Abdulmohsen H, A.-E. (2010). Simulation-based medical teaching and learning. *Journal of Family and Community Medicine*, *17*(1), 35. https://doi.org/10.4103/1319-1683.68787

Cook, D. A., Hamstra, S. J., Brydges, R., Zendejas, B., Szostek, J. H., Wang, A. T., Erwin, P. J., & Hatala, R. (2013). Comparative effectiveness of instructional design features in simulation-based education: Systematic review and meta-analysis. *Medical Teacher*, *35*(1), e867–e898. https://doi.org/10.3109/0142159X.2012.714886

Dale, E., Media, B. N.-E., & 1960, undefined. (n.d.). Cone of learning. *Mcdn.Nazwa.Pl*. Retrieved October 27, 2021, from http://mcdn.nazwa.pl/MCDN_19/PROJEKTY/SIEC/EN/S3A3.pdf

Fitch, M. T. (2007). Using high-fidelity emergency simulation with large groups of preclinical medical students in a basic science course. *Medical Teacher*, *29*(2–3), 261–263. https://doi.org/10.1080/01421590701297334

Garden, A., Mills, S., Wilson, R., Watts, P., Griffin, J., Gannon, S., & Kapoor, I. (2010). In situ simulation training for paediatric cardiorespiratory arrest: initial observations and identification of latent errors. *Anaesthesia and Intensive Care*, *38*(6), 1038–1042. https://doi.org/10.1177/0310057X1003800613

Houben, K. W., Van Den Hombergh, C. L. M., Stalmeijer, R. E., Scherpbier, A. J., & Marcus, M. A. E. (2011). New training strategies for anaesthesia residents. *Current Opinion in Anaesthesiology*, *24*(6), 682–686. https://doi.org/10.1097/ACO.0B013E32834C8842

Kirkpatrick, J., & Kirkpatrick, W. K. (n.d.). *An Introduction to The New World Kirkpatrick Model*. Retrieved April 6, 2023, from www.kirkpatrickpartners.com

Kurup, V., Matei, V., anaesthesiology, J. R.-C. opinion in, & 2017, undefined. (n.d.). Role of in-situ simulation for training in healthcare: opportunities and challenges. *Ingentaconnect.Com*. Retrieved October 14, 2021, from https://www.ingentaconnect.com/content/wk/coana/2017/00000030/00000006/art00021

Kyrkjebø, J. M., Brattebø, G., & Smith-Strøm, H. (2006). Improving patient safety by using interprofessional simulation training in health professional education. *Journal of Interprofessional Care*, *20*(5), 507–516. https://doi.org/10.1080/13561820600918200

Lavelle, M., Attoe, C., Tritschler, C., & Cross, S. (2017). Managing medical emergencies in mental health settings using an interprofessional in-situ simulation training programme: A mixed methods evaluation study. *Nurse Education Today*, *59*, 103–109. https://doi.org/10.1016/J.NEDT.2017.09.009

Liao, S.-C., & Hsu, S.-Y. (2019). Evaluating a Continuing Medical Education Program: New World Kirkpatrick Model Approach. *Online Submission*, *8*(4), 266–279. https://doi.org/10.32327/IJMESS.8.4.2019.17

Martin, A., Cross, S., and, C. A.-A. in M. E., & 2020, undefined. (n.d.). The use of in situ simulation in healthcare education: current perspectives. *Ncbi.Nlm.Nih.Gov*. Retrieved October 14, 2021, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7707431/

Mehrotra, A., Forrest, C. B., & Lin, C. Y. (2011). Dropping the baton: specialty referrals in the United States. *The Milbank Quarterly*, *89*(1), 39–68. https://doi.org/10.1111/j.1468-0009.2011.00619.x

Motola, I., Devine, L. A., Chung, H. S., Sullivan, J. E., & Issenberg, S. B. (2013). Simulation in healthcare education: A best evidence practical guide. AMEE Guide No. 82. *Medical Teacher*, *35*(10). https://doi.org/10.3109/0142159X.2013.818632

Patterson, M., Geis, G., Falcone, R., LeMaster, T., & Wears, R. (2013). In situ simulation: detection of safety threats and teamwork training in a high risk emergency department. *BMJ Quality & Safety*, *22*(6), 468–477. https://doi.org/10.1136/BMJQS-2012-000942

Riley, W., Davis, S., Miller, K., … H. H.-B. Q. &, & 2010, undefined. (2010). Detecting breaches in defensive barriers using in situ simulation for obstetric emergencies. *Qualitysafety.Bmj.Com*, *19 Suppl 3*. https://doi.org/10.1136/qshc.2010.040311

Sahin-Bayindir, G., & Buzlu, S. (2022). The effect of two simulations on students' knowledge and skills regarding physical health problems of psychiatric patients: A mixed-method study. *Nurse Education Today*, *119*. https://doi.org/10.1016/J.NEDT.2022.105537

Sánchez, M., López, L., López, O., Amb, S. Á.-C. M., & 2013, U. (2013). La simulación clínica como herramienta de aprendizaje Simulation based-training in Medicinie: A teaching tool. *Asecma.Org*, *18*(1), 25–29. www.asecma.org

Seybert, A. L., Kobulinsky, L. R., & McKaveney, T. P. (2008). Human patient simulation in a pharmacotherapy course. *American Journal of Pharmaceutical Education*, *72*(2), 37. https://doi.org/10.5688/AJ720237

Sørensen, J., Østergaard, D., LeBlanc, V., Ottesen, B., Konge, L., Dieckmann, P., & Van der Vleuten, C. (2017). Design of simulation-based medical education and advantages and disadvantages of in situ simulation versus off-site simulation. *BMC Medical Education*, *17*(1), 1–9. https://doi.org/10.1186/S12909-016-0838-3

Theilen, U., Leonard, P., Jones, P., Ardill, R., WeitzJ, J., Agrawal, D., & Simpson, D. (2013). Regular in situ simulation training of paediatric medical emergency team improves hospital response to deteriorating patients. *Resuscitation*, *84*(2), 218–222. https://doi.org/10.1016/J.RESUSCITATION.2012.06.027

van Schaik, S., Plant, J., Diane, S., Tsang, L., & O'Sullivan, P. (2011). Interprofessional team training in pediatric resuscitation: a low-cost, in situ simulation program that enhances self-efficacy among participants. *Clinical Pediatrics*, *50*(9), 807–815. https://doi.org/10.1177/0009922811405518

Wang, C., Lin, S., Tsai, S., & Shan, Y. (2019). Implications of long-term low-fidelity in situ simulation in acute care and association with a reduction in unexpected cardiac arrests: A retrospective research study. *PloS One*, *14*(3).

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Establishing contact: experiential workshops as tools for medical students to explore the patient perspective

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Abstract

The asymmetry inherent in the care relationship can expose the patient to the phenomenon of reification, which induces patient alienation. Clinical procedures that require contact have a high alienating potential. Showing care and attention to the patient's reactions during contact procedures can improve the doctor-patient relationship. This requires the ability to identify the patient's feelings, known as cognitive empathy. Experiential training has proven to be effective in promoting perspective-taking ability in healthcare professionals. This paper presents 6 pilot experiential workshops aimed at enabling medical students to explore patient perspective-taking. It also outlines the results of a preliminary evaluation of the impact of these workshops on students.

Keywords: *Medical Education; Clinical Contact; Perspective-taking; Cognitive Empathy; Experiential Workshops; Embodied Cognition.*

1. Introduction

The caring relationship is characterised by a constitutive asymmetry that places the clinician in the condition of acting subject and the patient in the condition of action subject. This is because the patient does not know the principles, methods and objectives of the clinical procedures. In Italy and other countries, the law guarantees the patient right to be informed about the principles and effects of clinical procedures in a simple and clear manner, so that they can give informed consent. However, a patient's choice to undergo a medical procedure that he or she does not know deeply cannot be truly informed (Pietrzykowski & Smilowska, 2021). Moreover, although consent allows the patient to be an active part of the decision-making process, it does not make the patient an active part of the treatment process. Some medical procedures (especially those

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requiring visual or physical contact) make the patient feel like being the object of the care relationship. This phenomenon, known as 'reification', is a highly debated bioethical issue (Taussig, 1980). Many clinical procedures are perceived by the patient as alienating because they require attentions and actions that invade the patient's intimate sphere. Such actions would be considered unacceptable in a non-medical context and are tolerated by the patient because of their purpose. However, the fact that patients consent to a medical procedure does not imply that they perceive it as pleasant. This may affect the clinician-patient relationship, inducing in the patient an attitude of closure, often unconscious. The patient's closed attitude may hinder the collection of anamnestic and clinical information, making it difficult to formulate a diagnosis. It can also hinder the success of treatment and reduce patient adherence to therapy.

The clinician's approach can affect the way patients perceive the procedure, influencing their attitude. Adopting a caring and reassuring approach contributes to making the patient feel at ease. This can increase patient compliance in the care relationship. It is therefore important to educate future clinicians to pay attention to the patient's feelings during all those contact actions that may put the patient in a state of awe. However, it is not easy to pay attention to the patient's reaction when the focus of action is clinical action. Knowing how to broaden the focus from the clinical action to the patient's reaction requires an attitude and training that many clinicians develop through experience. So, how can we educate students to pay more attention to the reactions of patients to contact actions?

The effectiveness of the experiential approach for empathic training of healthcare students and professionals has been proven (Bearman et al., 2015). This approach uses the perspective-taking modality to lead clinical to assume the patient's perspective, thus stimulating cognitive empathy. Despite its usefulness, this approach is quite uncommon in Italian medical training. At the University of L'Aquila, an integrated elective course in medical humanities for medical students has been activated since the academic year 2022-2023 (Tusoni et al., 2024). The course includes a module on Narrative Medicine (NM), aimed at promoting the development of an empathic attitude towards patients. However, the NM module does not focus on specific contact procedures and, although it is theoretical-practical, it is not based on an experiential approach.

We applied the experiential approach to a series of pilot workshops for medical students at the University of L'Aquila. The workshops aimed to make students explore the patient's perspective on contact actions, a critical but essential element of various clinical procedures. The objective of the present study was to assess the possible reaction of students to this type of workshops.

2. Methods

For our study, we sought medical students interested in ethical issues and open to experimenting with new types of workshops. Recruitment took place through the local branch of a student association, which forwarded our invitation to its members.

2.1. Structure of workshops

The workshops were designed as practical experiences, without theoretical preparation, but with a final discussion. The aim of the workshops was not to provide the students with pre-packaged answers, but to lead them to reflect independently on the situations they experienced and then to share their reflections with the other group members. Six workshops were conducted by two trainers/observers in three meetings over the course of a week. Each workshop addressed a different dimension of contact, proposing situations that may occur in clinical contexts.

2.1.1. Clinical observation (first day)

The first workshop aimed to simulate 3 general, prolonged clinical observation scenes (such as those occurring during a postural assessment). The workshop used the structure of role playing, with fixed roles, and tasks that varied during the various observations. The task of each participant was hidden from the others. Participants were divided into 'clinicians' and 'patients', randomly combined into clinician-patient pairs. The observations lasted 5 minutes each.

In the first observation, each 'clinician' was asked to take a close look at the patient he or she was paired with, with the aim of trying to find out what problem the 'patient' had. On the other hand, the 'patients' knew that they were visiting a doctor because they had an unspecified problem. We avoided mentioning a specific pathological situation to prevent participants from simulating specific symptoms. At the end of the observation, the 'clinicians' were asked to write on a piece of paper everything they had observed, while the 'patients' were asked to write how they had felt during the observation. In the second observation, each 'clinician' was asked to repeat the former task, supported by a real health professional, whose task was to 'help the colleague'. It was explained to 'patients' that the 'clinicians' who had examined them during the first observation 'had not been able to identify the problem and had asked for the support of a colleague'. Immediately after the observation, the 'clinicians' were required to write whether they had observed other details and what was their patient's emotional state; the 'patients' were asked how they had felt and whether they had perceived something different from the first observation. For the third and final observation, each 'patient' was assigned another 'clinician', as the first one 'had failed to understand his problem'. The 'clinicians', who had to visit a 'new patient', was explained that the 'patient' had already been seen by other colleagues without success; therefore, they were asked to try to put their 'patient' at ease and to observe him/her carefully to try to understand his/her problem. At the end of the observation, the 'clinicians' were asked whether they had succeeded in their task, while the 'patients' were asked how they had felt during the observation with the 'new clinician'.

2.1.2. Proximity (second day)

The second workshop aimed to explore proximity distance and how it changes depending on the people involved in the spatial interaction. This exercise was also carried out in pairs, pairing

students according to various degrees of confidence: one pair consisted of two roommates, one of two boyfriends, 2 pairs consisted of two students who barely knew each other and 2 pairs consisted of a student and a trainer. In each pair, one participant (A) was asked to remain still, while the other (B) was asked to slowly walk towards their partner, observing any conscious or unconscious reactions of the still partner. Bs were instructed to stop at what they believed to be the maximum distance of proximity accepted by their partner. During the activity, As' heart rate (HR) was measured with an oximeter, with the initial and final HR being recorded and its trend monitored. At the end of the action, As were asked whether the distance at which Bs had stopped were appropriate for them, or whether they thought it should be shorter or longer. Then, if necessary, the distance between the two students was adjusted according to the indications of A and then measured. After all pairs had performed the first experiment, the workshop was repeated with the same pairs, with the task reversed.

2.1.3. Sensitivity mapping (second day)

The third workshop aimed to explore the potential invasiveness of the look, in relation to the parts of the body considered most sensitive to eye contact. Each participant was given a drawing of a mannequin and asked to colour in yellow the areas they considered slightly vulnerable to eye contact and in red those they considered most vulnerable. Ten sensitivity maps were thus created. The students were then randomly paired. Within each pair, one student (A) was asked to observe the other (B) for a few minutes, trying to identify the areas of their partner that were sensitive to eye contact. When all As felt they had identified the areas, they were asked to reconstruct their partner's sensitivity map. The experience was repeated with the task reversed. At the end of the workshop, the sensitivity maps were compared with the 'reconstructed' maps to verify the correspondence between the actual and the assumed sensitive areas.

2.1.4. Touch feeling (second day)

The fourth workshop was designed to let students experience how a subject being touched can perceive different modes of touch. Participants were randomly paired. In each pair, one student (A) had to stand behind his/her partner (B) without the latter being able to see him/her. As were asked to define and write on a sheet of paper 3 different intentions with which to touch their colleague's shoulder. For each intention, As had to make 3 attempts at touching, while Bs were asked to write down on a sheet how he had perceived the touch. The experience was repeated with reversed parts. At the end, students compared to each other to see how well touch perceptions matched touch intentions.

2.1.5. Touch negotiation (third day)

The fifth workshop aimed at making students pay attention to the possible reactions of the subject being touched. Again, students were paired randomly. In each pair, one student (A) was to touch first the upper limb of his colleague (B), proceeding from the hand toward the shoulder,

then the lower limb, proceeding from the foot toward the hip. B had no specific task except to freely express his feelings. During the touching exploration, A had to catch any embarrassment of B and immediately stop the action. Alternatively, As could stop when they felt embarrassed, if their embarrassment preceded that of Bs. The experience was repeated in reverse.

2.1.6. Contact lab (third day)

The last workshop was designed to give students the opportunity to use their gaze and gestures to negotiate a contact relationship. This workshop also aimed to return positive energy to participants. In this case, students were given the opportunity to choose a partner with whom they felt kinship. Basic exercises inspired by contact improvisation techniques were proposed.

2.2. Data collection

We collected workshop-related data and reflections emerged during the discussions. In addition, at the end of the course we sent the students a link to a google form, through which we anonymously collected their feedback and suggestions for improving the course.

3. Results

3.1. Sample characteristics

Thirteen medical students responded to our invitation. Of these, 10 (5 males and 5 females) were able to attend the workshops on the scheduled days and times. Two students were enrolled in the 1st year of the degree course, 3 were enrolled in 2nd year, 3 in 5th year, and 2 in 6th year.

3.2. Reflections from the workshops

Some reflections emerged from the discussions among students and trainers/observers.

3.2.1. Clinical observation

Students' reflections - 'Patients' reported feeling the weight of the 'clinicians'' gaze in the first and, especially, the second observation (in which the clinician/patient ratio was 2:1). They also reported feeling judged, although some of them clarified that they rationalized the experience, considering being observed and judged as a necessary condition in a clinical setting. In the first two observations, the 'clinicians' focused mainly on details related to 'patients'' appearance and posture. Only one of them paid attention to the 'patient''s mood and to his own. In the third observation, the change in the task led the 'clinicians' to focus more on the 'patient''s emotional state, trying to see if they had succeeded in making the patient feel comfortable. All 'patients' noticed the different attitude of the 'new clinician' in the third observation, reporting that they felt understood and comfortable. 'Patients' traced this feeling back to the change of 'clinician',

not being aware of the 'clinicians'' new task assignment. *Observers' reflections* - Some 'patients' showed a closed attitude from the first observation (crossed arms, low gaze, etc.), which became more pronounced in the second observation. In the third observation all patients were visibly more relaxed.

3.2.2. Proximity

Students' reflections - The proximity distance was closely related to the relationship between the two subjects involved in the relationship, but it was not always symmetrical (the two did not perceive the relational proximity space as equal). Some students reported feeling uncomfortable while waiting for their partner to start moving. *Observers' reflections* - Subjects in many cases correctly identified the partner's preferred proximity distance. In only 2 cases was the distance preferred by the still subject a bit shorter or longer than that achieved by the approaching subject. In some cases, the HR of the still subject, as we expected, increased as the partner approached; in the other cases it increased as the partner started walking and then decreased as the partner approached.

3.2.3. Sensitivity mapping

Students' reflections - In general, subjects correctly identified some areas of sensitivity, but only in some cases did the reconstructed map come close to the original one. Some students reported discomfort during the final discussion over sharing their areas of sensitivity. *Observers' reflections* - In some cases, the observing subjects noticed sensitive areas that the observed subject had not coloured on the map (as initially was unaware of them) but which, after comparison, he or she recognized as sensitive.

3.2.4. Touch feeling

Students' and observers' reflections - The sensation perceived in many cases did not correspond to the intention of the gesture because, even if the physical dimensions of the touch were captured correctly (intensity, force, time and area of contact) nevertheless the gesture was received by the recipient with a different reaction than intended.

3.2.5. Touch negotiation

Students' and observers' reflections - In many cases, the subjects performing the task interrupted the action when they felt embarrassed or because they did not want to embarrass the subject undergoing the task. Participants reported perceiving embarrassment because the task was not associated with a clinical context, so they could not rationalise.

3.2.6. Contact

Observers' reflections - All participants got involved, without hesitation. At the end of the workshop, it seemed they did not want to stop experiencing contact. It would have been helpful to have more time to allow students to compare and fully understand the experience.

3.3. Participants' feedback and suggestions

We asked students to rate each workshop, indicating a score from 0 to 5. As Figure 1 shows, 4 workshops received an average rating above 3, including 1 with an average rating above 4.

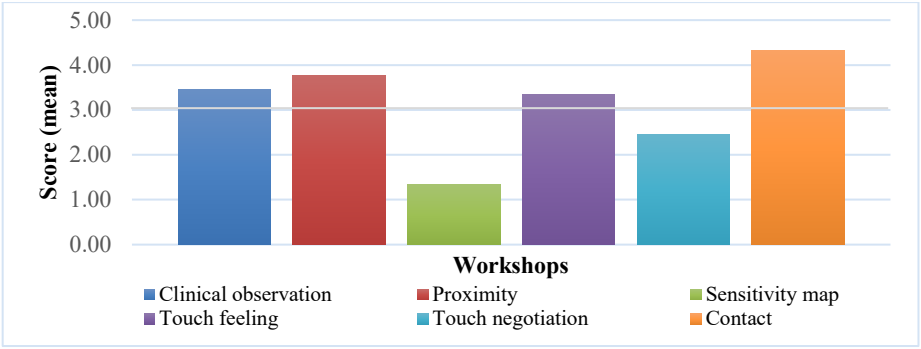


Figure 1. Students' evaluation of contact workshops

We asked students to provide us with suggestions for improving the course. Suggestions were about: increasing the number of meetings and expanding discussion times to allow for better assimilation of the experience; giving the opportunity to experience the workshops with different pairs and also making the first lab bilateral to broaden perspectives; delving into the various modalities of touch (fourth activity); providing a clinical context for the sensitivity map and touch negotiation activity as well to facilitate the approach; and reconsidering the structure of the sensitivity map activity because of the potential embarrassment that can be generated.

4. Discussion

The objective of our study was to investigate how experiential workshops aimed at exploring patients' perspectives could be received by medical students. Since these workshops were novel, we had no expectations. It became soon clear that participants found it difficult to experience contact, especially when they were given no explicit clinical context (2nd,3rd and 5th workshops). As reported by the students, the absence of a clinical context prevented them from rationalising the experience (i.e. relating an emotional experience of the body to a logical abstraction). The need to rationalise is closely linked to the tendency for 'disembodiment' of understanding, which is rooted in Western culture and prevents the so called 'embodied cognition' (Johnson, 2015). In some cases, embarrassment was more related to the expectation of contact than to

contact itself (e.g. in the proximity workshop HR peaks often occurred before the walking student started to move) and sometimes anticipated actual discomfort (in the 5th workshop, some people performing the action stopped before they even felt uncomfortable or sensed the other person's discomfort). This could be explained by a certain tendency towards affective empathy, which, if unregulated, can interfere with cognitive empathy and perspective-taking ability (Ardenghi et al., 2023). Interestingly, it was not physical contact that had the greatest impact, but eye contact alone or eye contact combined with physical contact. The workshop on touch feeling, in which there was no eye contact, did not cause any embarrassment. The last workshop, in which both partners negotiated the motor action with glances and gestures, was most successful. This is probably because neither party played a passive role, but both played an active and collaborative role. It emerged from the discussions that the students expected the trainers to provide useful strategies for handling various contact situations. However, as one of the participants pointed out, the reaction of the clinician and the patient to a contact cannot be defined a priori but depends on contingent factors each time. When the participants told us that, at the end of the experience, they found themselves without precise answers but with further questions, we realised that the workshops had reached their goal. Of course, our study could have benefited from a bigger sample size and more time devoted to the workshops. Future research should address these limitations and explore how embodied cognition may impact the development of empathic perception in healthcare professionals.

References

Ardenghi, S., Russo, S., Bani, M., Rampoldi, G., & Strepparava, M. G. (2023). The role of difficulties in emotion regulation in predicting empathy and patient-centeredness in pre-clinical medical students: A cross-sectional study. Psychology, Health & Medicine, 28(5), 1215–1229. https://doi.org/10.1080/13548506.2021.2001549

Bearman, M., Palermo, C., Allen, L. M., & Williams, B. (2015). Learning Empathy Through Simulation: A Systematic Literature Review. Simulation in Healthcare: The Journal of the Society for Simulation in Healthcare, 10(5), 308–319. https://doi.org/10.1097/SIH.0000000000000113

Johnson, M. (2015). Embodied understanding. Frontiers in Psychology, 6. https://doi.org/10.3389/fpsyg.2015.00875

Pietrzykowski, T., & Smilowska, K. (2021). The reality of informed consent: Empirical studies on patient comprehension—systematic review. Trials, 22(1), 57. https://doi.org/10.1186/s13063-020-04969-w

Taussig, M. T. (1980). *Reification and the consciousness of the patient*. Social Science & Medicine. Part B: Medical Anthropology, 14(1), 3–13. https://doi.org/10.1016/0160-7987(80)90035-6

Tusoni, F., Iagnemma, A., Franceschini, A., Ferrara, V., Cofini, V., Giusti, L., Necozione, S., Romano, S., & Fabiani, L. (2024). Teaching Medical Humanities to medical students: Implementing an integrated approach. In: 10th International Conference on Higher Education Advances (HEAd'24). https://doi.org/10.4995/HEAd24.2024.17209

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Standardized Program for Advancing Clinical Education (S.P.A.C.E.) - Effectiveness of Structured Pre-Clinical Training for Physiotherapy Education

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Abstract

This study evaluates S.P.A.C.E. program (Standardized Program for Advancing Clinical Education), a simulation-based intervention bridging classroom theory with clinical practice for physiotherapy students. It addresses challenges in translating theoretical knowledge into practical skills, alleviating student anxiety through a structured sequence of pre-training, simulated clinical experience with real-time feedback, and post-training reflection. A total of 135 undergraduate students participated the program. They were asked to complete a set of questionnaires before and after the program with items related to their perceived level of self-reported clinical confidence and competency; and specialty-specific knowledge questions. Significant increases in self-reported clinical confidence and competency as well as improvements in case-related knowledge were observed after the program. Regarding the perception of the program's usefulness in preparing them for clinical placement, the mean ratings ranged from 6.50 ± 1.66 to 7.08 ± 1.59, highlighting the S.P.A.C.E. program's effectiveness in enhancing clinical competency among physiotherapy students. The findings underscore the necessity of a structured training program to prepare students for the clinical environments they will encounter, the clinical educators they will collaborate with, and the diverse patient populations and conditions they will face during clinical placements. However, further research is needed to evaluate how such training impacts students' actual performance in real-world clinical settings.

Keywords: *Pre-clinical training, physiotherapy education, clinical education*

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1. Introduction

In today's rapidly evolving healthcare landscape, the need for highly competent and adaptable physiotherapists has never been more critical. A significant challenge in physiotherapy education lies in bridging the gap between classroom-based theory and integrated clinical practice (Petty et al., 2011; Wyres, 2019). While lectures and study materials provide the essential foundation of knowledge, many students struggle to translate this theoretical learning into practical skills required for patient care in hospital settings (Günay & Kilinç, 2018). The unpredictability of real-world clinical environments—marked by patient variability, dynamic interactions, and time pressures—often exposes limitations in traditional training methods (Burgess et al., 2019). Consequently, students may experience uncertainty and anxiety when applying classroom knowledge in high-stakes clinical scenarios (Günay & Kilinç, 2018; Petty et al., 2011).

Traditional approaches, such as peer role-playing and manikin-based simulations, have long been utilized to bridge this gap. However, these methods often fail to replicate the nuanced complexities of authentic patient interactions (Pritchard et al., 2020; Sherwood & Francis, 2018). The simulated environments they offer tend to lack the unpredictability and emotional depth of real clinical situations, thereby limiting students' preparedness for the demands of actual practice (Pritchard et al., 2020). Furthermore, the lack of standardized procedures and immediate, structured feedback often hinders the development of confidence and critical decision-making skills—qualities that are essential for independent clinical practice (Hoffmann et al., 2019).

In response to these challenges, **the Standardized Program for Advancing Clinical Education (S.P.A.C.E.)** program was developed. This innovative training framework aims not only enhance the integration of theoretical and practical knowledge but also empower students to overcome the fear and hesitation that hinder performance. Many students feel constrained by anxiety about meeting the high standards expected of seasoned practitioners, which can prevent them from fully realizing their potential during patient assessments and treatments (Edgar, 2015; Petty et al., 2011). The S.P.A.C.E. program directly addresses these concerns by providing a controlled yet realistic simulation environment where students can practice essential clinical skills. This structured program offers a comprehensive pathway for building confidence and competency.

Grounded in established educational theories—including Cognitive Load Theory, Experiential Learning Theory, and Social Cognitive Theory—the S.P.A.C.E. program optimizes the learning process (Kirschner et al., 2018; Mukhalalati et al., 2022; Sewell et al., 2018). By equipping students with foundational knowledge, engaging them in realistic clinical scenarios, and facilitating immediate constructive feedback, the program enables learners to effectively bridge the gap between theory and practice. The ultimate goal is to cultivate a generation of

physiotherapists who are not only technically proficient but also confident, adaptable, and prepared to excel in clinical settings.

The primary objective of this study was to evaluate the effectiveness of the S.P.A.C.E. program in enhancing clinical competencies among physiotherapy students. We hypothesized that this structured, simulation-based training approach would significantly improve students' clinical reasoning, practical skills, and overall confidence compared to traditional methods. The implications for physiotherapy education, this research offers insights into modernizing clinical training methodologies across allied health professions.

2. Methodology

This was a quasi-experimental study which examined the experience change after the S.P.A.C.E. program.

2.1. Procedures

2.1.1. Participants

All senior physiotherapy students were invited to participate in the S.P.A.C.E. pre-clinical training program before their clinical placements. Study details were explained to participants, and written informed consent was obtained before commencement. A total of 135 students (mean age: 21.64 ± 1.72 years) enrolled in the program. Participants were assigned to one of three specialties based on their clinical placement allocations: Cardiopulmonary (Cardio) (n = 45), Musculoskeletal (MSK) (n = 44), and Neurological (Neuro) (n = 46). The S.P.A.C.E. program simulated specialty-specific clinical environments mirroring hospital placement settings. The program comprised four key steps:

1) Pre-program quiz: Assessed specialty-specific knowledge and allowed students time to plan management strategies for two cases (Case A and Case B) within their assigned specialty.
2) Simulation training: Students worked in pairs to manage cases using standardized patients (trained actors portraying symptoms for MSK and Neuro cases) or manikins (for Cardio cases).
3) Debriefing: Teaching faculty provided feedback in styles reflecting real-world educator approaches (e.g., end-of-session feedback or mid-session feedback at critical moments).
4) Post-program quiz: Repeated the pre-program questions to evaluate if any knowledge gained.

2.1.2. Evaluation

Participants were asked to provide demographic data (age, gender) and report self-perceived level of stress before the S.P.A.C.E. program. Program effectiveness was assessed via a pre- and post-program survey evaluating 1) Readiness for clinical practice, 2) Self-perceived

confidence and competency and 3) Communication skills. Each item was rated on an 11-point scale (0 indicating no confidence/ competency; 10 indicating full confidence/ competency).

2.2. Statistical analysis

All continuous data were presented as mean ± standard deviation (SD). Paired t-tests were used to examine if any change in self-reported clinical confidence/ competency and specialty-specific knowledge pre- and post- program. One-way analysis of variance (ANOVA) was used to compare the students' feedback on the program across specialties (Cardio, MSK, Neuro). Significance was set at $p < 0.05$. All data were analyzed by statistical package (IBM SPSS Statistics for Windows, Version 29.0.2.0 Armonk, NY: IBM Corp).

3. Results

3.1. Self-reported clinical confidence and competency

Mean confidence and competency scores increased from 5.79 ± 1.30 (pre-program) to 6.33 ± 1.51 (post-program). Paired t-tests revealed significant improvements in most items ($p < 0.05$), except for items 5 and 18 (Table 1). These results suggest enhanced confidence and competency across most domains post-program.

3.2. Specialty-specific knowledge

A total of 6 cases, i.e., 2 cases per specialty were developed in S.P.A.C.E. Significant knowledge improvements were observed when students in Cardio group answered Case B with score increased from 15.50 ± 8.46 to 22.25 ± 8.91 ($t = 4.52$, $p < 0.001$) and those in Neuro group answered Case A with score increased from 21.71 ± 11.81 to 25.61 ± 9.76 ($t = 3.24$, $p = 0.002$). No change was observed in other cases.

3.3. Program feedback

On a 0–10 scale, participants generally held favorable views of the program. Overall, the mean scores ranged from 6.50 ± 1.66 to 7.08 ± 1.59 indicating moderately high ratings. Except for item (i.e., The patient actor portrayed the role of a patient in a realistic manner), there were no differences in all post program feedback score across the 3 specialties. The differences in Item 4, i.e., significantly lower in Cardio than the other 2 groups could be explained by the fact that Cardio adopted manikin which had no facial expression while the other two specialties adopted Standardized patient, i.e., trained actor who had facial expression mimicking real patient's responses. These suggest that manikin's limitation.

Table 1. Self-reported clinical confidence.

Items on confident and competent	Pre-program	Post-program
1. I feel confident in my ability to complete this activity to a high standard.	5.20 ± 1.72	5.66 ± 1.71**
2. I feel prepared for clinical placement in the area of physiotherapy.	5.08 ± 1.64	5.75 ± 1.71**
3. I am aware of my strengths in this role playing.	5.33 ± 1.64	6.01 ± 1.70**
4. I can identify areas of weakness related to this activity where I would benefit from further preparation for clinical placement.	6.17 ± 1.59	6.98 ± 1.76**
5. I feel confident in my ability to establish rapport with a client.	6.45 ± 1.60	6.57 ± 1.69
6. I feel confident I can use interpersonal skills such as reflective listening and appropriate use of questions when interacting with real clients.	6.36 ± 1.62	6.57 ± 1.60*
7. I feel confident that I can provide information and education to clients.	5.95 ± 1.47	6.45 ± 1.61**
8. I feel confident in my ability to use appropriate handling and practical skills with this client type.	5.34 ± 1.48	6.27 ± 1.64**
9. I feel confident I can interact in a professional manner.	5.99 ± 1.64	6.49 ± 1.70**
10. I feel confident I can identify key problems during an assessment.	5.54 ± 1.54	6.28 ± 1.75**
11. I feel competent in expressing my clinical reasoning and treatment plans to my CE.	5.24 ± 1.60	6.00 ± 1.79**
12. I feel comfortable in asking my CE for guidance when facing challenges during patient management.	5.65 ± 1.65	6.31 ± 1.84**
13. I feel comfortable when receiving feedbacks from CE.	5.90 ± 1.79	6.68 ± 1.81**
14. I feel competent to explain treatment plans to patients in a way they can understand.	6.02 ± 1.52	6.41 ± 1.63**
15. I am prepared to address patients' questions, concerns, or emotions during treatment.	5.78 ± 1.65	6.32 ± 1.62**
16. I am competent in building trust with patients through effective and respectful communication.	6.20 ± 1.62	6.52 ± 1.56**
17. I feel confident to be aware of the potential danger during patient management.	6.09 ± 1.56	6.36 ± 1.63*
18. I feel confident that I can ensure patient's safety	6.34 ± 1.67	7.08 ± 6.33
19. I feel competent to handle emergencies and unexpected patient conditions.	5.29 ± 1.73	6.02 ± 1.83**

Note. Data were presented as mean ± standard deviation (SD), * indicates $p<0.05$ and ** indicates $p<0.01$ as assessed by paired t-test.

Table 2. Scores on the program feedback

Items		Overall	Cardio	MSK	Neuro
1.	This program has provided me with experience to familiar with the real-life clinical environment.	6.81 ± 1.64	6.96 ± 1.36	6.79 ± 2.08	6.69 ± 1.44
2.	My self-confidence in performing assessment and treatment under supervision has been increased.	6.50 ± 1.66	6.60 ± 1.14	6.37 ± 2.16	6.53 ± 1.59
3.	I feel that the simulated patient scenarios have enhanced my readiness for real-life clinical placements.	6.82 ± 1.53	6.98 ± 1.34	6.77 ± 1.72	6.71 ± 1.53
4.	The patient actor portrayed the role of a patient in a realistic manner.	7.08 ± 1.59	6.38 ± 1.57	7.44 ± 1.68	7.44 ± 1.29
5.	The SPACE program is very helpful to prepare for my clinical placement.	7.03 ± 1.46	7.18 ± 1.21	6.95 ± 1.69	6.96 ± 1.48

Note. Data were presented as mean ± standard deviation (SD)

4. Discussion

The S.P.A.C.E. program effectively enhanced students' self-perceived confidence and competency in patient management, preparing them for clinical placements. Yet, the suboptimal and inconsistent results observed in specialty-specific knowledge assessments may stem from limitations in question design and content. To better evaluate knowledge improvement in this domain, future iterations of the program should integrate case management-focused questions, ensuring a fairer and more targeted assessment of competency.

Unlike static manikins—which lack facial expressions, ambulatory functions (e.g., walking), and realistic patient responses—the use of standardized patients (trained actors) resolved these limitations, creating an immersive clinical practice experience. This approach allowed students to engage in realistic scenarios mirroring actual clinical environments, where they practiced interacting with patients, interpreting their responses, and managing dynamic conditions. Early exposure to such simulations provided psychological and mental preparation for subsequent clinical placements.

Additionally, the program addressed hierarchical and power dynamics that often deter students from seeking feedback (Findyartin et al., 2023). Many students hesitate to ask questions due to fears of appearing incompetent or negatively impacting their performance evaluations, particularly when concerns involve "naïve" inquiries. The S.P.A.C.E. program also simulated diverse feedback styles used by clinical educators—such as sarcastic, questioning, or challenging tones, as well as variations in timing (mid-session vs. end-of-session feedback) and

delivery modes (directive vs. reflective). By training students to navigate these interactions, the program encouraged self-reflection, identification of strengths and weaknesses, and adaptation to educators' communication styles. This reduced anxiety around feedback-seeking and fostered skills to reinforce effective practices while addressing areas for improvement.

5. Conclusion

The findings underscore the necessity of a structured training program to prepare students for the clinical environments they will encounter, the clinical educators they will collaborate with, and the diverse patient populations and conditions they will face during clinical placements. However, further research is needed to evaluate how such training impacts students' actual performance in real-world clinical settings.

6. Ethical approval

Study approval was obtained from the institutional review board of The Hong Kong Polytechnic University (HSEARS20241230007).

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References

Burgess, A., Van Diggele, C., Roberts, C., & Mellis, C. (2020). Key tips for teaching in the clinical setting. *BMC Medical Education*, 20. https://doi.org/10.1186/s12909-020-02283-2

Edgar, S. (2015). Identifying the influence of gender on motivation and engagement levels in student physiotherapists. *Medical Teacher*, 37, 348–353. https://doi.org/10.3109/0142159X.2014.948829

Findyartin, A., Syah, N.A., Susilo, A.P., Nurokhmanti H., Qomariyah, N., Greviana, N., Ainin, D.Q., Sari, S.M., & Claramita M. (2023). Challenges and opportunities in cultivating medical students' competencies: Participatory action research from a hierarchical cultural setting. *Medical Education Online*, 28,2185122. https://doi.org/10.1080/10872981.2023.2185122

Günay, U., & Kılınç, G. (2018). The transfer of theoretical knowledge to clinical practice by nursing students and the difficulties they experience: A qualitative study. *Nurse Education Today*, 65, 81–86. https://doi.org/10.1016/j.nedt.2018.02.031

Hoffmann, T., Lewis, J., & Maher, C. (2019). Shared decision making should be an integral part of physiotherapy practice. *Physiotherapy*, 107, 43–49. https://doi.org/10.1016/J.PHYSIO.2019.08.012

Kirschner, P., Sweller, J., Kirschner, F., & Ramírez, J. (2018). From Cognitive Load Theory to Collaborative Cognitive Load Theory. *International Journal of Computer-Supported Collaborative Learning*, 13, 213–233. https://doi.org/10.1007/s11412-018-9277-y

Mukhalalati, B., Elshami, S., Eljaam, M., Hussain, F., & Bishawi, A. (2022). Applications of social theories of learning in health professions education programs: A scoping review. *Frontiers in Medicine*, 9. https://doi.org/10.3389/fmed.2022.912751

Petty, N., Scholes, J., & Ellis, L. (2011). Master's level study: Learning transitions towards clinical expertise in physiotherapy. *Physiotherapy,* 97(3), 218–225. https://doi.org/10.1016/j.physio.2010.11.002

Pritchard, S., Keating, J., Nestel, D., & Blackstock, F. (2020). Physiotherapy students can be educated to portray realistic patient roles in simulation: A pragmatic observational study. *BMC Medical Education*, 20. https://doi.org/10.1186/s12909-020-02382-0

Sewell, J., Maggio, L., Cate, T., Van Gog, T., Young, J., & O'Sullivan, P. (2018). Cognitive load theory for training health professionals in the workplace: A BEME review of studies among diverse professions: BEME Guide No. 53. *Medical Teacher*, 41, 256–270. https://doi.org/10.1080/0142159X.2018.1505034

Sherwood, R., & Francis, G. (2018). The effect of mannequin fidelity on the achievement of learning outcomes for nursing, midwifery and allied healthcare practitioners: Systematic review and meta-analysis. *Nurse Education Today*, 69, 81–94. https://doi.org/10.1016/j.nedt.2018.06.025

Wyres, M. (2019). Preparing undergraduate physiotherapy students for clinical practice through the use of simulation. *Physiotherapy*. https://doi.org/10.1016/j.physio.2018.11.092

Tagg, J. (2010). The learning-paradigm campus: from single- to double- loop learning. *New directions for teaching and learning*, 123, 51-62.

Wu, Y. F., Qi, L., Liu, Y., Hao, X. Y., & Zang, S. (2021). Development and psychometric testing of a Learning Behaviour Questionnaire among Chinese undergraduate nursing students. *BMJ Open*, 11(6). https://doi.org/ARTN e04371110.1136/bmjopen-2020-043711

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Predictability: Advancing Mental Health Modeling for Students

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Abstract

This study explores the development of a machine learning-based approach to proactively manage student mental health in higher education. Through these advanced analytical techniques, key mental health determinants were identified, integrating demographic, academic, socioeconomic, and behavioral factors. A Random Forest model, optimised via hyperparameter tuning, demonstrated superior predictive performance with an accuracy of 91% effectively classifying at-risk students. The determinants translate these findings into actionable insights, offering educators a comprehensive tool for timely interventions. By bridging technology and mental health management, this research underscores the transformative potential of predictive frameworks in fostering inclusive, supportive academic environments. This work advances the discourse on student mental health, emphasising data-driven strategies for early detection and intervention to improve educational outcomes.

Keywords: *human-environment-interaction; student health service; machine learning models; behavioural healthcare; predictive analytics; student metal health.*

1. Introduction

Human-Environment Interaction (HEI) plays a crucial role in shaping societal progress, cultural dynamics, and ecosystem transformations. In higher education (HE), this interplay is particularly significant, as global challenges - notably the mental health crisis - demand urgent and innovative responses. The COVID-19 pandemic exacerbated these challenges, intensifying stressors such as academic pressure, financial insecurity, and social isolation. These disruptions have significantly impacted students' academic performance, personal development, and career trajectories, underscoring the pressing need for targeted, data-driven interventions.

Mental health, encompassing emotional, psychological, and social well-being, is fundamental to student success (Skrividya, 2018). However, mental health disorders - including anxiety, depression, and stress - remain pervasive and often go unreported. A 2015 National Union of

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Students (NUS) survey found that 78% of UK university students experienced mental health challenges in the past year, with 33% reporting suicidal thoughts (Gil, *The Guardian*, 2015). Alarmingly, 54% of those affected did not seek support. The pandemic further heightened these risks, with over 50% of Northern England students exhibiting clinical levels of anxiety and depression, disproportionately affecting females due to financial instability and strained relationships (Chen & Lucock, 2022). This research explores how machine learning (ML) can transform mental health interventions in HE by identifying, classifying and predicting at-risk students. ML's ability to process complex datasets enables early identification, allowing for timely, personalised interventions. By analysing academic performance, behavioural trends, and socioeconomic factors, this study aims to foster proactive support mechanisms, enhance inclusivity, and normalise mental health disclosure within HE institutions

1.1. Significance of Machine Learning in Addressing Mental Health in Higher Education

Mental health challenges in higher education (HE) remain significantly underreported due to stigma and concerns over data privacy. UCAS (2021) indicates that nearly 70,000 UK students enter university annually with a mental health condition, yet 49% of first-year students choose not to disclose it. This reluctance exacerbates academic attrition rates and limits long-term career prospects. Globally, anxiety disorders affect 18.1% of adults and 25.1% of adolescents, yet only 36.9% seek treatment, largely due to cultural barriers and fear of discrimination (Anxiety and Depression Association of America, 2019). Addressing these challenges requires proactive, data-driven interventions that encourage disclosure and facilitate timely support. Machine learning (ML) presents a transformative solution to the mental health crisis in HE by identifying at-risk students early and enabling targeted interventions. Unlike traditional statistical models, ML excels at processing complex datasets, detecting subtle risk patterns, and providing personalised predictions. Supervised learning techniques, such as Decision Trees (DT) and their ensemble variant, Random Forests (RF), enhance prediction accuracy (Rahma et al., 2022). Support Vector Machines (SVMs) optimise decision boundaries, as demonstrated in predicting suicidal behaviours among French students (Macalli et al., 2021). Meanwhile, Artificial Neural Networks (ANNs) model intricate patterns but require higher computational resources, whereas Logistic Regression (LR) remains effective for binary classifications, such as assessing suicide risk (Navarro et al., 2021). This study integrates diverse ML models to identify mental health risks among UK university students, assessing their predictive accuracy and practical applications. Additionally, it introduces a real-time interactive assessment tool, bridging the gap between predictive insights and institutional action. By leveraging ML, this research not only advances early detection and intervention strategies but also informs policy development, fosters inclusivity, and strengthens institutional support systems, ultimately improving student well-being and resilience.

2. Methods: Predictive Modelling of Student Mental Health in UK Universities

This section outlines our mental health modelling approach, detailing its core components and operational processes. Central to the framework is the integration of data collected through web- and mobile-based questionnaires, which capture diverse indicators of student well-being. These data streams are systematically fed into a machine learning (ML) model, which processes and structures the information into actionable datasets. The outputs are then visualised through a real-time dashboard, providing institutions with dynamic, data-driven insights into emerging mental health trends. This end-to-end system enables timely identification of at-risk individuals, facilitating proactive interventions and fostering a more responsive, preventative approach to mental health management within higher education settings.

2.1. Data Collection, Cleaning, and Preprocessing

Effective machine learning solutions rely on a robust data pipeline tailored to the research problem (Rahman et al., 2023). This study collected data from 1,875 university students across the UK (54.1%), Nigeria (27.5%), Germany (9.9%), and other regions (8.6%) via an electronic questionnaire. The survey, developed from insights gained through five focus groups (n = 24) and document analysis, comprised 70 questions covering internal (e.g., lectures, course structure, timetables) and external (e.g., family background, demographics, personality) factors influencing student mental health. The dataset, exported as a CSV file, contained 70 labelled features for supervised learning classification. Python libraries - including NumPy, Pandas, Matplotlib, and Scikit-learn - were used for data exploration, manipulation, visualization, and machine learning tasks. The cleaning and preprocessing pipeline is structured as follows:

1. **Renaming Features:** All 70 question columns were renamed to concise feature phrases for streamlined processing using Pandas rename method.
2. **Standardising Categorical Data:** Variations in spellings across five categorical records (e.g., "UK" vs. "United Kingdom") were harmonised.
3. **Streamlining Verbose Text:** Ten features with verbose text entries were replaced with concise equivalents for easier handling.
4. **Dropping Irrelevant Columns:** Features deemed non-contributory to predictive modelling (e.g., ‘Consent,’ ‘Referrer Name,’ ‘Timetable preference reasons’) were removed, resulting in 26 dropped columns.
5. **Handling Missing Values:** Features with null values were excluded, leaving the dataset with no apparent missing data (confirmed using Pandas’ *isna* method).

The cleaned data was exported as a CSV file for subsequent preprocessing. This structured process ensured the dataset’s readiness for feature engineering, model training, and evaluation.

2.2. Data Transformation and Encoding

Data transformation and encoding are crucial for ensuring consistency, comparability, and compatibility in machine learning workflows. These processes enhance model performance by standardising numerical features, encoding categorical variables, and managing dimensionality. In this study, numerical features were normalized using the Min-Max Scaling technique, which rescales values to a range of 0 to 1, mitigating dominance of features with larger ranges, ensuring fair comparisons. Categorical variables were systematically encoded to facilitate seamless integration into the machine learning pipeline. Binary variables, such as *mental health issues declaration*, were mapped as 1 ("Yes") and 0 ("No"), while ordinal variables like *year of study*, *quality of life*, *family earning*, and *diet* were encoded based on hierarchical relationships. High-cardinality features, such as *home country* and *course of study*, were processed using binary encoding to preserve information while managing dimensionality. One-hot encoding was applied to variables like *ethnic_group* and *personality_type*, expanding them into binary indicator columns without inflating feature space. Following data transformation, the dataset comprised 54 features, optimised for predictive modelling. These preprocessing steps not only improved model accuracy and robustness but also provided deeper insights into key predictors influencing mental health outcomes.

2.3. Feature Engineering and Selection

Feature selection plays a pivotal role in enhancing the predictive performance thus, by refining features, we can reduce noise, improve interpretability, and optimise computational efficiency.

2.3.1. Consolidation of Features

To streamline analysis, related columns such as *hours spent on Facebook*, *hours spent on Twitter*, and *hours spent on Instagram* were merged into a single feature: *total hours spent on social media.* Similarly*, hours spent on desktop*, *laptop* and *smartphone* were merged as a single feature *Total_device_hours_per_day* to reduce redundancy and maintain information integrity.

2.3.2. Feature Selection Techniques

To identify the most impactful predictors, we applied three complementary feature selection methods: Chi-Square Test, Mutual Information Classification, and Random Forest Classifier to enhance model performance by uncovering key relationships and refining feature priority. Chi-Square Test assesses independence between categorical predictors and the target variable, highlighting relevant features without measuring the strength of association (Singhal et al., 2015). Mutual Information Classification captures both linear and non-linear dependencies, quantifying relationship intensity of between variables (Xu et al., 2007). The Random Forest Classifier ranks feature importance based on predictive contribution, offering a base for feature selection. By integrating these methods, we identified significant predictors while eliminating

less impactful features - below 25th percentile in the RF rankings. This refinement resulted in streamlined dataset enhancing model accuracy, reducing overfitting, and greater generalization.

2.4. Machine Learning Models

The modelling approach was guided by the dataset's characteristics and research objectives. Given the nature of the target variable, *Mental Health State*, the task was framed as a supervised, classification problem. Three ML models - neural networks, random forests, and support vector machines - were evaluated for modelling suitability. Using the *scikit-learn* library, a structured pipeline ensured computational efficiency and reliable outcomes. The dataset was split into training (75%) and testing (25%) sets, with classifiers trained on the former and validated on the latter. Performance was assessed through classification reports and ROC curves, confirming each model's predictive accuracy and interpretability. To enhance model's accuracy and reliability, in predicting mental health risks in HE, hyperparameter tuning was conducted using *GridSearch* (Zoller, 2019). *GridSearchCV* from *scikit-learn* iterated multiple hyper-parameter combinations to identify optimal configuration for RF model (Hutter et al., 2019).

3. Results

By combining advanced analytical methods, this study identified core mental health determinants with significant impact on student wellbeing. These determinants were then used to model a machine learning-based dashboard application, equipping educators with a powerful tool to support student mental health effectively. This approach bridges technology and education, fostering a more responsive and inclusive learning environment.

3.1. Key Mental Health Determinants in Higher Education

Using the three different techniques: Chi-Square test, mutual information classification and random forest classifier, twenty-seven features with significant parameters and weight associated with target variable (mental_health_issues_declaration) were identified (Table 1).

For this work, Chi-square and Mutual Information classification resulted in the identification of eighteen features and Random Forest classifier resulted in the identification of twenty-one feature having the best performance. All three techniques had nine common features.

3.2. Model Evaluation

While a high accuracy score may initially suggest strong model performance, accuracy alone fails to reveal insights into class-specific misclassifications. In this study, the models were evaluated using multiple classification metrics. The ROC Curve for the three models with AUC were computed via the scikit-learn package: 85%, 87% and 91% for SVM, neural network and random forest, respectively as shown in Figure 1.

Table 1. Predictive determinants for Mental Health in HE

No	Predictive Lifestyle Factors	Chi Square	Mutual Information Classification	Random Forest Classifier
1	alcohol_consumption	X	X	X
2	cost_of_study			X
3	course_of_study	X		X
4	diet	X	X	X
5	ethnic_group	X	X	X
6	exercise_per_week	X	X	X
7	family_earning_class		X	X
8	feel_afraid			X
9	financial_support	X	X	
10	form_of_employment	X	X	
11	home_country	X	X	
12	hours_between_lectures	X	X	X
13	hours_per_week_lectures	X		X
14	hours_per_week_university_work	X		X
15	hours_socialising	X	X	X
16	institution_country	X	X	
17	known_disabilities	X		
18	personality_type		X	X
19	quality_of_life	X	X	X
20	social_media_use		X	X
21	stress_before_exams			X
22	stress_in_general		X	X
23	total_device_hours	X	X	X
24	total_social_media_hours	X	X	X
25	well_hydrated		X	X
26	work_hours_per_week	X		
27	year_of_study			X

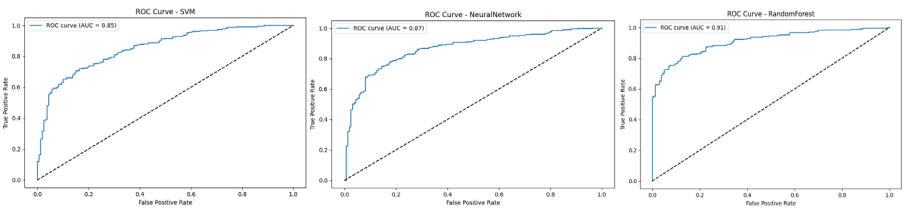


Figure 1. ROC Curve and AUC score for SVM, Neural Network and Random Forest models

Following hyperparameter optimisation performed via GridSearchCV, the random forest model presents the best modelling configuration amongst the three evaluated models. Therefore, the random forest model was adopted for the dashboard application development. By integrating academic performance, attendance, and self-reported surveys into computational models, the dashboard provides educators with actionable insights to foster a supportive learning. Features like filterable views and real-time updates enhance its utility, enabling institutions to address specific needs. By transforming raw data into accessible intelligence, the tool streamlines risk assessment and facilitates timely, targeted mental health interventions, exemplifying the power of machine learning in education.

4. Discussion

This study examined the effectiveness of machine learning models in predicting and classifying student mental health conditions, as well as identifying key risk factors influencing students' emotional well-being. While the number of respondents (1875) was lower than anticipated given the UK student population of 100,000, the dataset was sufficient for effective machine learning analysis. Employing a Random Forest classifier with hyperparameter tuning, the model achieved an accuracy of 91%, demonstrating robust predictive capability. Notably, the model's recall score indicated it correctly identified 75% of students with mental health conditions, while a precision score of 86% confirmed the reliability of positive predictions. The ROC curve further validated the classification strength, underscoring its potential for practical application.

4.1. Risk Factors Influencing Student Mental Health

This study reaffirms the complex interplay of financial, academic, and lifestyle pressures in shaping student mental health. Key predictors include lifestyle habits (diet, exercise, hydration), social engagement (social media use, socialisation hours), demographic attributes (ethnicity, economic class, student type), and situational stressors (anxiety, workload, employment hours). Structural factors, such as tuition costs and field of study, further influence mental well-being, underscoring the interconnected nature of these determinants. Consistent with prior research, these findings highlight the urgent need for universities to adopt systematic mental health interventions. Students facing mental health challenges experience lower retention rates, diminished academic performance, and limited career progression (UCAS, 2021). By integrating machine learning into predictive mental health frameworks, institutions can proactively identify at-risk students and connect them with targeted support. Embedding mental health considerations into university policies, and student services fosters a culture of inclusivity and proactive care. This data-driven approach enhances early intervention, strengthens student retention, and ensures equitable access to support systems. Ultimately, universities that bridge technological innovation with holistic well-being strategies will be better equipped to safeguard student success and create a resilient learning environment.

5. Conclusion, Limitations, and Recommendations for Future Research

The growing prevalence of mental health challenges among students highlights the urgent need for data-driven, predictive solutions. Machine learning models offer transformative potential by analysing diverse risk factors to identify at-risk individuals and enable timely interventions. This study advances predictive mental health modelling by pinpointing key risk indicators, yet several limitations reveal opportunities for refinement. First, the model's reliance on university-centric factors narrows its predictive scope. Excluding external influences such as family history and upbringing which are central determinants of mental health could reduce model's effectiveness. Expanding predictor variables in future research could enhance the model's comprehensiveness. Second, the binary classification system oversimplifies mental health conditions, failing to capture varying levels of severity. A more nuanced, spectrum-based approach distinguishing low, moderate, and high-risk cases would support tailored interventions and improve predictive accuracy. Finally, the study's relatively small dataset (1,875 observations) constrains its generalizability. Larger datasets would not only strengthen the model's reliability but enable more sophisticated machine learning techniques, enhancing predictive precision and scalability. Future research should prioritise broader risk factors, refined classification methods, and larger datasets. These advancements could transform predictive modelling into a powerful tool for proactive mental health interventions, ultimately improving student well-being and institutional support systems.

References

Anxiety and Depression Association of America. (2019). *Facts & Statistics*. Retrieved from https://adaa.org/facts-statistics

Chen, T., & Lucock, M. (2022). The impact of COVID-19 on student mental health in Northern England. *Journal of Mental Health*, 31(2), 123-134.

Gil, N. (2015). University students and mental health: A survey. *The Guardian*. Retrieved from https://theguardian.com

Macalli, M., et al. (2021). Predicting suicidal behaviors using SVMs. *BMC Psychiatry*, 21, 456.

Navarro, K., et al. (2021). Exploring suicide risk among young adults using logistic regression. *Mental Health Review Journal*, 26(3), 250-266.

Rahma, S., et al. (2022). Predicting mental health challenges using random forests. *AI in Healthcare*, 15(4), 345-362.

Skrividya, T. (2018). Mental health and productivity. *Psychological Studies*, 63(1), 45-58.

UCAS. (2021). *Mental health in higher education*. Retrieved from https://ucas.com

Van Vugt, M., Hogan, R., & Kaiser, R. B. (2008). Leadership, followership, and evolution: Some lessons from the past. *American Psychologist*, 63(3), 182-196. https://doi.org/fw5s2b.

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Interpreting Decision Tree model using ELI5 for modelling student performance: Case of a structural analysis graduate attribute-based teaching course

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Abstract

Decision tree is used in this study as a classification machine learning to model year mark, using mainly formative assessments. Binary digits are used to classify the different marks, which illustrate performing versus non-performing students when considering four assessments (e.g. 1 to 4). A structural analysis course is used for the application of the decision tree model and is part of the Advanced Diploma programme of engineering technologists. This new programme is designed and developed on engineering competency known as graduate attributes. The results revealed higher accuracy, precision and F1-score during the testing period. Although decision tree model can be easily interpreted through its tree structure, the interpretability of the model can be enhanced through ELI5, which could reveal the ranking of assessments as influencing factors for the whole dataset (globally) and for each student performance prediction (locally), during testing. Hence, the decision tree algorithm was proven elegantly to be a suitable candidate for modelling the competence level of students and could guide teaching staff on student fate, in an academic environment.

Keywords: *Interpretability, decision tree, modelling, prediction, year mark, assessments.*

1. Introduction

Institutions of higher learning use passrate as an indicator of student performance or competence in each course, whereas the throughput rate measures the degree to which students exit a specific programme. In either case, assessments play a major role. Formative assessments can be instrumental in monitoring the progress of the student by assessing her/him on specific learning outcomes, while summative assessment can be administered to evaluate the student at the close of the course by determining whether the student can move to the next level. Assessment criteria

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are critical to define the parameters that guide students on what different tasks should be covered in assessments. Hence, this should be communicated transparently to students, from the inception of the course. For instance, inappropriate assessment settings and the lack of timely and no-detailed feedback to students may contribute to the low-grade point average (Daka, et al, 2021). For a specific course, the year mark is often an aggregate of the weighted assessments, which is ultimately used for deciding on the student competence in the course. Although the grade of the student can be affected by external factors such as anger, anxiety or tiredness, assessments are acknowledged to play a very important role for achieving learning outcomes (Matzavela & Alepis, 2021). Artificial Intelligence (AI) has been embraced in many real word applications. Within AI in particular, Machine learning (ML) techniques have been used for measuring student performance (Rastrollo-Guerrerom et al., 2020, Hashim et al., 2020). The issue of interpretability or explainability has been the focus in recent years due to the nature of ML, which is perceived as a black box. Attempts have been made on utilising eXplainable AI (XAI) tools to carry out model interpretability and feature importance for student performance (Wang & Luo, 2024; Islam et al., 2024). However, the literature on student performance based solely on assessments by using interpretability techniques is very rare. This current research deals preliminarily with decision tree model as a popular algorithm to establish a relationship between assessments and year mark, which can be binarised to capture the two categories "pass" or "fail". Moreover, ELI5 (Explain like I am a 5-year-old) is used as an enhancing aspect in the interpretability of student performance outcome from the decision tree. ELI5 fits most algorithms (Matzavela & Alepis, 2021), particularly optimising sparse logical models such as decision trees (Rudin et al., 2022), by presenting trustworthy, accountable and interpretable ML algorithms. This study focuses primarily on assessments of a specific course as inputs to ML since they are the only factors that contribute to the year mark of the student and ultimately, they are the only barometric variables to decide on student competence. The teaching module is assessed based on graduate attributes (GA) to decide on the student competence, particularly for new engineering technology programmes that have been introduced four years ago in the South African education. There should be a distinction between the weight of each assessment towards 100 % of the year mark and the weight derived from the interpretability of the decision tree algorithm, through ELI5. In what follows, course will mean teaching module. Algorithm, model, and technique will have synonymous meaning.

2. Decision Tree classifier

2.1. Fundamentals of a decision tree model

A decision tree algorithm deals with both supervised classification and regression problems for ML. For classification problems, decision tree uses a structural tree, where each attribute is represented by a node and the value of the attribute is represented by its branch, while the class

is represented by the leaf (Sulistiani & Aldino, 2020). The root constitutes the top node of this decision tree. Figure 1 illustrates a simple structure of decision tree.

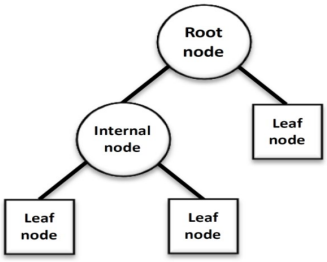


Figure 1. Simple form of decision tree model. Source: https://www.researchgate.net/figure/Basic-structure-of-a-decision-tree-All-decision-trees-are-built-through-recursion_fig3_295860754

A dependent variable is depicted by each leaf node for classification problems. The decision tree algorithm operates recursively, enabling the dataset to be partitioned into subsets, using the independent variable. For each iteration, the independent variable is selected if it has split the dataset into homogeneous subsets (in terms of the dependent variable). Conditions are set for the operations to be carried out. Usually, these conditions are for example maximum depth, or minimum number of samples for a given node. Entropy shows the purity of a subset of a system and helps to measure the split. It is given by the following expression

$$H = \sum_{i=1}^{n} p_i Log(p_i) \quad (1)$$

Where p_i: proportion of labels present in the subset and n: number of dependent variables the subset. The splitting process is associated with information gain and the parent node gives birth to a child node. In this way, child nodes whose information gain is maximised are searched by the decision tree. The information gain is given by

$$\mathrm{G} = \mathrm{H_P} - \sum_{\mathrm{i=1}}^{\mathrm{q}} \beta_{\mathrm{i}}(\mathrm{Hc_i}) \quad (2)$$

Where H_P: entropy for the parent node; β_j: fraction of points in the child node concerning points in the parent node, q: number of child nodes and Hc_i: entropy for each child node.

The Gini index called the Gini impurity, which should be low for a better split, is given by Equation (3) below.

$$\mathrm{Gini} = 1 - \sum_{\mathrm{i=1}}^{\mathrm{q}} (p_i)^2 \quad (3)$$

2.2. Metrics for model performance assessment

The model performance of the classification can be done both for training and testing parts. Most importantly, the interest is more on the testing part to measure the prediction capability of the ML algorithm. Therefore, the usual metrics to assess the model performance for classification

problems are accuracy, recall, precision and f1-score (e.g. Ouedraogo, 2021; Prabaswara et al., 2023). These metrics are derived from the confusion matrix,

$$Confusion\ matrix = \begin{bmatrix} TN & FP \\ FN & TP \end{bmatrix} \quad (4)$$

Where TP: True Positive assignments associated with positive classes which are correctly predicted; TN: True Negative assignments associated with negative classes which are correctly predicted, FP: False Positive assignments associated with positive classes which are incorrectly predicted; and FN: False negatives associated with negative classes which are incorrectly predicted. Therefore, the performance metrics are given by the following equations:

$$Accuracy = \frac{TP+TN}{TP+FP+TN+FN} \quad (5)$$

$$Recall = \frac{TP}{TP+FP} \quad (6)$$

$$Precision = \frac{TP}{TP+FN} \quad (7)$$

$$F1-score = 2\ \frac{Precision \times Recall}{Precision + Recal} \quad (8)$$

In the above equations, the values of TP, TN should be far higher than FP and FN for good model performance, which is associated with high values of these metrics. It should be noted that F1-score in Equation (8) also called balanced F-score, is defined by the harmonic mean value derived from the Precision and the Recall.

2.3. Interpretability and explainability of machine learning

The black box nature of ML has been attributed to the lack of understanding how ML arrives at its conclusion during modelling process (Ouedraogo, 2021). Interpretation capability of ML may ensure unbiasedness during modelling process; by providing trust and transparency, thus reducing model complexity (Ouedraogo, 2021). Trust is not necessarily created by using explainable models; however, it is possible that distrust could be possible, hence they enable the model users to make a decision of trust or not (Rudin et al., 2022). When the inner operations of systems are intelligible, interpretable systems are said to be explainable, hence understandable by a human (Yildirim et al., 2024). In the literature, interpretable machine learning seems to be popular, therefore this study will use quite often interpretability as opposed to explainability. Generally, interpretability and explainability of ML fall under the category of the eXplainable AI (XAI) field, which is widely recognised to be very important for the AI models deployment (Arrieta et al., 2020). There are various interpretable models; for example, the ELI5 XAI was used in conjunction with LIME (Local Interpretable Model agnostic Explanations) and SHAP (SHapley Additive exPlanations) algorithmic frameworks (Vishwarupe et al., 2022). It is reiterated that this preliminary study focuses on ELI5 since it is

one of the simplest and popular interpretability metrics. ELI5 can be used as local based explanation method, with the characteristics of approximating a complex model locally to a linear model, where the output is close to a regression model, which includes coefficients and bias (Ouedraogo, 2021). ELI5 as other methods can fit to both global interpretation where model's parameters are observed for the purpose of pointing out how the model works at global and local interpretation, where features leading to a specific single prediction are identified (Huilgol, 2020). In applications other than student performance, it is noted that decision tree model has been interpreted with ELI5 (Kawakura et al., 2022; Shivaprasad et al., 2024).

3. Data availability and methods

3.1. Data availability

Structural Analysis 3 course is taught at Advanced Diploma level. The course constitutes 120 notional hours, which is equivalent to 12 credits. This module is offered by the Department of Civil and Environmental Engineering, and Building Science, at the University of South Africa. Graduate attribute 1 covers essentially aspects to develop student's capability for identifying, formulating, analysing and solving broadly defined engineering problems. For a student to be declared competent in this specific GA, the student should score at least 50% for the year mark. Additionally, the student should achieve at least 50% for assessment 2, which is a project assignment in the form of a portfolio. Besides, assessments 1, 3 and 4 were considered. All assessments counted 30% each, except assessment 1, which weighed 10%. The number of attributes used in the ML were 146 for the year 2023 semester 2 and were complete, hence did not contain missing values.

3.2. Methods

The attributes were composed of independent variables (features) and the dependent variable namely (label). These attributes were used in the model training and testing of the decision tree. Independent variables were the four assessments, and the dependent variable (year mark) was translated in a binary class. The binary digit was a conversion of a "fail" or "pass" final score used for student performance in the module under investigation. This conversion enabled easy learning of the model. The dataset was split into the ratio 8:2 for training and testing respectively. The decision tree algorithm was implemented elegantly using scikit-learn library in Python. Google Collaboratory programming environment was used to implement the algorithm. Hence, the DecisionTreeClassifier() function was used during training. The randomised state was set to 42 to ensure the results were reproducible. The performance metrics were then used to evaluate the model. The model interpretation was globally and locally done by using the

following code: eli.explain_weights(classifier_dtc) and eli.show_prediction(classifier_dtc, X_test.iloc[1], feature_names=list(X.columns), show_feature_values=True)

4. Results and discussion

Figure 2 below shows the degree of association among the features, which was assessed to avoid any duplication of information for strongly correlated features. The features were noted as Ass1, 2, 3 and 4 to describe assessments 1, 2, 3 and 4 respectively. Generally, the correlation values were shown relatively weak. Hence, none of the features could be left out.

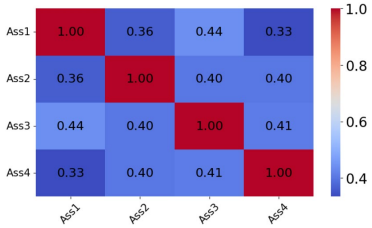


Figure 2. Pearson correlation values between assignment and year mark.

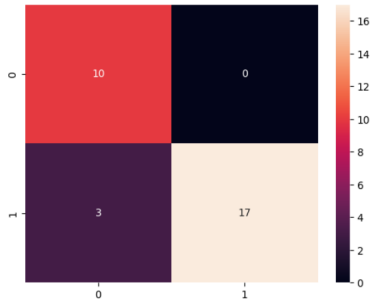


Figure 3. Confusion matrix emanating from the student performance in the structural analysis graduate attribute-based module.

From the confusion matric displayed in Figure 3, FN and FP were 3 and 0 respectively whereas the TN and TP were 10 and 17 respectively. The sum of TP and TN outweighs the sum of their counterparts FN and FP. Hence, the model was believed to perform well. However, the prediction of TP dominated. This could justify the use of decision tree model in predicting student performance from assessments. The Accuracy, Precision, Recall and F1-score of the model for structural analysis course were 0.9, 0.92, 0.90 and 0.9 respectively. Thus, the model demonstrated good performance in identifying performing students versus non-performing students, as shown in Figure 4. In the tree model Ass1, 2, 3 and 4 are equivalent to x0, x1, x2 and x3 respectively. In this figure, the decision model with its root at the top, is depicted with all nodes, leaves and branches and shows transparently the decision rule during the splitting process. If a mark for Ass2(x1) < 46.5 is true, the splitting process is good at 9.5% with a high

degree of purity and the 90.5% undergoes a check on Ass3 = x2 and so on. Hyperparameter tuning led to a maximum depth of 5 for the model performance.

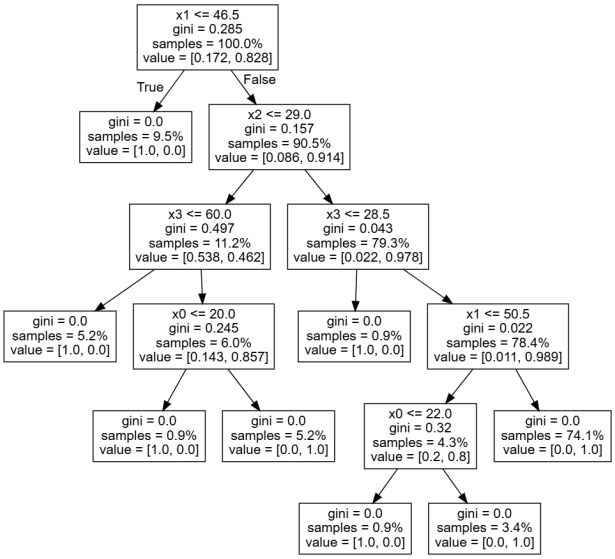


Figure 4. Decision tree model for the structural graduate attribute-based course.

Figure 5 displays the permutation importance by visualising feature weights in the decision tree model and their level of contribution as a way of global interpretability derived from ELI5 library. In the descending order, the feature importance visualization is Ass2 = x1, Ass4 = x3, Ass3 = x2 and Ass1 = x0. Therefore, academics should pay attention primarily to the project, and the 2 tests. These assessments have 30% in weight for contribution to the year mark. Furthermore, model inspection on the prediction level is supported, which uses similar visualization with weights adding up to either probability of a class in classification models or predicted value in case of regression models (Gashi et al., 2022). In Figure 6, ELI5 shows only the prediction of the first record in the training dataset (local interpretability). Hence, using this interpretability technique, the top prediction can be easily explained and a good fashion of visualising the feature impacts plus a bias term is displayed. The gradient of green and red color indicates the positive and negative impact on the model decisions and no interactive options exist (Gashi et al, 2022). For the local level at the first two features, Ass1 and Ass3 have a strong impact on the first student (record). ELI5 is not a fully flagged model-agnostic explanations technique, but it is seen as an enhancer of the tree-based model. This situation may improve trust in the final score computation and decision-making about the student's competence in a specific course. This is of great importance in the educational system that requires transparency and insights into prediction results to set effective strategic measures (Tong & Li, 2025).

Weight	Feature
0.5143	x1
0.2019	x3
0.1837	x2
0.1001	x0

Figure 5. Global interpretability for the structural graduate attribute-based course.

y=0 (probability **1.000**) top features

Contribution[?]	Feature	Value
+0.857	Ass1	12.000
+0.453	Ass3	0.000
+0.172	<BIAS>	1.000
-0.087	Ass2	71.000
-0.396	Ass4	87.000

Figure 6. Local interpretability for the structural graduate attribute-based course.

5. Conclusion

The decision tree machine learning has been evaluated preliminarily and showed good accuracy for students' performance, based on graded continuous assessment tasks. The ML learning hereto referred has demonstrated its capability to predict student competence for a structural analysis module taught in engineering. Although the model displayed the complex characteristic of the relationship between the independent variables and the dependent variable in the form of a binary class, the use of ELI5 XAI technique enabled local interpretability, by clarifying transparency the prediction of the final score of each student. It also displayed the impacts of each assessment on the overall model performance, hence helped for global interpretability. The versatility of the decision tree method to deal with various problems, including student performance problems, does not mean an end on its own, but requires accountability and transparency in the modeling outputs. This preliminary study has demonstrated that course leaders, may enhance their decision on student performance, by focusing on assessments that may contribute impactfully on the students' fate. In this way ML can be applied in strengthening best practices of teaching and learning to assist struggling students, who are not successful in the graduate attribute assessed courses. Thus, compelling attention could be drawn to the students who were declared not competent. These preliminary results present some limitations due to the dataset size and ELI5 has been applied as a monolithic interpretability method. A re-evaluation of the decision tree model could be done as the dataset increases over time. It is suggested that future research could include more ML algorithms other that decision tree. Hence, interpretability methods other than ELI5 could be explored.

References

Arrieta, A. B., Díaz-Rodríguez, N., Del Ser, J., Bennetot, A., Tabik, S., Barbado, A., ... & Herrera, F. (2020). Explainable Artificial Intelligence (XAI): Concepts, taxonomies,

opportunities and challenges toward responsible AI. *Information fusion*, *58*, 82-115. https://doi.org/10.1016/j.inffus.2019.12.012

Daka, H., Mulenga-Hagane, M. L., Mukalula-Kalumbi, M., & Lisulo, S. (2021). Making summative assessment effective. *European Modern Studies Journal*, *5*(4), 224-237.

Gashi, M., Vuković, M., Jekic, N., Thalmann, S., Holzinger, A., Jean-Quartier, C., & Jeanquartier, F. (2022). State-of-the-art explainability methods with focus on visual analytics showcased by glioma classification. *BioMedInformatics*, *2*(1), 139-158. https://doi.org/10.3390/biomedinformatics2010009

Islam, M. R., Nitu, A. M., Marjan, M. A., Uddin, M. P., Afjal, M. I., & Mamun, M. A. A. (2024). Enhancing tertiary students' programming skills with an explainable Educational Data Mining approach. *PloS one*, *19*(9), e0307536. https://doi.org/ 10.1371/journal.pone.0307536

Hashim, A.S. Awadh, W.A. & Hamoud, A. K. (2020) Student performance prediction model based on supervised machine learning algorithms. *In IOP conference series: materials science and engineer*ing 928(3), p. 032019). IOP Publishing.

Huilgol, P. (2020). 6 Python Libraries to Interpret Machine Learning Models and Build Trust https://www.analyticsvidhya.com/blog/2020/03/6-python-libraries-interpret-machine-learning-models/

Kawakura, S., Hirafuji, M., Ninomiya, S., & Shibasaki, R. (2022). Adaptations of explainable artificial intelligence (XAI) to agricultural data models with ELI5, PDPbox, and skater using diverse agricultural worker data. *European Journal of Artificial Intelligence and Machine Learning*, *1*(3), 27-34

Matzavela, V., & Alepis, E. (2021). Decision tree learning through a predictive model for student academic performance in intelligent m-learning environments. *Computers and Education: Artificial Intelligence*, *2*, 100035.

Ouedraogo, D. N. (2021). Interpretable Machine Learning Model Selection for Breast Cancer Diagnosis Based on K-means Clustering. *Applied Medical Informatics*, *43*(3), 91-102.

Prabaswara, R., Lemantara, J., & Jusak, J. (2023). Classification of Secondary School Destination for Inclusive Students using Decision Tree Algorithm. *Jurnal RESTI (Rekayasa Sistem dan Teknologi Informasi)*, *7*(5), 1009-1018. https://doi.org/10.29207/resti.v7i5.5081

Rastrollo-Guerrero, J.L., Gómez-Pulido, J.A. & Durán-Domínguez, A. (2020). Analyzing and predicting students' performance by means of machine learning: A review, *Applied Sciences*, *10*(3), 1042. doi:10.3390/app10031042

Rudin, C., Chen, C., Chen, Z., Huang, H., Semenova, L., & Zhong, C. (2022). Interpretable machine learning: Fundamental principles and 10 grand challenges. *Statistic Surveys*, *16*, 1-85. https://doi.org/10.1214/21-SS133.

Shivaprasad, S., Chadaga, K., Dias, C. C., Sampathila, N., & Prabhu, S. (2024). An interpretable schizophrenia diagnosis framework using machine learning and explainable artificial intelligence. *Systems Science & Control Engineering*, *12*(1). https://doi.org/10.1080/21642583.2024.2364033

Sulistiani, H.; Aldino, A.A. (2020). Decision tree c4.5 algorithm for tuition aid grant program classification (case study: department of information system, universitas teknokrat Indonesia). Jurnal Ilmiah Edutic/Vol.7, No.1, November 2020, 40-50. doi:10.21107/edutic.v7i1.8849

Tong, T., & Li, Z. (2025). Predicting learning achievement using ensemble learning with result explanation. *PloS one*, *20*(1), e0312124. https://doi.org/10.1371/journal.pone.0312124

Vishwarupe, V., Joshi, P. M., Mathias, N., Maheshwari, S., Mhaisalkar, S., & Pawar, V. (2022). Explainable AI and interpretable machine learning: A case study in perspective. *Procedia Computer Science*, *204*, 869-876. 10.1016/j.procs.2022.08.105

Wang, S., & Luo, B. (2024). Academic achievement prediction in higher education through interpretable modeling. *Plos one*, *19*(9), e0309838. https://doi.org/10.1371/journal.pone.0309838

Yildirim, M., Okay, F. Y., & Özdemir, S. (2024). A comparative analysis on the reliability of interpretable machine learning. *Pamukkale Üniversitesi Mühendislik Bilimleri Dergisi*, *30*(4), 494-508. doi: 10.5505/pajes.2023.49473

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Scalable Modeling for a Shirt Supply Chain

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Abstract

Scalable Modeling is a 1:32 scale physical representation of a supply chain that integrates key logistics operations and links. For pedagogical purposes, it was linked to shirts and implemented in a course for two groups of fourth-semester Industrial Engineering students. The objective was to enhance their competency in quality, productivity and optimization methodologies, ensuring they develop a deeper understanding of supply chain dynamics. The implementation focused on three key learning objectives. Increasing motivation, improving learning, and developing competency. A qualitative approach was adopted utilizing surveys, questionnaires, and grade analysis to assess the impact of the activity. While no statistically significant differences were found between groups, students exhibited greater motivation, improved comprehension and enhanced mastery of key concepts. This initiative reinforced experiential learning, allowing students to engage with real-world supply chain scenarios, strengthening both their analytical skills and practical application of methodologies.

Keywords: *Scalable Modeling, Supply Chain, educative innovation, Optimization, Experiential Learning and Mastery.*

1. Introduction

University teaching practices aim to connect students with their professional fields. However, Industrial Engineering education requires urgent improvements to foster participation and collaboration in modeling real-life scenarios relevant to their careers. Given the limited time to master key topics—such as optimization, operations management, logistics, and supply chain management—enhancing student learning experiences is crucial for developing competitive advantages. A key approach is making learning experiences authentic, closely mirroring real-world challenges. Scaled modeling provides a quick and effective understanding of key relationships, particularly in supply chains.

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In the scale physical representation of a supply chain is possible to observe its links or workstations with elements to execute operations. An approximate description is as follows. In the supplier station there are pallets, forklifts, wood and metal blocks to represent the load of products and cargo trucks. Trucks are moved using a conveyor belt. For storing, there is a set of shelves. For order preparation there is a wrapping machine. For the distribution and redistribution processes, the students can use a whiteboard to record information, and origami is used for manufacturing shirts. Figure 1 shows some pictures of the operations of the supply chain. Our innovation is divided in the main links in aimed to improve student mastery of the competency: "*Enhancing the competitiveness of key systems and processes in organizations through quality, productivity, and optimization methodologies*". This competency is part of the fourth-semester course "*Process Improvement in Organizations*" at TEC de Monterrey Campus CEM (March 2024). The objectives of the innovation were: (1) evaluate increased student motivation in operations management through scaled modeling, (2) assess improvements in learning, and (3) determine its contribution to competency development. A qualitative methodology was used, emphasizing a human-centered and contextualized approach. The process included diagnostics, objective formulation, activity design, implementation and result analysis. Findings confirmed the achievement of objectives, with students reaching the highest level of competency. The paper presents the theoretical framework, methodology, development, results, and concludes with key insights and future perspectives.



Figure 1. Some operations in the shirt supply chain – scale representation -

2. Theoretical framework

According to Gándara (2022), authentic learning activities must include relevant and meaningful tasks that motivate students and spark interest. Scalable modeling and game-based teaching are essential tools in Industrial Engineering education, enabling students to engage in complex, realistic situations through active learning. These methods provide a safe environment for experimentation, fostering autonomy, problem-solving and the practical application of theoretical concepts. Naumann *et al.* (2018) define scalable modeling as creating simplified representations of complex systems that can be expanded or reduced with minimal effort and risk. It allows inferences about system behavior while optimizing resources before real-world implementation. However, its use in universities remains limited, mainly for testing, simulations and prototyping (Chung *et al.,* 2024).

Game-based learning promotes exploration, discovery and engagement, enhancing knowledge retention and key skills such as critical thinking, decision-making, and teamwork (Huotari & Hamari, 2017). Kapp (2012) highlights how games create a learning environment where students can experiment with different approaches and consequences, fostering informed decision-making. Similarly, Sitzmann (2011) found that games improve cognitive, motor and social skills, enhancing competency development. Developing an innovation project using game-based teaching and scalable modeling in Industrial Engineering provides significant benefits. Games are intrinsically motivating, engaging, and challenging (Skibski *et al.,* 2022). They also help the students develop essential skills for real-world challenges (Nieveen *et al.,* 2024). Emphasizing these methods promotes active, practical learning, leading to higher student engagement and stronger professional competencies.

3. Methodology and development

The methodological approach was qualitative, consisting of five stages: diagnosis, objective formulation, activity design, implementation and result analysis. The diagnosis identified the need for methodologies connecting students to real-world contexts, as traditional methods hindered topic comprehension. Objectives were based on key reflections: How can student motivation and learning be enhanced? How does innovation improve learning? How can outcomes be evaluated? Assessment tools included a questionnaire, a survey (20 perception questions on motivation and learning) and an evaluation rubric. The questionnaire introduced supply chain links, an origami shirt-making video, and questions on competency achievement, positive aspects and improvement opportunities. Student engagement was evaluated through participation, interest, interaction, and reduced distractions. Key questions included: Did participation increase? Did students show more interest and ask more questions? Was there greater collaboration? Positive student feedback confirmed the effectiveness of innovation.

The questions of the survey were: Q_1) Do you think this activity makes learning more interesting or motivating? Q_2) Do you feel more engaged or active in your learning process? Q_3) Does the activity adapt to your individual needs as a student? Q_4) Does the activity encourage more participation than a traditional one? Q_5) Do you think this activity helped you enjoy the learning process more? Q_6) Did you notice a stronger connection with your classmates during the activity? Q_7) Do you feel that this activity gave you more confidence to participate in class? Q_8) Did this activity inspire you to better appreciate the importance of your training as an Industrial Engineer? Q_9) Do you feel more motivated to learn with this method compared to traditional ones? Q_{10}) Do you find this approach more appealing for learning? Q_{11}) Do you feel that this activity can improve your problem-solving skills compared to traditional lectures? Q_{12}) Does the implementation of this activity enhance your learning ability? Q_{13}) Can you transfer the knowledge acquired to practical or real-life situations more easily? Q_{14}) Does this activity allow you to explore topics of interest more deeply compared to traditional lectures? Q_{15}) Is it easier

for you to understand the situation being scaled for a real-life supply chain? Q_{16}) Did this activity help you understand the concepts of this module more easily? Q_{17}) Do you think this activity helped clarify your doubts? Q_{18}) Did the activity make the topics seem easier to learn? Q_{19}) Do you think you learned faster with this methodology compared to traditional methods? Q_{20}) Did the activity allow you to express your doubts and receive clear answers more quickly?

The competency has two sub-competencies (S_1 and S_2), which were evaluated using a mastery scale with four hierarchical levels (55, 75, 88 and 100 points). In S_1, the student analyzes key factors influencing competitiveness within the context of an organization. This includes identifying fundamental aspects of quality, productivity and optimization, understanding performance indicators, and viewing the organization as a system. In S_2, the student designs improvement solutions for organizational processes by selecting appropriate industrial engineering methodologies and tools. This involves proposing solutions to enhance productivity and quality, evaluating their impact on indicators and assessing the strengths and limitations of these methodologies. The responses were recorded, contributing to the rubric and validating the results. Student Evaluations of Teaching "SET" provided further insights into the impact of innovation. The implementation involved two groups (Group 1: 23 students and Group 2: 27 students) in a 90-minute Industrial Engineering lab session. Students received instructions, completed the activity and provided feedback, which was highly positive. Data analysis was conducted using Microsoft Excel and Minitab software.

4. Results

The results are illustrated according to the achievement of objectives collectively in each of the groups. For the first two objectives, the percentage of positive perception per question was determined by counting the number of times students recognized an increase in motivation and the advantages at implementing the activity. Subsequently, it was assessed whether there were significant differences in responses between groups through a hypothesis test for proportions (p) for two samples with a confidence level of 95% ($\alpha = 0.05$), defining the null hypothesis as the difference being zero (H_0: $p_1 - p_2 = 0$) and the alternative hypothesis as them being different from zero (H_a: $p_1 - p_2 \neq 0$). Additionally, it was verified whether the difference obtained per question was included in the confidence interval. Figure 2 presents a table with the proportions per question per group, the difference between proportions ($p_1 - p_2$), the confidence interval (CI), and the p-value for the hypothesis test at not rejecting H_0. Additionally, a comparative bar graph of the proportions of the two groups is illustrated.

Concerning the first objective, it is evident that the percentages of positive perception reached 100% in both groups for questions Q_1 and Q_4. For the rest of the questions, both groups scored above 90%, except for Q_6 with 87.5% and 85.2% respectively. While these percentages could be considered favorable, they indicate that future practices should focus on improving student

communication. At analyzing columns Difference, CI and p-value, in Q_1 and Q_4, there is no difference between groups, and thus, the recorded asterisk validates them. For the remaining questions, the differences in proportions are not significant, considering the confidence interval and p-value. Regarding the CI, the difference belongs to it. For instance, in Q_2, the difference is -0.03241, which is included within (-0.094674, 0.159489). Related to the p-value, none is lower than 0.05, leading to the conclusion that there is no evidence to reject H_0. For example, for Q_2 (p-value= 0.617). It might be considered that the difference is different from zero for Q_5, Q_7, Q_8, and Q_{10}. However, this suspicion was rejected despite a p-value of 0.142 for Q_7 and Q_{10}. This finding supports the implementation of practices to improve communication, which would boost student confidence and engagement.

Question	Proportion		Difference	CI	p-value
	Group 1	Group 2			
Q_1	1.000	1.000	0.000	*	*
Q_2	0.958	0.926	0.032	(-0.094674, 0.159489)	0.617
Q_3	0.917	0.926	-0.009	(-0.157533, 0.139015)	0.903
Q_4	1.000	1.000	0.000	*	*
Q_5	0.958	1.000	-0.042	(-0.121612, 0.038279)	0.307
Q_6	0.875	0.852	0.023	(-0.165165, 0.211462)	0.810
Q_7	1.000	0.926	0.074	(-0.024710, 0.172858)	0.142
Q_8	0.917	0.963	-0.046	(-0.177830, 0.085238)	0.490
Q_9	1.000	0.963	0.037	(-0.034197, 0.108271)	0.308
Q_{10}	1.000	0.926	0.074	(-0.024710, 0.172858)	0.142
Q_{11}	1.000	0.889	0.111	(-0.007430, 0.229652)	0.066
Q_{12}	0.958	0.926	0.032	(-0.094674, 0.159489)	0.617
Q_{13}	0.917	0.926	-0.009	(-0.157533, 0.139015)	0.903
Q_{14}	1.000	0.963	0.037	(-0.034197, 0.108271)	0.308
Q_{15}	1.000	0.926	0.074	(-0.024710, 0.172858)	0.142
Q_{16}	0.958	0.889	0.069	(-0.073536, 0.212424)	0.341
Q_{17}	0.875	1.000	-0.125	(-0.257313, 0.007313)	0.064
Q_{18}	0.875	0.852	0.023	(-0.165165, 0.211462)	0.810
Q_{19}	0.917	0.926	-0.009	(-0.157533, 0.139015)	0.903
Q_{20}	0.958	0.963	-0.005	(-0.111707, 0.102448)	0.932

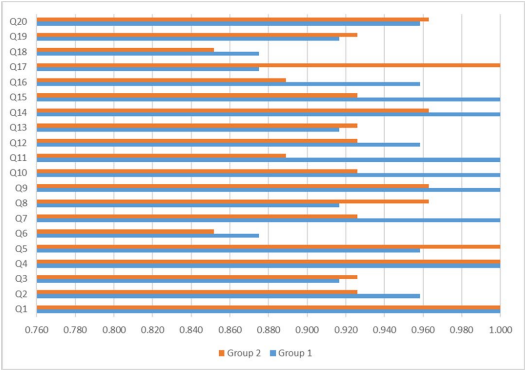


Figure 2. Results for Positive perception in motivation and learning

To validate the achievement of Objective 2 and considering the same Figure, it is observed that for most questions, the percentage of positive perception exceeds 90%. However, for three questions, it falls between 85% and 90%. This occurs in Q_{16} for Group 2, Q_{17} for Group 1, and Q_{18} for both groups. This finding highlights the need to refine the instruction text and provide additional explanations to facilitate learning. Analyzing both groups in the table (Figure 2), it can be stated that there are no significant differences in responses between groups. However, questions Q_{11}, Q15 and Q_{17} suggest the need to develop strategies adaptable to different student group sizes and skill diversity, as their p-values are closest to 0.05 (0.066, 0.142 and 0.064, respectively). The evaluation questionnaire provided insights into Objectives 1 and 2, with students highlighting the activity's engaging, didactic, and real-world relevance. They valued their own role in knowledge retention, concept reinforcement, and motivation to learn. Improvement opportunities included group size, laboratory infrastructure, environmental conditions, supply chain component quality and execution training. The impact of the activity was evident in SET comments. Group 1 emphasized improved learning, lab usage, and professional development. While, Group 2 highlighted the experience of new practices, particularly in the Supply Chain Simulation of shirt production.

For Objective 3, the student responses allowed to determine the highest level of mastery achieved. Regarding S_1, students identified key aspects such as defining a production line, recognizing bottlenecks, and proposing mitigation strategies. They also acknowledged the importance of communication, teamwork, and collaboration for process success, as well as strategies for supply chain synchronization, quality assurance, operator training and preventive maintenance. Additionally, students developed strategies to optimize logistics operations, including storage within distribution vehicles and pallet combinations for transportation, all while recognizing the value for the final customer. For S_2, the students demonstrated an understanding of pull and push approaches to supply chain management, resource calculation based on capacity and its alteration considering efficiency and workforce numbers.

Based on the findings above, it is possible to approximate the fulfillment of the objective by validating whether innovation led students to achieve average scores approaching the highest mastery level—specifically, statistically validating that the final grade average exceeds 88 points with a normal distribution model at a 95% confidence level (α=0.05). For this purpose, the analysis considered the grade frequency histogram, the Anderson-Darling normality test (AD), the box plot, the confidence interval, and the hypothesis test for the mean. It can be seen in Figure 3 for both groups. Figure 3(a) presents the results report for Group 1. In this figure, the normal distribution curve is modeled over the grade frequency histogram, with a mean of 93.603 and a CI of (92.633, 94.573). The box plot reveals a higher concentration of grades to the right of the mean. Regarding the AD (p-value= 0.502), which suggests that the grades follow a normal distribution. Additionally, the hypothesis test highlighted in the rectangle at the bottom right (p-value = 0.00) confirms that the mean grade is greater than 88. In Figure 3(b) illustrates the results report for Group 2. The normal distribution curve is modeled over the grade frequency histogram, with a mean of 91.558 and a CI (89.664, 93.452). The box plot shows a higher concentration of grades to the left of the mean. The p-value in the AD is 0.12, supporting the assumption of normality and confirming that the mean is greater than 88. The analyses derived validated both the normality and the mean scores exceeding 88 points. Next, the statistical significance of the difference between the mean grades of both groups was evaluated through a hypothesis test with $\alpha = 0.05$ (see Figure 4).

At the top of Figure 4, it is observed that in the test the difference of means equal variances were not assumed, resulting in a p-value of 0.055. Consequently, there is no sufficient evidence to conclude that the means are different (as the null hypothesis was not rejected). However, the proximity to 0.05 suggests the need for strategies that accommodate different group sizes and the diversity skill levels. Additionally, the difference of 2.04 is included in (-0.05, 4.14). In the bottom right of the same Figure, the diagram of individual observations reveals greater dispersion in Group 2, while the box plot on the right highlights the concentration of observations and the gap between the means. The illustrated results demonstrated the achievement of the objectives. Moreover, their analysis provides opportunities to enhance

student learning through continuous improvement and encourages teachers to reflect on their role in considering modern educational scenarios.

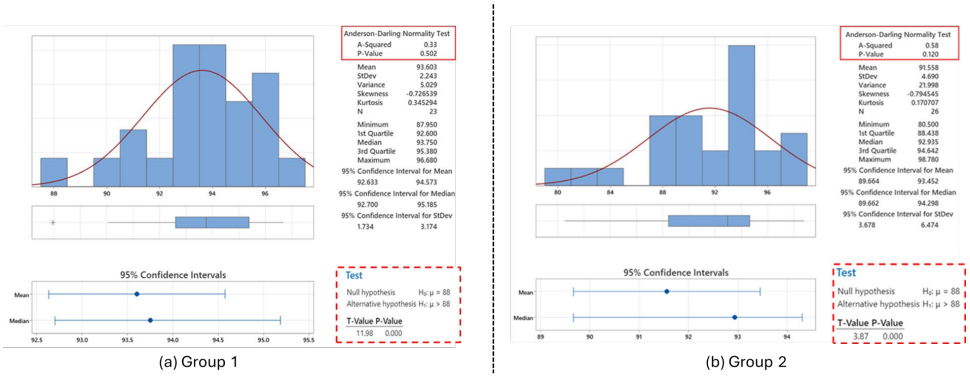


Figure 3. Final grade report for the groups

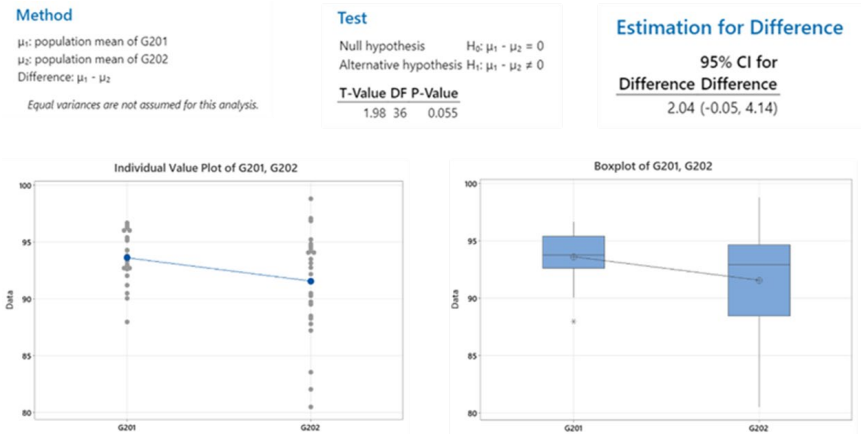


Figure 4. Report on the difference of means in the final grade between Groups 1 and 2

5. Conclusions and perspectives

This document presents the educational innovation Scalable Modeling for a Shirt Supply Chain, implemented in Improvement of an Organizational Process as part of the Industrial and Systems Engineering curriculum at TEC de Monterrey (2024). The objective was to enhance students' proficiency in the competency: “Improves the competitiveness of key systems and processes in organizations through quality, productivity, and optimization methodologies”. The innovation focused on increasing student motivation, improving learning through scalable supply chain modeling and assessing its contribution to competency development. Results confirmed that

students achieved the highest proficiency level. The methodology positively influenced motivation and learning, helping students develop skills for a globalized industrial landscape. The findings highlighted opportunities for improving instruction, fostering teamwork, utilizing laboratories, and designing activities aligned with industry trends such as additive manufacturing and virtual reality. In fact, the results contributed to develop the educative innovation ID 844307 “Digital Twins” recorded in the registration-I belonging to the TEC de Monterrey.

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The authors gratefully acknowledge the insightful feedback provided by the referees, which contributed substantially to the improvement of the research outcomes. Financial support from the Writing Lab, the Institute for the Future of Education, and the Department of Industrial and Systems Engineering at the State of Mexico Campus (Tecnológico de Monterrey, Mexico) is also duly recognized and appreciated for facilitating the development of this work.

References

Chung, S. W., Choi, Y., Roy, P., Moore, T., Roy, T., Lin, T.Y. & Baker, S. E. (2024). Train Small, model big: Scalable physics simulators via reduced order modeling and domain de composition. Computer Methods in Applied Mechanics and Engineering, 427, 117041. https://doi.org/10.1016/j.cma.2024.117041.

Huotari, K., & Hamari, J. (2017). A definition for gamification: anchoring gamification in the service marketing literature. Electronic markets *27*(1), 21-31. DOI 10.1007/s12525-015-0212-z

Gándara, D. G. (2022). Actividades de evaluación auténtica para una evaluación psicopedagógica inclusiva. EDUCA. Revista Internacional para la calidad educativa, 2(1), 46-62. https://revistaeduca.org/index.php/educa/article/view/20

Kapp, K. M. (2012). The gamification of learning and instruction: Game-based methods and strategies for training and education. Pfeiffer.

Naumann, M., Poggenhans, F., Lauer, M., and Stiller, C. (2018). Coincar-sim: An open-source simulation framework for cooperatively interacting automobiles. In Intelligent Vehicles Symposium (IV). doi:10.1109/IVS. 2018.8500405.

Nieveen, N., van der Veen, J., & Ventura-Medina, E. (2024). Pathways to innovative STEM education.

Sitzmann, T. (2011). A meta-analytic examination of the instructional effectiveness of computer - based simulation games. Personnel psychology, 64(2), 489 528. https://doi.org/10.1111/j.1744-6570.2011.01190.x

Skibski, O., Suzuki, T., Grabowski, T., Sakurai, Y., Michalak, T., & Yokoo, M. (2022). Measuring power in coalitional games with friends, enemies and allies. Artificial Intelligence, 313, 103792.

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From Immersion to Impact: A Major University's Response to the Covid and Post-Covid Pandemic Needs of New York City and State Schools

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Abstract

Established in 2006, the Center for Educational Partnerships (CEP) at Fordham University's Graduate School of Education propelled Fordham's immersion in the educational landscape of New York City and State public and non-public schools. Today the Center serves more than 900,000 students grades pre-K - 12, thousands of teachers and hundreds of administrators and parents.

In this paper, we describe how the 2020 COVID-19 pandemic challenged CEP's ability to continue to serve schools both with programs that would assist them with their "real time needs," as well as modes of delivery; and how the Center's initiatives, expertise, and experience prior to the pandemic enabled Fordham to pivot and successfully respond.

Keywords: *higher education; NYC and State public and non-public schools; COVID-19 pandemic.*

1. Introduction

A vision to contribute in meaningful ways to improve New York City's public schools, coupled with faculty and graduate students' desire to work with schools in underserved neighborhoods fueled Fordham University's outreach to New York City Schools. The establishment of Fordham's Center for Educational Partnerships at the Graduate School of Education in 2006 propelled Fordham's immersion in the educational landscape of New York City public schools and in so doing, transformed the university's relationship with the system. (Wilson, 2012)

"The projects at the Center for Educational Partnerships allow us to deepen our involvement with schools because the work isn't at the theoretical level. We are in those buildings working with teachers and administrators to help improve student learning." James J. Hennessy. Ph.D.,

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Dean Emeritus, Graduate School of Education (2008). Immersing itself in the educational landscape of New York City was in keeping with the university's mission.

In 2006, the Center for Educational Partnerships (CEP) was established as the "outreach arm" of Fordham University's Graduate School of Education (GSE). In so doing, Fordham reimagined the role of higher education to go beyond degree granting programs and certification tracks. Today the center serves more than 900,000 students in grades pre-k - 12, thousands of teachers and hundreds of administrators and parents both public and non-public in schools throughout New York State.

In this paper, we describe how the COVID-19 pandemic challenged the Center for Educational Partnerships' ability to continue to serve public and non-public schools both with programs that would assist them in meeting their "new needs and challenges," as well as modes of delivery.

We discuss how our initiatives, that go beyond traditional programs and services, are currently responding to the "real time" needs and demands of the schools throughout New York City and State that we are serving in this post-Covid period. Section 2 outlines the programs that were implemented through 2019 and then discusses recent Covid/post-Covid programs and their development as a result of responding to the needs of New York City and State Schools. Section 3 presents impact data; Section 4 concludes the paper with a summary and discussion of further work into the future.

2. The Center for Educational Partnerships – Initiatives developed and implemented 2006 through 2019 (Pre-Covid)

The Center for Educational Partnerships (CEP) at Fordham University, serves one of the largest school systems in the United States; namely, the New York City public school system consisting of 912,064 Pre-K to 12th grade students and 1,596 schools with a budget of over $40 billion. In addition, CEP also serves teachers and administrators from among the 1,800 independent and religious schools throughout New York City and state as well as 212 Community Schools in the Eastern Region of NY State.

Our initiatives focus on the on-going need for instructional support in the form of "Professional Development" for current teachers and administrators through numerous formats including in-classroom coaching at school sites; as well as workshops, institutes, and conferences held throughout the city and state. Each of our initiatives, funded by grant awards and contracts from State and City governments during (2006-2019) were designed to support a specific educational area of need (Bilingual/Bicultural education, on-site coaching in academic subject areas-Literacy, STEM, Social Studies), the Community Schools model, educational reform, school partnerships, and professional development for non-public schools.

Our work has always been research based and outcome oriented; with the goal of bringing critical resources and expertise to teachers whose student populations are most at-risk of academic failure.

The Center's initiatives, expertise, and experience from (2006-2019) enabled Fordham to pivot and develop new initiatives, (as well as to adjust existing initiatives), and modes of delivery, to meet the Covid and post-Covid needs of New York City and State Schools.

2.1. Covid-Post-Covid Initiatives (2020-Present)

Mid-March 2020 as New York City went into "lockdown" the University physically closed and New York City Schools closed also. Within a matter of days we became a virtual center operating through Zoom and other platforms. We continued providing services through our initiatives, but realized the need for a major focus shift to address mental health/social emotional needs and escalating crime.

2.2. Mental Health Support

As of April 2020 through our professional development initiatives, we began a series of virtual sessions (conducted by mental health specialists) for teachers, administrators, and parents (English and Spanish) focusing on trauma, anxiety, depression, cultural diversity, and prolonged trauma. Our Bilingual/Bicultural initiatives delved deeper into cultural differences concerning mental health awareness, treatment, availability and/or acceptance. Additionally, in 2022 we were awarded a mental health awareness grant from the federal government to provide training for teachers and school staff in the borough of the Bronx (one of the poorest boroughs and severely affected by Covid) focusing on developing a deeper awareness of signs of mental health concerns in elementary school (grades Pre-K to 5) students. De-escalation techniques for emotionally challenged students as well as mental health provider linkages with hospitals, clinics, other NPO providers are also addressed.

2.3. US Coronavirus Aid, Relief, and Economic Security (CARES) ACT

In 2021 Fordham's Community Schools Technical Assistance Center at CEP was selected by the New York State Education Department to distribute over $1.2 million of New York State CARES Act monies to high need "at risk" schools throughout New York City and on Long Island, NY, to address both "learning loss" and Covid-related "Mental Health" Issues. Both a distribution formula and an application process were developed by the CEP CARES ACT Staff.

Figure 1 illustrates that school and district administrators surveyed reported that Social Emotional Learning Support for Students (57.1%) and Support to Multilingual Learners (46.4%) were the two highest needs of support requested to address the challenges related to the COVID-19 pandemic

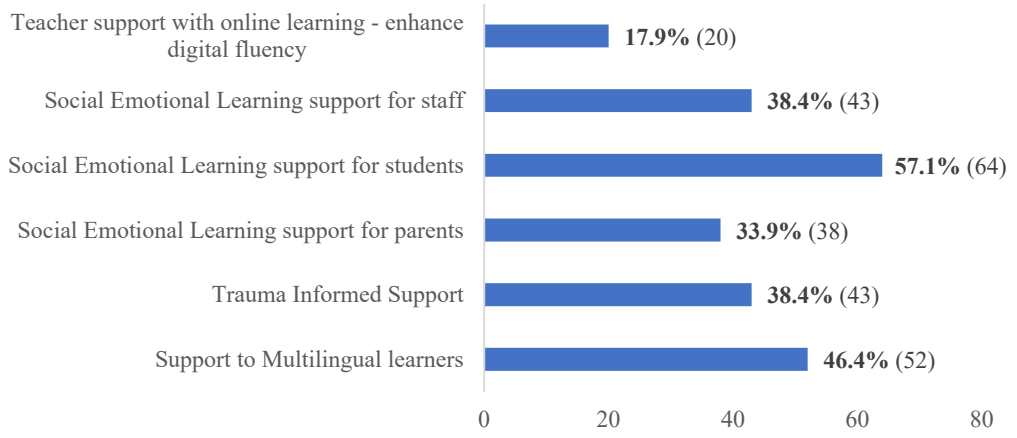


Figure 1. CARES Act Initiative Survey Data Results. (2021)

2.4 Stop School Violence

The serious problem of school violence in NYCDOE schools is prevalent throughout the city's five boroughs. The latest (School Year 2020-21) School Safety and Educational Climate (SSEC) Incidents Report published by the New York State Education Department (NYSED) for NYC reported a total of 1,031,193 elementary and secondary students attending NYCDOE schools during that period. That report cited 4,143 violent incidents in various categories (e.g. assault resulting in no/minor or severe physical injury or weapons possession) among the city's 1,851 public schools that compromised school climate and safety in SY 2021-2022. Table 1 details those student infractions.

As schools began to re-open in the fall of 2020, the Center for Educational Partnerships received a grant from the United States Department of Justice to address School Violence in the Bronx. Focusing on trauma informed practices, school staff and groups of students grades (6-12) participated in sessions addressing trauma, bullying, social-emotional issues, gang violence and reaction to crime in their neighborhoods. The purpose being to improve and sustain a positive school climate Covid/post-Covid.

In 2023 we received a second grant to implement this program in the borough of Manhattan grades (3-12).

2.5 Social Emotional Challenges (2021-Present)

A significant number of students throughout New York City, especially those in under-served communities, returned to school exhibiting Social Emotional challenges (anxiety, depression, decreased social skills); due to COVID-19 as well as virtual and/or hybrid learning that took place during lockdown.

Table 1. NYCDOE SCHOOL SAFETY INFRACTIONS – SY 2021-2022 Source: NYSED (2023).

Type of Incident	# of Occurences
Homicide	0
Sexual Offenses: Forcible Sex Offenses	9
Sexual Offenses: Other Sex Offenses	70
Assault: Physical Injury	209
Assault: Serious Physical Injury	13
Weapons Possession: Routine Security Check	141
Weapons Possession: Other	169
Discrimination, Harassment, and Bullying: All excluding Cyberbullying	1,230
Discrimination, Harassment, and Bullying: Cyberbullying ONLY	2,125
Bomb Threat	22
False Alarm	35
Use, Posession, or Sale of Drugs	111
Use, Posession, or Sale of Alcohol	9
TOTAL ALL Incidents	4,143

3. Impact Data

As a result of the new programs developed and the change of focus in pre-Covid programs, a summary of surveys conducted show participant ratings indicate high levels of satisfaction with sessions focusing on mental health and social emotional needs.

During this period 2022-23 our social emotional learning sessions focused on utilizing empathetic communication skills that support student academic success, and understanding the social emotional framework and the benefits. Figure 3 depicts participant satisfaction.

Our efforts to work with schools to improve school climate utilizing trauma informed practices has resulted in participants' increased understanding of promoting a positive school climate; gaining knowledge of ways to help improve school culture and climate, and improved understanding of the link between mental health, student behaviors, and school safety.

Table 2. Participant Ratings – All workshops combined SY20 – SY22. Source: Policy Studies Associates (2022)

Quality Measure	2019-20 (n=81)		2020-21 (n=125)		2021-22 (n=91)	
	Mean Rating	Percent 'Strongly Agree	Mean Rating	Percent 'Strongly Agree"	Mean Rating	Percent 'Strongly Agree'
Presenters were knowledgeable about the topic	4.9	89%	4.9	94%	4.8	95%
Presenters responded to participants' questions, comments and/or ideas in a positive way	4.9	89%	4.9	96%	4.8	95%
Workshop/Presentation was engaging	4.8	86%	4.9	96%	4.8	95%
Purpose of the workshop/ presentation was clear	4.8	85%	4.9	94%	4.8	95%
Workshop/ presentation was well organized	4.8	83%	4.9	96%	4.8	95%
Information provided/ discussed was useful	4.7	79%	4.9	96%	4.8	94%
Workshop/ presentation accomplished its objectives	4.7	77%	4.9	94%	4.7	92%
I plan to use information from this event in my own work	4.7	79%	4.9	96%	4.8	95%
The content of the workshop/ presentation addressed my professional learning needs	4.7	77%	4.9	95%	4.8	94%
Workshop/ Presentation increased my knowledge about the topic presented	4.6	73%	4.9	96%	4.8	94%
I plan to share information from this event with others	4.5	76%	4.9	97%	4.8	95%
OVERALL	4.7	81%	4.9	95%	4.8	94%

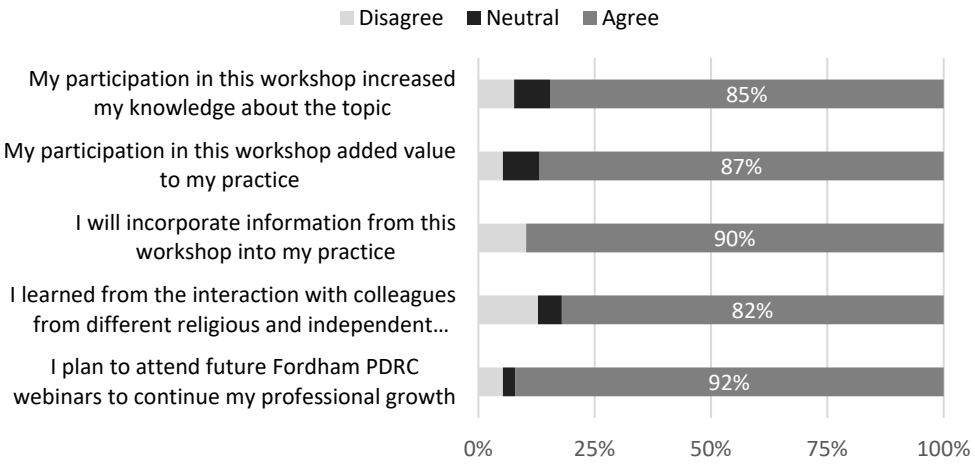


Figure 3. Satisfaction Scores for SEL Sessions (2022-2023) Source: Policy Studies Associates (2022)

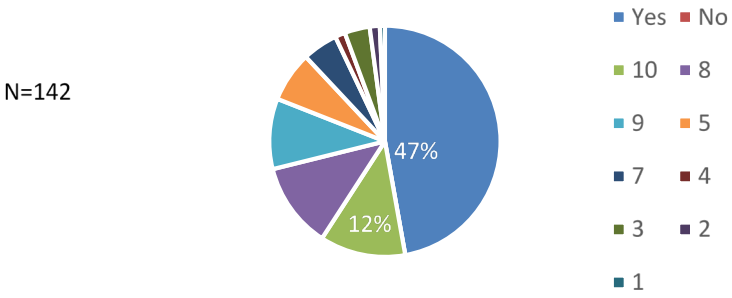


Figure 4. Was there a Connection between the workshop and promoting a positive school climate? Source: CEP Internal Document (2024)

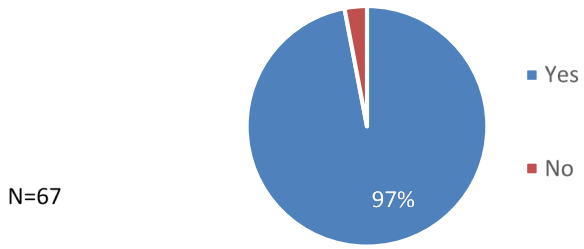


Figure 5. Do you feel you learned ways to help improve school's culture and climate?. Source: CEP Internal Document (2024)

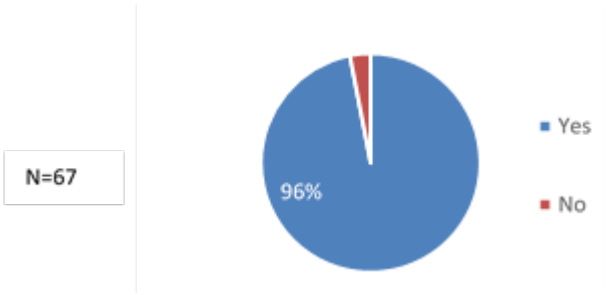


Figure 6. Did workshop help improve your understanding of the link between mental health, student behaviors, and school safety? Source: CEP Document (2024)

4. Conclusion

Fordham was able to develop new programs that meet the "real time" Covid/Post-Covid needs of schools throughout New York City and State. Program participants noted that the professional development sessions and related supports were "immediately useful" in their work.

4.1. Summary

This paper illustrates how a major university has responded an continues to respond to the needs of the public and non-public schools it serves both pre and post Covid through its Center for Educational Partnerships (CEP) established 19 years ago. By developing programs and securing funding to complement them, the CEP is impacting schools in this post-pandemic period with initiatives focusing on mental health, school climate, social emotional concerns and improving teacher practice enabling students to overcome learning loss.

4.2. Future Work

Future work includes supporting NYC and State schools in relation to the major influx of migrant students, the expansion of our Community School Technical Assistance work to serve the entire Eastern Region of New York State and the expansion of services to non-public schools statewide, for which we have recently been funded; working with rural schools, continuing our mental health focus, and sharing our work both nationally and internationally.

References

Barron, J., The fear factor and crime in New York. *New York Times*; March 16, 2022. https://www.nytimes.com/2022/03/16/nyregion/crime-nyc-mental-health.html

Batisti, A. V., & Pizzingrillo, M. E. (2020). Beyond Degree Programs: How a Major University Immersed Itself in the Educational Landscape of New York City. In: *6th International*

Conference on Higher Education Advances (HEAd'20). Valencia, 777-784 June 2020. DOI: https://dx.doi.org/10.4995/HEAd20.2020.11142.

Bhatnagar, R., & Many J. (2022). Teachers Using Social Emotional Learning: Meeting Student Needs during COVID-19. *International Journal of Technology in Education*, 5(3), 518-534. DOI: https://doi.org/10.46328/ijte.310

Closson, T., & Piccoli, S. Children out walking get caught between a gunman and his target. *New York Times*; June 18, 2021. https://nytimes.com/2021/06/18/nyregion/bronx-shooting-video-children.html

Moore, T., Marino, J., Morpher, J., & Janoski, S. Teenage boy shot outside NYC high school, triggering lockdown. *New York Post*, March 14, 2023. https://nypost.com/2023/03/14/teen-boy-shot-outside-nyc-high-school-triggering-lockdowns/

Wilson D. (2012). Teach the teachers. *Fordham Magazine*, *Winter 2012*, 16-20.

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State Contexts, Local Markets: U.S. Public Four-Year Universities' Role in Offering Dual Enrollment Programs

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Abstract

Given the surge of dual enrollment programs in the United States, this study focuses on the relationship between public four-year universities' offering of dual enrollment programs in the context of in-state and within-proximity community colleges offering similar programs. This study is guided by the classic supply and demand perspective in higher education to understand public four-year universities' behaviors in offering dual enrollment programs and the size of these programs. Using a national dataset, we found that public four-year universities, especially non-doctoral institutions, do not seem to compete with nearby community colleges to offer similar dual enrollment programs. However, non-doctoral public four-year universities are responsive to student needs in dual enrollment in-state overall, and they supplement community colleges' role to supply dual enrollment programs when needed.

Keywords: *US higher education; dual enrollment; institutional competition.*

1. Introduction

While higher education remains a cornerstone of youth preparation for civic engagement, career development, and lifelong learning, U.S. colleges and universities have experienced significant enrollment declines over the past decades. Between 2010 and 2020, enrollment in higher education dropped by nearly 2 million students (National Student Clearinghouse Research Center [NSCRC], 2023). This decline can be attributed to various factors, including demographic shifts such as lower birth rates leading to fewer high school graduates (Grawe, 2018), a strong labor market reducing the immediate need for postsecondary education (Barr &

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Turner, 2015), rising tuition costs (Ma & Pender, 2021), and growing concerns over the return on investment of a college degree (Akers & Chingos, 2016; Carnevale et al., 2010).

In contrast to this downward trend, dual enrollment programs, which allow high school students to simultaneously earn high school and college-level credits, have seen rapid growth, becoming a vital strategy for both educational access and institutional sustainability. Between 2003 and 2011, dual enrollment grew at an average annual rate of 7% (Marken et al., 2013), driven by state policies promoting early college access and partnerships between high schools and postsecondary institutions. The growth accelerated further during COVID, a period marked by overall enrollment struggles for colleges and universities. Community colleges, in particular, experienced a nearly 10% drop in traditional-age student enrollment from 2019 to 2020 (NSCRC, 2022). However, the rate of decline was reduced to just 0.4% the following year, primarily due to an 11% increase in dual enrollment among high school students (11%) (NSCRC, 2022). According to Fink (2024), nearly 2.5 million high school students enrolled in at least one dual enrollment course at a college or university in the 2022-23 academic year, and over 70% of students enrolled in community colleges' dual enrollment programs. Given intensified enrollment competition among public colleges and universities and the constant struggle between institutional prestige and access expansion (Jaquette, 2013; Torres Lugo & Pingel, 2024), it is important to understand the role public four-year universities play in the surge of dual enrollment programs. The research questions guiding this study include:

1. Are public four-year universities more likely to offer dual enrollment programs, with fewer community colleges offering similar programs in-state and within proximity?
2. Do public four-year universities enroll more dual enrollment students, with fewer community colleges offering similar programs in-state and within proximity?
3. Does this relationship vary based on the public four-year universities' Carnegie classification?

2. Enrollment Competition in the Complex Postsecondary Landscape in the U.S.

This surge in dual enrollment reflects both changing student needs and institutional strategies. High school students and their families view dual enrollment as a way to reduce future college costs and improve college readiness and success (Schaller et al., 2023). Simultaneously, higher education institutions, especially community colleges, have leveraged dual enrollment to stabilize enrollment numbers amidst broader declines (Fink, 2022). Dual enrollment has the potential to serve as an innovative enrollment management strategy.

While the U.S. higher education system is highly stratified based on institutional selectivity and resources available (Slaughter & Taylor, 2016), enrollment competition amongst institutions intensifies when the number of high school graduates declines (Bransberger et al., 2020; Plane, 1989). Previous research indicated that public colleges and universities strategically invest in

enrollment management to attract particular student groups and prioritize institutional missions (Schulz & Lucido, 2011). In particular, regional public universities struggle between striving to gain prestige and ensuring access and equity (Warshaw et al., 2021). These institutions are often expected to "evolve dynamically as anchor institutions to respond to regional needs while advancing educational equity and opportunity" (Supplee & Orphan, 2023, p. 518).

In the higher education market, unique characteristics in supply and demand can complicate enrollment levels across different sectors of colleges and universities. With the proliferation of dual enrollment (Fink, 2024; Taylor et al., 2022), the demand for high school students remains strong. As U.S. colleges and universities face the enrollment cliff, dual enrollment has been used as a recruitment tool to boost college matriculation (Webber et al, 2022). In the meantime, in many rural areas and college deserts, limited supply of dual enrollment programs continues to prevent aspiring high school students from taking college-level courses, and dual enrollment access varies greatly even within the same state (Acton et al., 2024; Gagnon et al., 2021). In the broad higher education context, students' college choice is a function of institutional prestige, distance, price, and individuals' (perceived) academic ability (Toutkoushian & Paulsen, 2016). In the dual enrollment market, institutional mission, selectivity, location, and capacity can all lead four-year universities to consider offering dual enrollment programs to meet student needs.

3. Research Design

In the study, we used institution-level data from the Integrated Postsecondary Education Data System (IPEDS) and state-level high school enrollment size from Common Core of Data in 2022-23 from the U.S. Institute of Education Sciences (IES) to examine public four-year universities' offering of dual enrollment programs in relation to programs offered by community colleges in-state and within-proximity, respectively. We first restricted our sample to 1,794 degree-granting, primarily baccalaureate or above institutions, and we further excluded 1,212 private, not-for-profit institutions. Among the 582 public four-year universities in the sample, 228 are doctoral universities, and 354 are non-doctoral universities. Over 80% of public four-year universities (n = 482) enroll at least one high school student taking college-level courses, including 198 doctoral and 284 non-doctoral universities.

3.1. Variables

We define public four-year universities' role in providing dual enrollment as whether they offer dual enrollment programs, and the number of students enrolled in dual enrollment programs. We include these two dependent variables in the study, with the dual enrollment offering being dichotomous for the full sample and the number of students enrolled as a continuous variable for public four-year universities that offer dual enrollment programs.

The key independent variables are operationalized based on the role community colleges play in offering dual enrollment programs either in-state or within proximity. For *in-state* competition, we calculated the number of within-state community colleges offering dual enrollment programs and the total number of students enrolled in these programs. For *within-proximity* competition, we followed Turley (2009) to identify community colleges within proximity to each public four-year university (i.e., within 50 miles for universities in rural/town settings, within 25 miles for universities in urban/suburban settings). Similarly, we calculated the number of within-proximity community colleges offering dual enrollment programs and the total number of students enrolled in these programs.

Following prior literature on dual enrollment offering and the supply and demand theory, we controlled for state and institutional characteristics that could contribute to the likelihood and capacity of offering dual enrollment programs. We used a parsimonious model specification to control for the four variables, including institutional urbanicity, Carnegie classification, institutional size, and the total number of high school students in the state (logged).

3.2. Analytic Strategy

We used logistic regression to test whether public four-year universities' likelihood of offering dual enrollment programs is associated with in-state and within-proximity competition from community colleges, and we used multiple linear regression to test whether the relationship between the number of students enrolled in dual enrollment programs was associated with in-state and within-proximity competition, respectively. We conducted statistical assumption checks to obtain unbiased estimates and implemented log transformations when the normality assumption was violated.

4. Results

To answer the first research question, we found that public four-year universities are less likely to offer dual enrollment programs, with more community colleges offering similar programs in-state and within proximity (Table 1 Panel A). Specifically, each additional in-state community college offering dual enrollment programs is associated with a 3% reduced probability for the public four-year university to offer a similar program (odds ratio [OR] = 0.971, $p < .001$,) and a 7.9% reduced probability for each additional within-proximity community college offering dual enrollment programs (OR = 0.921, $p = .008$). While no statistically significant relationship was found between public four-year universities' likelihood of offering dual enrollment programs and the number of dual enrollment students enrolled in in-state community colleges ($\beta = -0.594$, $p = .127$), a 1% increase in the number of dual enrollment students enrolled in within-proximity community colleges is associated with a 26.1% reduced probability for the public four-year university to offer a similar program (OR = 0.739, $p = .012$).

In addition, our findings indicate that, among the public four-year universities that offer dual enrollment programs, the number of students enrolled is associated with in-state, but not within-proximity, community college offerings. Each additional in-state community college offering

Table 1. Coefficients of the Relationship between Dual Enrollment (DE) Offering in Community Colleges and Dual Enrollment Offering at Public Four-Year Universities

Independent Variable	Likelihood to Offer DE	Number of DE Students Enrolled (logged)
Panel A: Full Sample of Public Four-Year Institutions		
Number of DE-offering in-state community colleges	-0.030*** (0.004)	-0.014*** (0.004)
Number of DE students enrolled in in-state community colleges (logged)	-0.594 (0.390)	0.769*** (0.203)
Number of DE-offering in-proximity community colleges	-0.083** (0.031)	0.002 (0.026)
Number of DE students enrolled in in-proximity community colleges (logged)	-0.303* (0.121)	0.032 (0.069)
Number of Observations	582	482
Panel B: Sub-Sample of Doctoral Public Four-Year Institutions		
Number of DE-offering in-state community colleges	-0.055*** (0.016)	-0.762 (1.623)
Number of DE students enrolled in in-state community colleges (logged)	-0.005 (0.006)	0.583 (0.344)
Number of DE-offering in-proximity community colleges	-0.056 (0.057)	-0.361 (0.302)
Number of DE students enrolled in in-proximity community colleges (logged)	0.020 (0.039)	0.189 (0.108)
Number of Observations	228	198
Panel C: Sub-Sample of non-Doctoral Public Four-Year Institutions		
Number of DE-offering in-state community colleges	-0.025*** (0.005)	-0.018*** (0.005)
Number of DE students enrolled in in-state community colleges (logged)	-0.665 (0.414)	0.912*** (0.252)
Number of DE-offering in-proximity community colleges	-0.087* (0.042)	-0.013 (0.036)
Number of DE students enrolled in in-proximity community colleges (logged)	-0.277* (0.138)	-0.077 (0.090)
Number of Observations	354	284

dual enrollment programs is associated with a 0.014% reduction in the number of students enrolled in a dual enrollment program offered by four-year universities (β = -0.014, p < .001). Every 1% increase in the number of dual enrollment students enrolling in in-state community colleges, which perhaps indicates a greater demand, is associated with a 0.769% increase in the number of students enrolled in a dual enrollment program offered by four-year universities (β = 0.769, p < .001). No such relationships were found between the number of dually enrolled students at public four-year universities and dual program offerings and enrollment size at within-proximity community colleges.

In our sub-group analysis to answer the third research question, we disaggregated doctoral universities (n = 228) and non-doctoral universities (n = 354) and repeated the regression analyses (Table 1 Panel B and C). We found that significant relationships might be driven by non-doctoral universities, and that all significant relationships for this sub-sample are consistent with the full sample analysis. Specifically, each additional in-state community college offering dual enrollment programs is associated with a 2.5% reduced probability for a non-doctoral public four-year university to offer a similar program (OR = 0.975, p < .001) and an 8.4% reduced probability for each additional within-proximity community college offering dual enrollment programs (OR = 0.916, p = .038). Each 1% increase in the number of dual enrollment students enrolled in within-proximity community colleges is associated with a 24.2% reduced probability for the non-doctoral public four-year university to offer a similar program (OR = 0.758, p = .045). Among the non-doctoral public four-year universities that offer dual enrollment programs, each additional in-state community college offering dual enrollment programs is associated with a 0.018% reduction in the number of students enrolled (β = -0.018, p < .001). Every 1% increase in the number of dual enrollment students enrolling in in-state community colleges is associated with a 0.912% increase in the number of students enrolled in a dual enrollment program offered by non-doctoral four-year universities (β = 0.912, p < .001). However, for doctoral public four-year universities, the only statistically significant relationship indicated that each additional in-state community college offering dual enrollment programs is associated with a 5.4% reduced probability for doctoral public four-year universities to offer a similar program (OR = 0.946, p < .001).

5. Discussion

As U.S. higher education continues to expand dual enrollment programs, it is important to ensure equitable access for all high school students. Our study was guided by the demand and supply perspective in higher education to examine public four-year universities' behaviors in offering dual enrollment programs and the size of these programs. The findings indicate that public four-year universities, especially non-doctoral institutions, are less likely to offer dual enrollment programs when there are more community colleges in the state or within proximity that offer similar programs. They are also less likely to offer dual enrollment programs when

more high school students are dually enrolled in within-proximity community colleges. This correlational relationship provides suggestive evidence that public four-year institutions do not initiate programs to compete with community colleges, especially the ones within commuting distance for students in the region in the dual enrollment market. For universities that are at the margin of offering these programs to increase enrollment, they need to consider the uniqueness of their program with respect to program quality, class modality, and student services provided.

For the public four-year universities that offer dual enrollment programs, the size of their program follows the general principle of market supply and demand in the state context: When more community colleges provide similar programs in the state (i.e., a supply increase), the number of dually enrolled students reduce, probably because students have more accessible in-district options and do not rely on public four-year universities which often have a great service area. When more students attend community colleges for their dual enrollment programs (i.e., a demand increase) in the state overall, more students also dually enrolled at public four-year universities. Doctoral public four-year universities are less responsive to the dual enrollment market due to their mission of research development beyond state or regional service, while non-doctoral public four-year universities, which are commonly regional public universities, often supplement community colleges' role to meet student needs when there is a demand (Supplee & Orphan, 2023). Future research should incorporate the qualitative approach to understand dual enrollment in the context of mission prioritization and as an innovative approach to manage enrollment at public four-year universities in the U.S. and beyond.

References

Acton, R. K., Cortes, K., & Morales, C. (2024). *Distance to opportunity: Higher education deserts and college enrollment choices* (No. w33085). National Bureau of Economic Research.

Akers, E., & Chingos, M. M. (2016). *Game of loans: The rhetoric and reality of student debt*. Princeton University Press.

Barr, A., & Turner, S. (2015). Expanding enrollments and contracting state budgets: The effect of the Great Recession on higher education. *Annals of the American Academy of Political and Social Science, 650*(1), 168–193.

Bransberger, P., Falkenstern, C., & Lane, P. (2020). *Knocking at the college door: Projections of high school graduates.* Western Interstate Commission for Higher Education.

Carnevale, A. P., Rose, S. J., & Cheah, B. (2010). *The college payoff: Education, occupations, lifetime earnings*. Georgetown University Center on Education and the Workforce.

Fink, J. (2022). *Revamping dual enrollment to promote equitable pathways to college degrees*. Community College Research Center.

Fink, J. (2024). *How many students are taking dual enrollment courses in high school? New national, state, and college-level data.* Community College Research Center.

Gagnon, D., Liu, J., & Cherasaro, T. (2021). *Understanding access to and participation in dual enrollment by locale and income level*. Regional Educational Laboratory Central.

Grawe, N. D. (2018). *Demographics and the demand for higher education*. Johns Hopkins University Press.

Harmon, H., & Johnson, J. (2024). Dual enrollment equity in rural America's two-year public postsecondary institutions. *Community College Journal of Research and Practice, 48*(9), 557–572.

Jaquette, O. (2013). Why do colleges become universities? Mission drift and the enrollment economy. *Research in Higher Education, 54*, 514–543.

Ma, J., & Pender, M. (2021). *Trends in college pricing and student aid*. College Board. https://research.collegeboard.org/pdf/trends-college-pricing-student-aid-2021.pdf

Marken, S., Gray, L., & Lewis, L. (2013). *Dual enrollment programs and courses for high school students at postsecondary institutions: 2010-11*. National Center for Education Statistics. https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2013002

Taylor, J. L., Allen, T. O., An, B. P., Denecker, C., Edmunds, J. A., Fink, J., Giani, M. S., Hodara, M., Hu, X., Tobolowsky, B. F., & Chen, W. (2022). *Research priorities for advancing equitable dual enrollment policy and practice.* University of Utah.

National Student Clearinghouse Research Center. (2022). *Stay informed with the latest enrollment information.*

National Student Clearinghouse Research Center. (2023). *Working with our data*. https://nscresearchcenter.org/workingwithourdata/

Plane, D. A. (1989). Competition for university enrollments: The Repercussions of changing US age composition, 1978 to 2001. *The Social Science Journal, 26*(2), 205–221.

Schaller, T. K., Routon, P. W., Partridge, M. A., & Berry, R. (2023). A systematic review and meta-analysis of dual enrollment research. *Journal of College Student Retention: Research, Theory & Practice*, 15210251231170331.

Schulz, S. A., & Lucido, J. A. (2011). What enrollment management structures reveal about institutional priorities. *Student Access, Finance, & Success in Higher Education, 12*, 12–44.

Slaughter, S., & Taylor, B. J. (2016). *Higher education, stratification, and workforce development: Competitive advantage in Europe, the US, and Canada*. Springer.

Supplee, L. C., & Orphan, C. M. (2023). The "people's universities" over time: Tracing the histories and evolutions of regional comprehensive universities as anchor institutions between 1970 and 2000. *The Review of Higher Education, 46*(4), 517–546.

Torres Lugo, S., & Pingel, S. (2024). Dueling institutions: Intentionally supporting public research and regional universities amid declining enrollment. *Change: The Magazine of Higher Learning, 56*(4), 31–37.

Toutkoushian, R. K., & Paulsen, M. B. (2016). Demand and supply in higher education. In R. K. Toutkoushian, & M. B. Paulsen (Eds.), *Economics of Higher Education: Background, concepts, and application*s (pp. 149–198). Springer.

Turley, R. N. L. (2009). College proximity: Mapping access to opportunity. *Sociology of Education, 82*(2), 126–146. https://doi.org/10.1177/003804070908200202

Warshaw, J. B., McNaughtan, J., & DeMonbrun, M. (2021). Between two fields: US public master's institutions–Striving for prestige or equity? *Higher Education Policy, 34*, 344–369.

Webber, T., Anderson, S., Devlin, E., & VanDyke, D. (2022). A tale of two community colleges: A dual enrollment recruitment outreach strategy. *College and University, 97*(4), 55–59.

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The European university alliances challenges and acceleration services solutions

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Abstract

University alliances promote collaboration and address complex challenges in higher education. However, these alliances face several obstacles that must be understood and addressed to maximize their effectiveness. This paper aims to explore existing research on the challenges encountered in university alliances. The review identifies key themes and provides insights into strategies that can help overcome these challenges. By understanding the challenges and potential solutions, universities and policymakers can enhance the effectiveness of alliances and foster fruitful collaborations. As a result, we discuss how all these challenges have an effect on the sustainability of their partnerships and how projects such as aUPaEU can overcome some of these challenges.

Keywords: *Education, University Alliance, Challenges, Acceleration services, Digital transformation, partnership*

1. Introduction

The global COVID-19 pandemic has proved the significance of higher education's contributions to individuals and society(Teixeira & Klemencic, 2021).University alliances have gained advantage as key drivers of research, education, and innovation (Fedák et al., 2022). While these alliances offer numerous benefits, they also encounter challenges that can hinder their progress. The European University Association highlights the achievements facilitated by university alliances, including knowledge transfer, intercultural skill development, and enhanced innovation(Estermann et al., 2021). University alliances represent the integration of universities with shared objectives and goals, allowing them to share resources, foster innovation, and improve research outcomes (Deiaco & Melin, 2006). The European Higher Education Strategy aims to support the sectors potential as a catalyst for skills and knowledge development as well as a driver for addressing societal challenges through innovation (Maassen et al., 2023). Presently, there are 65 European universities, comprising approximately 570 higher education

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institutions located around European countries[1]. University alliances promote mobility by addressing challenges related to student access to study and training opportunities while also providing support services for teachers, researchers, and administrative staff[2]. The Commission Communication on Achieving the European Education Area by 2025 emphasises that learning mobility and cooperation enhance the quality of education and training institutions[3]. However, some educators and learners still face challenges due to insufficient information and guidance regarding learning mobility, difficulty in language learning , and issues of accessibility. These partnerships have fostered a competitive environment for universities operating within Europe (Tranmer & Silva, 2016).The aim of this literature review is to analyse the current research regarding the challenges that university alliances face and propose strategies to overcome them. The aUPaEu project has provided potential solutions for these challenges, specifically focusing on partnerships in European higher education. The study will primarily focus on the five most significant challenges encountered by university alliances in Europe while acknowledging the possibility of additional challenges. The University Partnership for Acceleration of European Universities (aUPaEU)[4] is a collaborative project between five university in Europe and two European university alliances, Unite![5] and EPiCUR[6]. It aims to integrate and implement acceleration services in the context of a coordinated support system for HEIs, networks, university alliances, and their umbrella organisations. The ultimate purpose is to develop methodologies, sustainability plans, coaching services, and tangible digital technologies to accelerate the process. The aUPaEU project implement these strategies through different Agora platforms that created for different University alliance and match with their nature of alliances and try to address challenges within university alliances. One of successful sample of Agora is Unite! Agora[7] which is digital platform designed for the Unite! European University Alliance, which connects nine partner institutions across Europe. The platform facilitates collaboration in research, innovation, and education by providing tools and services for students, researchers, and staff. It serves as a central hub for finding research infrastructures and shared facilities, providing acceleration services for research and innovation, and hosting knowledge-sharing.

2. Methodology

The methodology of study composed of the analysis of a range of sources, including reports, repositories, articles and books, as well as conference papers. A process was undertaken,

[1] https://education.ec.europa.eu/education-levels/higher-education/european-universities-initiative (last seen 29 January 2025)

[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52020DC0625 (last seen 29 January 2025)

[3] https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1743 (last seen 29 January 2025)

[4] https://cordis.europa.eu/project/id/101095314/reporting (last seen 29 January 2025)

[5] https://www.unite-university.eu/ (last seen 29 January 2025)

[6] https://epicur.edu.eu/ (last seen 29 January 2025)

[7] https://agora.unite-university.eu/

involving an initial survey of approximately 150 articles and books, from which a refined selection of almost 50 journal articles and conference papers was made. The keywords, such as "university alliances," "higher education collaborations," and "challenges," selected. The study's findings encompassed an evaluation of the challenges faced by university alliances and highlighted how the aUPaEU project aims to address these challenges.

3. Key Challenges

The aUPaEU project has identified some challenges faced by university alliances and is actively searching for solutions to address them. By providing acceleration services, the project aims to address these challenges and ensure the sustainability and long-term impact of the alliances. Below is a list of the five challenges identified:

3.1. Communication Barriers

The Communication can be a real challenge in university alliances, especially since they bring together people from different countries, each with their own languages and cultures (Faiman & Tariman, 2019).This diversity can make it hard for everyone to understand each other, leading to misunderstandings and strained relationships. Finding solutions to make communication smoother is crucial for the success of these alliances(Yusof & Rahmat, 2020). One of the main obstacles is the language barrier, and communication styles (Faiman & Tariman, 2019). These factors can all get in the way of information flowing freely between member institutions, causing misunderstandings and delays. Overcoming these challenges is essential for fostering more effective collaboration within university alliances(Yang et al., 2021).Previous research has highlighted issues such as making judgments, dealing with distance, and maintaining ethical standards in online interactions (Isman & Altinay, 2005).

3.2. Resource Sharing

In university alliances, resource allocation means deciding how to share resources like funding and people among the member universities(Zhao et al., 2021). Each university might give some funding to the alliance, and then that funding can be used for different things like doing research together, building new things, or running joint programs .The universities in an alliance have lots of different experts and teachers with different skills. Allocating resources might mean deciding which teacher works on which project based on what they're good at. Administrative resources, like people who help manage the alliance and make sure everything is running smoothly, also need to be shared fairly. Resource allocation is super important for university alliances because it makes sure that each university gives something to the alliance and gets something back (Yu & Ll, 2021). It needs careful planning and making sure everyone gets a fair

share so that the alliance can do its best work and all the universities can work together successfully(Martins et al., 2021).

3.3. Student Mobility

Student mobility challenges in university alliances can cause various problems when students move between different member institutions. These challenges affect both local and international students. Research has shown that students face significant obstacles such as worries about finding a job after graduation, issues with social class divisions, problems with transferring credits between universities, and difficulties with language and culture (López-Duarte et al., 2021). Expenses for studying, traveling, and the big differences in income between European countries are the main barriers for students who want to move (Wulz & Rainer, 2015).

Another big problem is the lack of information and support services for students who are moving. This can make them feel lost and frustrated(Breznik & Skrbinjek, 2020). They might struggle to understand how things work, find the right courses, or get help with their studies. Dealing with complicated paperwork, like enrolling in classes or getting the right permits, can also be stressful and take up a lot of time for mobile students(d'Hombres & Schnepf, 2021).

3.4. Coaching services

Coaching services play an important role in European university alliances, supporting students, researchers, and staff in developing skills, and fostering collaboration across institutions(Hawkins, 2008). Coaching services in European university alliances face several challenges, including a lack of a unified framework, limited awareness, cross-cultural barriers, and resource constraints[8]. Different coaching approaches across universities create inconsistencies, making support uneven. Tracking long-term impact is also difficult without proper monitoring.

3.5. Alignment with External Stakeholders

In university alliances, it's important to keep communication channels open and transparent with people outside the alliance who are involved or interested(Volk & Zerfass, 2020). This means regularly telling them about what the alliance is doing, sharing important information, and asking for their thoughts and feedback. It's also a good idea to involve them in making decisions. This could mean having them on committees, working groups, or advisory boards so their ideas are part of what the alliance does (Chan, 2021). Figuring out who these stakeholders are, how important they are, and what they care about can help manage things better.

[8] https://www.eesc.europa.eu/en/policies/policy-areas/enterprise/database-self-and-co-regulation-initiatives/150 (last seen 29 January 2025)

4. Strategies to Address Challenges

In this section, we will refer to the challenges discussed earlier by reviewing relevant research findings. The aUPaEU project will carefully analyse existing challenges and identify gaps in the current literature. Subsequently, the project will propose effective strategies to address these challenges.

4.1. Improved Communication and Collaboration

By providing acceleration services, the project aims to solve these challenges and ensure the sustainability and long-term impact of the alliances. Additionally, the Unite! platform offers translation for pages in 9 languages, making it more accessible, and provides services, allowing users to learn different languages from one another (Alcober & Haji Mohammadali, 2023).

4.2. Facilitating Resource Sharing

Unite! Agora promotes equitable resource sharing by providing a Research Infrastructure Catalogue, ensuring that researchers across partner institutions can discover, request, and utilise shared facilities and services efficiently. The platform's integrated CRM tracks resource requests and interactions to optimise resource distribution (Haji Mohammadali et al., 2025).

4.3. Enhanced Student Mobility

Unite! Agora enhances student mobility by providing a centralised platform where students can easily access exchange programmes, joint courses, and mobility opportunities across the nine partner universities Additionally, its knowledge-sharing and event features support virtual mobility, enabling students to participate in international collaborations, training sessions, and networking events. By improving accessibility, transparency, and coordination, Agora fosters a more inclusive and seamless mobility experience within the European university alliance (Haji Mohammadali et al., 2025).

4.4. Improve coaching services

Unite! Agora improves coaching services by providing a structured digital environment where students, researchers, and staff can connect with experienced mentors and advisors across partner universities. Additionally, Agora integrates virtual coaching sessions, webinars, and resource-sharing tools, making expert guidance more accessible and fostering professional growth within the European university alliance(Haji Mohammadali et al., 2025).

4.5. Enhanced External Stakeholder Alignment

Unite! Agora improves external stakeholder alignment by providing a platform for universities, industry partners, and research institutions to collaborate and share knowledge. The platform's

CRM tracks interactions, ensuring everyone is aligned with project goals. Agora also offers events and resources to keep external stakeholders engaged and contribute to research and innovation efforts.

5. Discussion and result

From May 2024 to January 2025, the Unite! Agora platform has seen notable success, particularly in retaining users. With 5,213 returning visits, the platform has demonstrated strong user retention, as evidenced by an average visit duration of 8 minutes 56 seconds and 5.4 actions per visit.

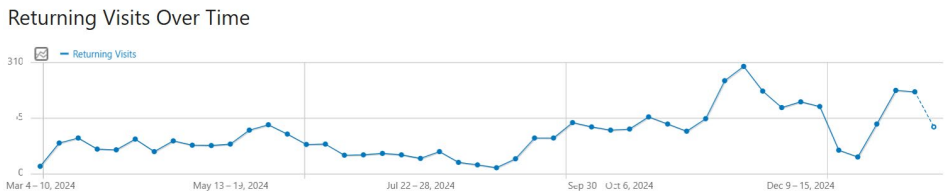


Figure 1. Unite! Agora user engagement :Matomo analytic (2025)

New visitors, totalling 4,696 visits, have shown engagement, with an average visit duration of 2 minutes 41 seconds .

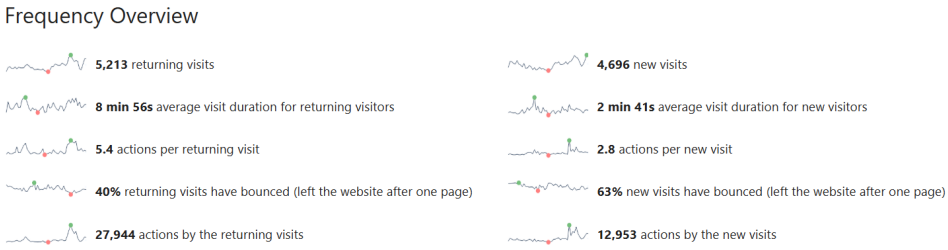


Figure 2. Unite! Agora Frequency overview :Matomo analytic (2025)

These results highlight that Unite! Agora has been successful in fostering engagement among returning visitors from May 2024 to January 2025, while offering opportunities to improve the experience for new users.

6. Conclusion

Fortunately, the aUPaEU project has successfully introduced a range of solutions aimed at overcoming the challenges identified in order to promote sustainability. The aUPaEU project has implemented strategies such as coaching services, collaboration and knowledge exchange,

sustainability plans for funding and governance, and the utilisation of tangible digital technologies. Currently the project implementing these innovative strategies, that aims to foster successful institutional reform and transformation, ultimately contributing to the long-term viability and impact of university alliances.

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References

Alcober, J., & Haji Mohammadali, F. (2023). *The digital platform for the Unite! Alliance: The Metacampus* (p. 169). https://doi.org/10.4995/HEAd23.2023.16265

Breznik, K., & Skrbinjek, V. (2020). Erasmus student mobility flows. *European Journal of Education*, *55*(1), 105–117. https://doi.org/10.1111/ejed.12379

Chan, G. (2021). Stakeholder Management Strategies: The Special Case of Universities. *International Education Studies*, *14*(7), Article 7. https://doi.org/10.5539/ies.v14n7p12

d'Hombres, B., & Schnepf, S. V. (2021). International mobility of students in Italy and the UK: Does it pay off and for whom? *Higher Education*, *82*(6), 1173–1194. https://doi.org/10.1007/s10734-020-00631-1

Deiaco, E., & Melin, G. (2006). Considerations On University Alliances: Motives, Risks And Characteristics. *Royal Institute of Technology, CESIS - Centre of Excellence for Science and Innovation Studies, Working Paper Series in Economics and Institutions of Innovation*.

Estermann, T., Pruvot, E. B., & Stoyanova, H. (2021). *The Governance Models of the European University Alliances: Evolving Models of University Governance I. Briefing*. European University Association.

Faiman, B., & Tariman, J. D. (2019). Shared Decision Making: Improving patient outcomes by understanding the benefits of and barriers to effective communication. *Clinical Journal of Oncology Nursing*, *23*(5), 540–543.

Fedák, V., Hudák, R., & Jakab, F. (2022). Best Practice for Boosting Innovation in the HEI through the Initiative of European University Alliances. *2022 20th International Conference on Emerging eLearning Technologies and Applications (ICETA)*, 153–158. https://doi.org/10.1109/ICETA57911.2022.9974895

Haji Mohammadali, F., Alcober, J., Roma Gómez, A., López Rubio, J., & Oller, A. (2025). *Exploring the Implementation of Acceleration Services in Higher Education: A Case Study of Unite! Agora as a Transformative Platform*. https://doi.org/10.29007/zjjj

Hawkins, P. (2008). The coaching profession: Some of the key challenges. *Coaching: An International Journal of Theory, Research and Practice*, 28–38. https://doi.org/10.1080/17521880701878174

Isman, A., & Altinay, F. (2005). Communication Barriers: A Study of Eastern Mediterranean University Students' and Teachers' of Online Program and Courses. *The Turkish Online Journal of Distance Education*, *6*.

López-Duarte, C., Maley, J. F., & Vidal-Suárez, M. M. (2021). Main challenges to international student mobility in the European arena. *Scientometrics*, *126*(11), 8957–8980. https://doi.org/10.1007/s11192-021-04155-y

Maassen, P., Stensaker, B., & Rosso, A. (2023). The European university alliances—An examination of organizational potentials and perils. *Higher Education*, *86*(4), 953–968. https://doi.org/10.1007/s10734-022-00951-4

Martins, C. L., Almeida, A. T. de, & Morais, D. C. (2021). Design of a Decision Support System for Resource Allocation in Brazil Public Universities. In *Research Anthology on Decision Support Systems and Decision Management in Healthcare, Business, and Engineering* (pp. 470–486). IGI Global Scientific Publishing. https://doi.org/10.4018/978-1-7998-9023-2.ch022

Teixeira, P., & Klemencic, M. (2021). *Valuing the Civic Role of University Education in an Age of Competition and Rapid Change* (pp. 145–151). https://doi.org/10.1007/978-3-030-67245-4_23

Tranmer, J., & Silva, V. e. (2016). Benefits and challenges of international partnerships in nursing. *Acta Paul Enferm.*, *29*(5), Article 5. https://doi.org/10.1590/1982-0194201600067

Volk, S. C., & Zerfass, A. (2020). Alignment: Explicating a Key Concept in Strategic Communication. In *Future Directions of Strategic Communication*. Routledge.

Wulz, J., & Rainer, F. (2015). Challenges of Student Mobility in a Cosmopolitan Europe. In A. Curaj, L. Matei, R. Pricopie, J. Salmi, & P. Scott (Eds.), *The European Higher Education Area: Between Critical Reflections and Future Policies* (pp. 43–58). Springer International Publishing. https://doi.org/10.1007/978-3-319-20877-0_4

Yang, Z., Chen, H., Du, L., Lin, C., & Lu, W. (2021). How does alliance-based government-university-industry foster cleantech innovation in a green innovation ecosystem? *Journal of Cleaner Production*, *283*, 124559. https://doi.org/10.1016/j.jclepro.2020.124559

Yu, H., & Ll, C. (2021). The design of university resource sharing system based on alliance chain. *2021 3rd International Academic Exchange Conference on Science and Technology Innovation (IAECST)*, 269–272. https://doi.org/10.1109/IAECST54258.2021.9695903

Yusof, A. N. A. M., & Rahmat, N. H. (2020). COMMUNICATION BARRIERS AT THE WORKPLACE: A CASE STUDY. *European Journal of Education Studies*, *7*(10), Article 10. https://doi.org/10.46827/ejes.v7i10.3299

Zhao, J., Xi, X., Wang, S., & Gong, C. (2021). Dynamic analysis of different resource allocations: Implications for resource orchestration management of strategic alliances. *Computers & Industrial Engineering*, *158*, 107393. https://doi.org/10.1016/j.cie.2021.107393

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Enhancing Student Engagement through Social Media-Based Gamification in a UI/UX Design Course

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Abstract

Nowadays, incorporating innovative teaching methods that enhance student engagement has become increasingly crucial. In our study, we examine a new pedagogical practice which relies on gamified formative peer assessment and social media to improve student engagement and digital skills in higher education. The approach was implemented and validated with 300 IT students in a UI/UX Design course. Students were requested to design high-fidelity wireframes as part of a project, which were posted on Instagram, where followers voted for the best wireframe using Instagram's poll feature. The wireframe with the most votes was awarded, adding a competition aspect to gamification. These results show a significant impact on student engagement. High level of interest was confirmed on Instagram. Students expressed excitement about using social media as part of the course and valued the move away from a teacher-centred pedagogical approach.

Keywords: *Gamification; Social media; Student Engagement; UI/UX Design.*

1. Introduction

Gamification in higher education involves integrating game-based elements, such as rewards, challenges, and interactive activities, into the learning process, such as formative assessment, to enhance student engagement and motivation (Alsawaier et al. 2018). By leveraging principles of game design, this approach transforms traditional educational experiences into dynamic and immersive environments (Subhash et al., 2018). It can positively influence students' academic performance, engagement, and motivation. Therefore, it's important to further explore the needs and challenges that students encounter when learning through gamified approaches (Manzano-León et al., 2021). Rewards, as a key constituent of gamification, play a central role in maintaining student motivation by providing tangible recognition for their achievements. These incentives, whether in the form of badges, points, relevant gifts or other rewards, substitute a

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sense of accomplishment and encourage continuous participation. By aligning rewards with learning objectives, educators can reinforce positive behaviors and sustain engagement throughout the learning process (Sahli & Spriet, 2023).

Despite extensive proliferation of social media in different domains, the use of social media in higher education is not well documented (Barrot et al., 2021). Chugh et al. (2021) highlight that higher education academics must become more aware of and accustomed to using social media as a professional tool rather than merely a personal platform. The study by Al-Rahmi et al. (2022) emphasizes that the integration of social media in education enhances students' motivation for learning and facilitates peer interaction. The research also highlights those factors such as performance expectancy, effort expectancy, and the individual's social and technological characteristics positively influence the use of social media, thereby improving academic performance and increasing task-technology fit. Interactive elements on social media platforms like Instagram play a significant role in enhancing user engagement and facilitating dynamic communication. Instagram is interesting thanks to its social features, such as posting stories, voting, polls, and quizzes offer users new ways to interact, collaborate, and share knowledge. For example, polls and quizzes can be used to reinforce content in a fun and engaging way, allowing user to participate actively in discussions and real-time interaction. Instagram offers accessible and dynamic platforms for sharing educational content. The visually engaging and interactive features make it effective tools for capturing students' attention and encouraging learning (Lee, 2023). But not all teachers are open to adopting Instagram into their educational tradition, often perceiving it as too informal. However, the study of (Richter et al., 2022), identified three profile types of teachers, teachers with a greater enthusiasm for teaching were more likely to use Instagram for information seeking, while those with higher levels of self-efficacy were more inclined to share content.

Instagram, with its diverse and visually engaging content, plays a significant role in enhancing creativity, particularly in design education. The platform’s emphasis on aesthetic presentation encourages students to produce high-quality work, knowing it will be shared publicly and viewed by a broad audience. As demonstrated in the study by Salehudin et al., students are capable of developing their own digital visual aids when sharing them on Instagram. This highlights the impact of creative online learning through Instagram on students' ability to create new products in the Technology and Learning Media course (Salehudin et al., 2021).

This paper addresses the following overarching research question: “Can the use of poll tools on Instagram, in an educational context enhance learning outcomes and student engagement?”. We contribute to answering this question by introducing the Instagram polling tool, an interactive digital element, to personalize peer assessment experience in computer science education, that allows students and peers to engage with a UI/UX design course in a less formal manner while continuing pedagogical activities.

This paper is divided into four parts. Section 2 provides a description of the research settings. The third section is devoted to analyzing and discussing the results. Finally, the last section summarizes the main conclusions of the work and perspectives.

2. Research settings

This study aims to evaluate student engagement and motivation through a social media-based gamification activity for peer assessment in a UI/UX Design course offered to IT students specializing in System Development at the higher institute of technological studies in Sousse. The course is held during the first semester of the third year of the Bachelor program and has a total course duration of 12 weeks, with 7 bi-monthly sessions of 3 hours. The session is reserved for evaluation. The UI/UX design course follows a project-based learning methodology and is structured around iterative design stages. enables students to design and present solutions to practical challenges.

As shown in Figure 1, the first five sessions focus on understanding and applying user research techniques, such as persona creation and empathy mapping, to define user needs and emotional responses, then carrying out UI/UX benchmarking to analyze competitors and identify design opportunities, followed by information architecture development through sitemap creation and finally designing high-fidelity functional wireframes and interactive prototypes using free wireframing tools, such as Figma. The 6th session focuses on a small design project to provide students with the required skills to create high fidelity functional prototypes while going through a full real-world design process. Each student has to design during the week a mobile or web application prototype and deliver a final high-fidelity prototype ready for client presentation. The applications to be designed are proposed by the instructor. It could be applications such as a real estate agency application, a fitness center application, a platform for electric vehicle charging stations, or a flight ticket price comparison application. The one-week small design project timeline emphasizes efficiency and adaptability, simulating the fast-paced nature of professional UI/UX design tasks. The 7th session is dedicated to the presentations by the students of the outcome of their individual project, in the form of high-fidelity wireframes. The presentations are public and structured as a defense. Each student presents their work using a video projector in front of the instructor and their peers. Each presentation is allocated 20 minutes, ensuring sufficient time for discussion and feedback. These presentations are part of the evaluation. For this study, the new gamified assessment process relying on Instagram is introduced after the presentation session.

Short one-minute videos of each small design project are submitted by volunteer students to the educator. Then, the instructor shared them on her Instagram story account (about 1000 followers), labeling each entry with a unique identifier number for easy reference. Next, she initiated a voting process, inviting all peers and followers to participate in selecting the best

projects, using Instagram's poll functionality. The challenge lasts 24 hours, adhering to Instagram's story duration. After the voting period, the instructor shared the results and announced the top three winners as visually appealing stories designed by the professor highlighting the students' ranking podium. The winning videos were reshared on the instructor's account to further celebrate the students' success. Additionally, a dedicated story was posted to congratulate the winners and to announce the significant rewards associated with their achievements.

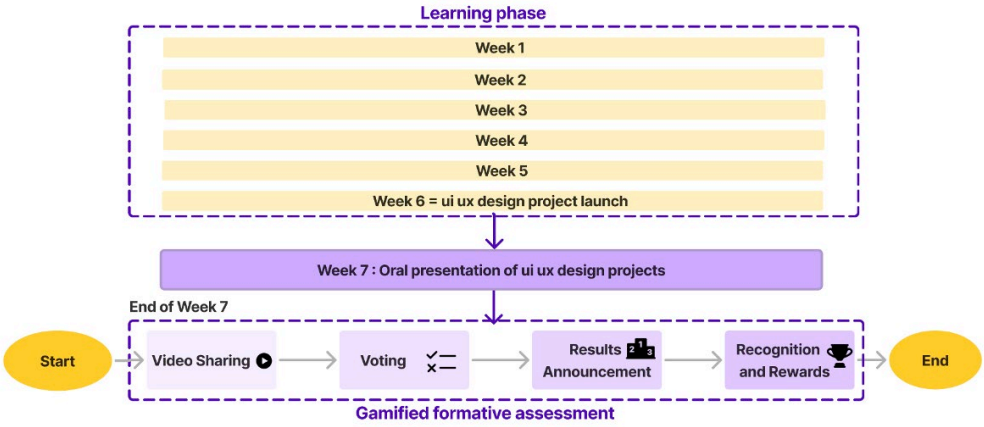


Figure 1. Timeline of the course.

The experiment was carried out over two academic years to assess the impact of integrating gamification and social media into the learning process. Overall, 300 IT students (124 male, 176 female) were involved in the studies. 120 students in 2023 and 180 in 2024. Each year, students were getting the course per group on a different week day.

3. Research data and outcome

The impact of the proposed pedagogical approach and the additional gamified formative assessment is based on the data collected at the end of the course on Instagram related to the videos posted and the associated votes across the different stages of the gamified peer assessment, including the post of an introductory story, the launch of the activity presented as a challenge on a specific subject, the posting of students' videos stories and the voting phase. The following parameters were taken into account: accounts reached and views, navigation and interaction behavior, and votes.

3.1. Account Reached and Views

Considering that accounts reached indicate the number of unique users who have consulted the story, while views reflect the total number of times the story has been consulted, including repeated consultations by the same users. Figure 2 provide a comparison of accounts reached and views during the different phases of the Instagram stories on the teacher account. Compared to the regular story phase, there is a noticeable increase. The highest engagement rate was observed during the presentation phase of the videos submitted by the students, with 1,038 unique accounts reached and 1,590 total views. This could indicate strong interest from followers, suggesting the personalized and interactive nature of the content. The launch of the challenge also saw a notable level of engagement, confirming the initial interest generated among students and followers. In contrast, normal day stories without content directly related to the challenge had the lowest range and impressions, suggesting that content focused on the challenge has a significantly higher impact on audience engagement. The voting phase showed balanced engagement, indicating continued interest.

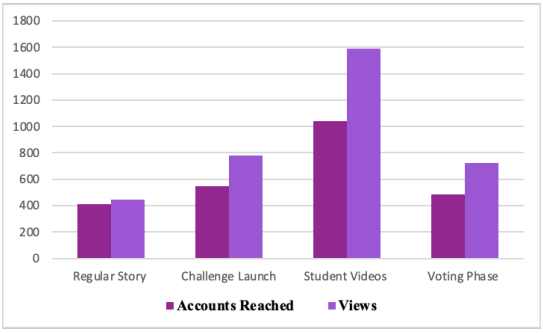


Figure 2. Comparison of accounts reach and impression.

3.2. Navigation and Interaction Behavior

To begin with user navigation behavior (exits, next story taps and back taps). Exits is the number of users who left the story during each phase, next story taps is the number of users who proceeded to the next story and back taps the number of users who returned to the previous screen or story. User navigation behavior provides insight into content retention and interest.

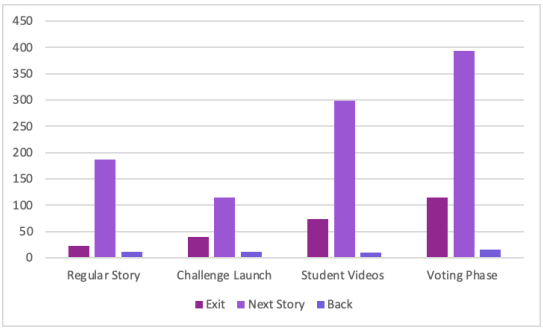


Figure 3. Comparison of user navigation behavior.

As seen in Figure 3, the regular story phase has a high engagement rate with many users proceeding to the next story, indicating that the content is compelling. The high engagement rate during the regular story phase indicates that the content is succeeding in capturing users' interest, encouraging them to continue. However, the increased exit rate during the challenge phase implies that some users may find the challenges less engaging or potentially difficult to complete. This could highlight the need to optimize challenge design to maintain user interest. The voting phase has the highest exit rate, but also the highest engagement in terms of progression, suggesting a polarized response.

3.3. Analyzing of voting

With the goal of selecting the best video using Instagram polling feature. For the same subject and the same group, each volunteer student submitted their video, and the submissions were curated into four options per story, adhering to Instagram's limit for poll choices. A poll between four posted videos on a specific subject corresponding to what we refer to as a challenge. Instagram poll was then created with a predefined audience, including peers, educators, and external participants. Ten UI/UX design subjects were proposed by the educator for which the corresponding data are shown in Figure 4.

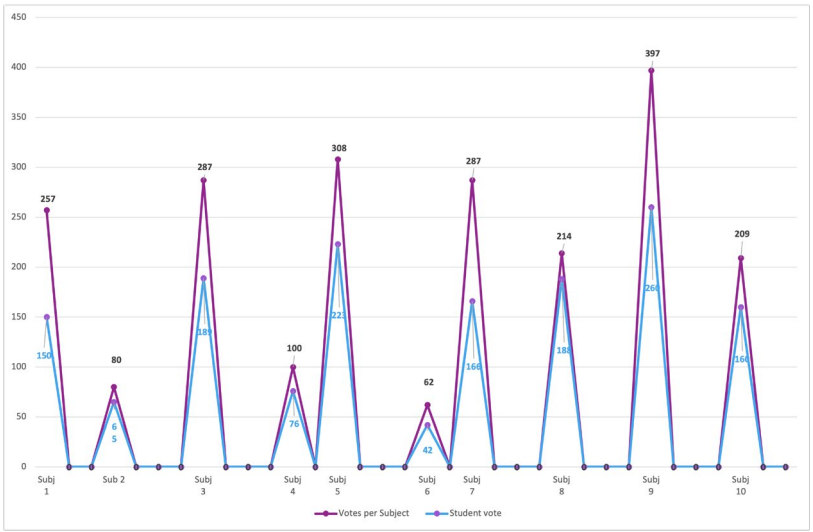


Figure 4. Comparison of votes by students and others (each data correspond to a specific subject).

The data provided represents the number of votes per subject (Subj) and the corresponding student votes. It indicates the level of user engagement during the voting phase focusing on both student and follower participation.

Key observations reveal that videos from subject 9 achieved the highest engagement with 397 votes (260 student votes), closely followed by subject 5 with 308 votes (223 student votes). Data from subjects 2, 4 and 8 were moderately engaged, while datasets 3, 7, 1 and 10 showed progressively lower engagement, with dataset 6 being the least engaged with 62 total votes (42 student votes). This indicates a clear disparity in engagement levels between datasets, with the best performing subjects attracting significantly more interest from students and followers. Subject 9 entitled SonyCupCake, a mobile application for personalized cakes. The high number of votes can be attributed to the nature of the female-focused subject, combined with a group composition of 83% female participants.

The experimental results show strong student engagement, as shown in the graph with an average of 220 votes per subject, highly above the average size of the group assigned to a challenge (average 20 students). This indicates active student participation, particularly in the highest performing subjects (9 and 5). However, the relatively low number of follower votes compared to the size of the potential audience suggests that there is room to improve engagement with external audiences. Given that the Instagram account is relatively new, this is to be expected and future experiments are likely to see an increase in follower engagement as the account grows. Notably, a significant proportion of non-follower votes came from former students (from the last two years), indicating that the projects have generated substantial interest even beyond the current cohort of students. In addition, targeted strategies to convert non-

followers (particularly alumni) into followers could be implemented, leveraging their interest to create a stronger community around the account.

4. Conclusions

In the context of non-traditional teaching, the use of social media platforms has emerged as a new method of increasing student engagement. We evaluated the impact of our pedagogical approach of gamified formative peer assessment through the Instagram social network.

The educator has been recognized for being the teacher who shares their students' work on Instagram. Initially, this practice was implemented to showcase students' academic achievements and creative productions, in line with contemporary pedagogical strategies that emphasize the recognition and validation of students' efforts. It is interesting to note that this initiative has exceeded its initial objective. Students now proactively request that their projects and presentations be recorded and shared on this platform. This reflects their appreciation of the value of public recognition in developing a sense of achievement and improving their personal effectiveness. It also gives them the opportunity to disseminate their work beyond the classroom, bridging the gap between academic learning and real-world applications.

The high rate of engagement from followers also highlights that the experiment was able to reach and engage an external audience, which is an essential measure for assessing the wider impact of such initiatives. However, certain limitations must be acknowledged. The Instagram algorithm may influence the visibility of stories, potentially affecting the reach and fairness of the voting process. Additionally, students may vote without thoroughly analyzing the videos, and some votes could be influenced by the popularity of participants, particularly those with a large number of followers, rather than the quality of their work. Despite these limitations, the results highlight the potential of integrating social media platforms into educational assessments to foster engagement.

In conclusion, integrating social media, especially Instagram, into the educational process can serve as a powerful tool for student engagement. This method challenges traditional pedagogical paradigms and redefines the teacher's role from a transmitter of knowledge to a facilitator of collaborative and active learning experiences. It not only enhances the learning experience but also promotes key new skills such as digital literacy.

References

Al-Rahmi AM, Shamsuddin A, Wahab E, Al-Rahmi WM, Alyoussef IY, Crawford J. Social media use in higher education: Building a structural equation model for student satisfaction and performance. Front Public Health. 2022 Sep 20;10:1003007. doi: 10.3389/fpubh.2022.1003007. PMID: 36203665; PMCID: PMC9530898.

Alsawaier, R. S. (2018). The effect of gamification on motivation and engagement. The International Journal of Information and Learning Technology, 35(1), 56-79.

Barrot, J. S. (2021). Scientific mapping of social media in education: A decade of exponential growth. Journal of Educational Computing Research, 59(4), 645-668.

Chugh, R., Grose, R., & Macht, S. A. (2021). Social media usage by higher education academics: A scoping review of the literature. Education and information technologies, 26(1), 983-999.

Lee, Y. J. (2023). Language learning affordances of Instagram and TikTok. Innovation in Language Learning and Teaching, 17(2), 408–423. https://doi.org/10.1080/17501229.2022.2051517

Manzano-León, A., Camacho-Lazarraga, P., Guerrero, M. A., Guerrero-Puerta, L., Aguilar-Parra, J. M., Trigueros, R., & Alias, A. (2021). Between Level Up and Game Over: A Systematic Literature Review of Gamification in Education. Sustainability, 13(4), 2247.

Richter, E., Carpenter, J. P., Meyer, A., & Richter, D. (2022). Instagram as a platform for teacher collaboration and digital social support. Computers & Education, 190, 104624.

Sahli, S., & Spriet, T. (2023, September). Gamification Based Collaborative Learning: The Impact of Rewards on Student Motivation. In International Conference on Interactive Collaborative Learning (pp. 124-130). Cham: Springer Nature Switzerland.

Salehudin, M., Nasir, M., Hamzah, S. H., Toba, R., Hayati, N., & Safiah, I. (2021). The Users' Experiences in Processing Visual Media for Creative and Online Learning Using Instagram. European Journal of Educational Research, 10(4), 1669-1682.

Subhash, S., & Cudney, E. A. (2018). Gamified learning in higher education: A systematic review of the literature. Computers in human behavior, 87, 192-206.

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Boosting students' motivation for cultural sensitivity via the use of Metaverse in flipped classrooms

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Abstract

Cultural sensitivity, the ability to interact with diverse cultural backgrounds, is often developed through experiential learning, such as service-learning. Flipped learning involves students reviewing theoretical information before practicing skills in class. Undergraduate students increasingly consist of Generation Z, whose growing environment filled with technology, prefer active online learning. This study examined the use of the Metaverse as a flipped learning approach to enhance undergraduate students' cultural sensitivity. Twenty-two undergraduates used the Metaverse to learn about ethnic minorities and engage in interactive activities before designing service projects. Questionnaires were used to gather their insights on this experience. Results indicated high satisfaction with the Metaverse, as it enhanced their understanding of ethnic minorities and offered reflection opportunities. Interactive activities and the design of virtual environment (e.g., tasks-oriented) in the Metaverse were key factors in motivating students to develop cultural sensitivity through peer collaborations. These findings offer valuable insights for educators on optimising Metaverse design.

Keywords: *The Metaverse; flipped learning; cultural sensitivity; service learning.*

1. Introduction

Cultural sensitivity, defined as the ability to interact appropriately with people from diverse cultural backgrounds (Brook et al., 2019), is built on cultural competence and is mainly accumulated through practical experiences (Laszloffy & Habekost, 2010). Undergraduate students are increasingly made up of Generation Z, which refers to individuals born between 1995 and 2010, have grown up surrounded by technology (e.g., the Internet). They prefer active roles in online learning environments (Anastasiadis et al., 2018), making lesson designs aimed at enhancing their learning motivation more challenging.

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The flipped classroom approach, where students review teaching materials (e.g., videos) before attending face-to-face classes for hands-on practice, has gained popularity in higher education in recent years (Divjak et al., 2022). Research indicates that this approach enhances students' critical thinking and problem-solving skills, essential for addressing 21st-century global challenges (Zhao et al., 2021). However, it relies heavily on technology (Tomas et al., 2019), which is crucial for students' motivation, engagement and satisfaction (Wang & Zhu, 2019). A recent review from Baig and Yadegaridehkordi in 2023 highlighted the common technology tools used in flipped classrooms, such as learning management systems (e.g., Blackboard), video creation tools (e.g., YouTube), and collaboration platforms (e.g., Google Drive), only allow one-way interactions. Of note, such limitation would reduce students' interest and motivation, further hindering their ability to apply learned knowledge in face-to-face classes.

The Metaverse, a virtual three-dimensional (3D) world (Alpala et al., 2022), offers a solution by enabling continuous real-world interactions and cultural exchanges (Lee & Hwang, 2022). Known as the Educational Metaverse, its use in education has become a significant topic of interest (Camilleri, 2023). Within the Metaverse, students can interact and collaborate with peers and teachers through their chosen avatars, engaging with teaching materials in a dynamic 3D environment. A recent study from Hwang and colleagues in 2023 has shown that adopting the Metaverse can enhance students' motivation and interest, promoting autonomous learning as a lifelong learner.

By integrating the Metaverse as a flipped classroom, we can create a more interactive and engaging learning experience. This approach not only addresses the technological preferences of Generation Z students, but also enhances their motivation of being culturally sensitive, further preparing them to interact with people from diverse cultural background in various settings (e.g., workplace). While the Metaverse's immersive capabilities offer a promising avenue for fostering students' deeper cultural understanding and engagement, however, as suggested by López-Belmonte et al. (2023), the use of the Metaverse in education is still in its infancy, therefore more research should be conducted to assess its impacts on students' learning.

The present study aimed to explore students' experience using the Metaverse in a flipped classroom. To achieve this, we conducted a survey on undergraduate students enrolled in a service-learning course at a local university in Hong Kong. Service-learning involves students in designing and delivering community-based service activities to enhance their academic skills and civic responsibility (Naudé, 2011). These students needed to have a good understanding of ethnic minorities before designing service activities for a partnered secondary school with ethnic minority students.

2. Methods

This study was conducted in the fall semester of the 2024/25 academic year and included a total of 22 undergraduate students from a local university in Hong Kong enrolled in a service-learning course focused on promoting child and adolescent development. Given that our partnered secondary school consists of ethnic minorities, it is crucial for the undergraduate students (acting as service providers) to be culturally sensitive when planning and executing service activities.

To enhance their understanding of ethnic minorities in Hong Kong, students were invited to join Frame VR (a Metaverse platform that requires no downloads or installations) to learn the background information about ethnic minorities as part of the e-learning module, using a flipped classroom approach.

In Frame VR, the virtual space is divided into four areas. Students first gathered in the "Welcome Area" to be greeted by the teacher and sign a virtual whiteboard, enhancing platform familiarity and engagement. They then spent 20 minutes in the "Exhibition Area" exploring information on ethnic minorities' daily challenges (e.g., language barriers) and relevant ordinances (e.g., the Race Discrimination Ordinance) through group discussions with peers and the teacher via their chosen avatars.

After learning about ethnic minorities, students entered individual rooms for interactive activities. Each room provided background information on the partnered school (e.g., ethnicity percentages). Each room featured virtual whiteboards for students to jot down thoughts and virtual posters linking to Padlet boards. In Padlet, guiding questions assisted students brainstorm ideas for suitable service activities for their service targets.

After the interactive activities, students completed a survey on the Qualtrics platform in the "Evaluation Area", achieving a 100% response rate. The survey included 8 statements on a 5-point Likert scale (1=Strongly Disagree to 5= Strongly Agree), assessing their opinions on using the Metaverse for learning about ethnic minorities. Two open-ended questions were also included for additional insights. A week later, students visited the school to interact with service targets in real life settings and began designing service activities with their university teacher in subsequent face-to-face workshops.

3. Results and Discussion

Overall, students' responses regarding their experience with the adoption of the Metaverse as a flipped learning approach were very positive, with a strongly agreement and agreement percentages of approximately 72% for all questions (Table 1). Our students reported not only being satisfied with using the Metaverse to learn about ethnic minorities but also being willing to recommend the E-learning module to others. This finding aligns with Elliott and Shin (2002),

showing students' satisfaction crucially influence their willingness to recommend courses, with peer influence significantly impacting learning motivation (Admed et al., 2024).

Table 1. Student responses on Metaverse as flipped classroom approach.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
This E-learning module enhanced my knowledge of the ethnic minorities in Hong Kong	27.3%	54.5%	4.5%	9.1%	4.5%
This E-learning module promoted my understanding of the needs of the service targets	36.4%	50.0%	0%	13.6%	0%
This E-learning was relevant to what I might be expected to do when conducting service activities	22.7%	59.1%	13.6%	4.5%	0%
This E-learning module provided content that is relevant to my role in conducting service activities	31.8%	50.0%	4.5%	9.1%	4.5%
The use of Metaverse in this E-learning module enhanced my motivation to learn more about the ethnic minorities in local communities	40.9%	31.8%	9.1%	13.6%	4.5%
I would be more motivated to participate this E-learning module if more people joining me simultaneously	27.3%	50.0%	13.6%	4.5%	4.5%
I was satisfied with this E-learning module overall	40.9%	40.9%	9.1%	4.5%	4.5%
I would recommend this E-learning module to others	22.7%	59.1%	13.6%	0%	4.5%

3.1. Unveiling the Positive Aspects: Students Embrace the Metaverse

Two open-ended questions gathered students' insights on the Metaverse's strengths and weaknesses for flipped learning. Students reported that the Metaverse enhanced their understanding of ethnic minorities' daily challenges and provided them with an interactive platform for brainstorming and reflections with their peers about ways to coexist with ethnic minorities in local communities. This aligns with service-learning goals in university education, which aim to deepen students' understanding of curriculum-community connections, as well as fostering personal growth and social responsibilities through service experience reflections (Naudé, 2011).

The Metaverse's immersive capabilities, presenting information in various formats (e.g., texts, images and videos), engaged students by allowing them to navigate freely with chosen avatars. Key motivators included peer and teacher interactions with instant feedback, which foster active learning through group brainstorming, is crucial in flipped classroom (Thai et al., 2024). Unlike other tools like Blackboard, the Metaverse uniquely offers simultaneous bi-directional interactions with instant feedback (Baig & Yadegaridehkordi, 2023). Most students reported increased motivation to learn about ethnic minorities, enhanced by collaborative learning in Frame VR. Motivation and willingness to learn about cultural diversity are vital for developing cultural sensitivity (Alizadeh & Chavan, 2016).

The Metaverse's layout of information motivated students by offering a task-orientated learning environment. Student first learned theorical background on cultural sensitivity and ethnic minorities before engaging in interactive activities. This layout provided two benefits: it helped students understand service targets' needs and teachers' expectations, forming a foundation for designing suitable service activities in face-to-face lessons. Additionally, service-learning courses emphasise experiential learning, where cultural sensitivity is developed through practical experiences (Laszloffy & Habekost, 2010). Thus, using the Metaverse in flipped learning can enhance students' cultural sensitivity.

3.2. Students' Concerns: Addressing the Flaws

Although the Metaverse allows users to navigate virtual environments freely with their chosen avatars, its resemblance to real-life settings can cause inconvenience. For example, students reported being blocked from reading information posted in the virtual environment when others moved in front of them unexpectedly, Additionally, the text size should be larger to ensure readability from a distance.

This study has several limitations. Firstly, the findings are limited to one university in Hong Kong and may not be generalisable to other institutions or educational settings. The small participants number, despite a 100% response rate, limits generalisability, particularly without mathematical justification for conclusions. Secondly, the analysis lacks sociodemographic

information (e.g., gender and academic discipline), which could hinder our understanding of how these factors influence the Metaverse's impacts as a flipped classroom tool. Thirdly, the study focuses solely on students' experiences with the Metaverse, neglecting their digital competence. Students' prior Metaverse exposure (e.g., online gaming) can influence their perception of it as a learning tool (Sezer & Gül, 2024). Future research should involve a larger, more diverse sample, along with examinations of their digital competence and prior Metaverse exposure.

4. Conclusion

Flipped learning encourages students to review materials before class practice, but traditional tools (e.g., YouTube) often lack interaction, reducing motivation. This study explored the Metaverse's impacts on Generation Z undergraduates' motivation to develop cultural sensitivity. These tech-savvy students found it effective for learning about ethnic minorities. The immersive environment fostered cultural sensitivity and reflection, aligning with service-learning goals. Interactive activities enhanced motivation through collaboration, despite real-life-like navigation issues. Enlarging font sizes can improve readability.

Acknowledgements

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Ethical Approval

This study (HSEARS20250221002) was approved by the institutional review board of the Hong Kong Polytechnic University.

References

Ahmed, F., Ali, A., Azam, M., Mukhtar, R., & Fatima, M. (2024). Peers' Influence on Student Motivation and Performance in Physical Education and Sport Sciences: A Systematic Review. *Pakistan Journal of Humanities and Social Sciences*, 12(3), 2883-2894. https://doi.org/10.52131/pjhss.2024.v12i3.2536.

Alizadeh, S., & Chavan, M. (2016). Cultural competence dimensions and outcomes: a systematic review of the literature. *Health & Social Care in the Community*, 24(6), e117-e130. https://doi.org/10.1111/hsc.12293.

Alpala, L. O., Quiroga-Parra, D. J., Torres, J. C., & Peluffo-Ordóñez, D. H. (2022). Smart factory using virtual reality and online multi-user: Towards a metaverse for experimental frameworks. *Applied Sciences*, 12(12), 6258. https://doi.org/10.3390/app12126258.

Anastasiadis, T., Lampropoulos, G., & Siakas, K. (2018). Digital game-based learning and serious games in education. *International Journal of Advances in Scientific Research and Engineering*, 4(12), 139-144. http://doi.org/10.31695/IJASRE.2018.33016.

Baig, M. I., & Yadegaridehkordi, E. (2023). Flipped classroom in higher education: a systematic literature review and research challenges. *International Journal of Educational Technology in Higher Education*, 20(1), 61. https://doi.org/10.1186/s41239-023-00430-5.

Brooks, L. A., Manias, E., & Bloomer, M. J. (2019). Culturally sensitive communication in healthcare: A concept analysis. *Collegian*, 26(3), 383-391. https://doi.org/10.1016/j.colegn.2018.09.007.

Camilleri, M. A. (2024). Metaverse applications in education: a systematic review and a cost-benefit analysis. *Interactive Technology and Smart Education*, 21(2), 245-269. https://doi.org/10.1108/ITSE-01-2023-0017.

Divjak, B., Rienties, B., Iniesto, F., Vondra, P., & Žižak, M. (2022). Flipped classrooms in higher education during the COVID-19 pandemic: findings and future research recommendations. *International Journal of Educational Technology in Higher Education*, 19(1), 9. https://doi.org/10.1186/s41239-021-00316-4.

Elliott, K. M., & Shin, D. (2002). Student satisfaction: An alternative approach to assessing this important concept. *Journal of Higher Education policy and management*, *24*(2), 197-209. https://doi.org/10.1080/1360080022000013518.

Hwang, G. J., Tu, Y. F., & Chu, H. C. (2023). Conceptions of the metaverse in higher education: A draw-a-picture analysis and surveys to investigate the perceptions of students with different motivation levels. *Computers & Education*, 203, 104868. https://doi.org/10.1016/j.compedu.2023.104868.

Laszloffy, T., & Habekost, J. (2010). Using experiential tasks to enhance cultural sensitivity among MFT trainees. *Journal of Marital and Family Therapy*, 36(3), 333-346. https://doi.org/10.1111/j.1752-0606.2010.00213.x.

Lee, H., & Hwang, Y. (2022). Technology-enhanced education through VR-making and metaverse-linking to foster teacher readiness and sustainable learning. *Sustainability*, 14(8), 4786. https://doi.org/10.3390/su14084786.

López-Belmonte, J., Pozo-Sánchez, S., Moreno-Guerrero, A. J., & Lampropoulos, G. (2023). Metaverse in Education: a systematic review. *Revista de Educación a Distancia (RED)*, 23(73). https://doi.org/10.6018/red.511421.

Naudé, L. (2011). Your culture or mine? Changes in cultural sensitivity in a service-learning class. *Journal of Psychology in Africa*, 21(3), 487-491. https://doi.org/10.1080/14330237.2011.10820487.

Sezer, H., & Gül, A. (2024). Health sciences students' perspectives on metaverse and digital technology use: cross-sectional descriptive study. *BMC nursing*, 23(1), 656. https://doi.org/10.1186/s12912-024-02309-w.

Thai, N. T. T., De Wever, B., & Valcke, M. (2024). Providing feedback during the online phase of a flipped classroom design: Fostering sustainable learning performance while considering study time Management. *Sustainability*, 16(7), 3089. https://doi.org/10.3390/su16073089.

Tomas, L., Evans, N. S., Doyle, T., & Skamp, K. (2019). Are first year students ready for a flipped classroom? A case for a flipped learning continuum. *International Journal of*

Educational Technology in Higher Education, 16(1), 1-22. https://doi.org/10.1186/s41239-019-0135-4.

Wang, K., & Zhu, C. (2019). MOOC-based flipped learning in higher education: students' participation, experience and learning performance. *International Journal of Educational Technology in Higher Education*, 16(1), 1–18. https://doi.org/10.1186/s41239-019-0163-0.

Zhao, L., He, W., & Su, Y. S. (2021). Innovative pedagogy and design-based research on flipped learning in higher education. *Frontiers in Psychology*, 12, 577002. https://doi.org/10.3389/fpsyg.2021.577002.

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Understanding Student Learning Behaviours in E-Learning: Insights from STEM and Social Science Modules

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Abstract

The concept of E-learning has gained popularity among universities and students in recent years as E-learning education platforms can record student learning behaviours in its many forms to recognise and analyse student learning styles. However, it is known that the challenges this brings in monitoring student engagement with course material can be considerable and variable between STEM (Science, Technology, Engineering, Math) and Social Sciences courses. This paper applies a graph-based community detection method that integrates the cumulative actions of a student with the Virtual Learning Environment (VLE), through a preprocessing technique, facilitating deeper analysis of student performance using the OULAD dataset[1]. Our findings reveal that this method is trustworthy, and we show that it outperforms traditional classification and clustering methods and achieves superior accuracy in evaluating and predicting academic outcomes—encompassing both formative assignments and terminal assessments. Moreover, this method uncovers variations in learning styles among students in STEM and Social Sciences, indicating commonalities and diversity of the learning approach for the different types of classes, in the same E-learning system.

Keywords: *Learning analytics; E-learning strategies and methodologies; STEM and social sciences; community detection.*

1. Introduction

E-learning platforms are known to create new challenges across both STEM and Social Science modules (Alfaro et al., 2021), requiring educators and students to discover effective learning styles (Downes, 2005). Due to the difficulties in maintaining engagement and communication, managing diverse learning preferences, and integrating technology effectively, having suitable

[1] Open University Learning Analytics Dataset, https://analyse.kmi.open.ac.uk/open_dataset

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E-learning strategies is crucial (Ouadoud et al., 2021). Given sufficient E-learning data, Artificial Intelligence (AI) could be expected to be a powerful tool for addressing the learning approach for each kind of module. Additionally, understanding student behaviour in E-learning environments is essential for comprehending how they engage with course materials and how their learning processes are represented (Qiu et al., 2022). In other words, beyond basic course information, E-learning environments offer other meaningful data, such as mouse-clicking behaviour analysis that can be examined in greater depth (Mai et al., 2022). AI can provide insights that contribute to the field of learning analytics (Krugel et al., 2015; Duane, 2024), functioning as a tool to simulate and analyse student E-learning behaviour data. This can enable educators to identify hidden information that informs effective adaptations to learning strategies such as early warning of at-risk students or enhancing course materials quality (Sweeney, 2023). This research enhances the teaching strategies for both STEM and Social Science modules, answering various questions about how both course types benefit from similar methods (Stanigar and Carson, 2020).

In addition, in the domain of applying AI in learning analytics, graph methods are a group of techniques that have shown a significant impact in understanding student behaviours (Porras et al, 2023) and cognitive engagement (Chi et al., 2014). They can represent a group of students in one cohort or class by illustrating their study behaviour data as nodes, and the relationships in learning behaviours as edges, allowing for the recognition of hidden information, such as similarities in learning patterns (Mai et al., 2023). This method has been shown to be highly effective for the visual representation of students in one class (Le et al., 2024), thus potentially offering great benefits to educators (e.g. targeted intervention) in pedagogy. However, considerable effort is needed to preprocess and model data before applying AI methods.

Overall, this paper aims to answer these research questions:

a. How can real-world student learning behaviours be modelled in the context of E-learning?
b. What do these behaviours show in terms of differences in student learning behaviours that can be identified between students in STEM classes and those in Social Sciences classes?

In section 2 of this paper, we apply the method of modelling and analysing the OULAD dataset. After that, we describe the experiment results compared to popular methods and conclude our findings in section 3. Finally, we put our discussion in section 4 before concluding.

2. Methods

2.1. Pre-process method

2.1.1. Feature selection in the OULAD dataset

To reveal commonalities and differences in learning styles between the two types of classes, this research utilised the OULAD dataset (Kuzilek et al., 2017), which features seven e-learning modules in both Social Sciences and STEM that exhibit similar types of online VLE (Virtual Learning Environment) behaviours. The number of interactions for each E-learning element per course per student is counted by date and can be aggregated to describe the learning style at that moment. Consequently, each interaction type is treated as one feature column for the analysis, contributing to the overall learning behaviour. This facilitates a comparison between the two class types—an intriguing topic compared to common questions in this dataset (Jin et al., 2024).

In addition to the VLE interactions, the OULAD dataset records the students' progress assignments and final test results for students of three social sciences and four STEM modules, divided by each class regarding the semester. As both types of modules share similar VLE elements, it allows this research to compare the learning styles of both cases. All the results are converted into two values: 0 for fail and 1 for pass, with 40 as the passing score. Students who deregister during the learning period are excluded, as are assessments with item weights of less than 10%, because they do not greatly add to learning progress. Overall, data from 18,029 e-learners was considered for analytics. Table 1 describes modules information.

Table 1. Information of modules in the OULAD dataset

Module	Number of classes	Number of observed students	Observed formative assignments	Number of types of VLE elements
AAA	2	589	5	9
BBB	3	3609	5	11
CCC	2	2212	4	9
DDD	4	3400	5 or 6	18
EEE	3	1668	4	11
FFF	4	4579	5	18
GGG	3	1972	0	7

2.1.2. Virtual Learning Environment interactions accumulate

The number of interactions with VLE elements is accounted by summation through each action from the time they did the registration, reflecting student engagement in the course and mirroring how teachers summarise data. Afterwards, data is divided into two granularities (one-week or two-week period) for retrospective analysis of student learning behaviours throughout learning time. In addition, for measuring progress, the closest assessment result is applied as the

label for a learning interval, along with the terminal test result. For example, if a student has an assignment in the 7th interval, the label for intervals 0 to 7 is that assignment's result. For the next assignment in the 9th interval, its result labels both the 8th and 9th intervals. Moreover, types of VLE interactions are considered as features for the AI method to figure out important factors affecting the test results in modules, which also represent the learning style.

2.2. Graph-based community detection

2.2.1. Graph constructions

Each interval of the learning progress is transformed into a graph, the nodes of which represent student learning behaviour vectors, i.e. the number of VLE features equals the number of dimensions for each node. The graph's edges are calculated based on the correlation between two nodes v_i and v_j via Pearson correlation coefficient (Equation 1) and using the distance metric (Equation 2) to preserve nodal separation after transformation. Therefore, two nodes with short distance imply high similarity of the VLE interactions between two students depicted.

$$C_{ij} = \frac{\sum_{k=1}^{n}(V_{ik}-\overline{V_i})(V_{jk}-\overline{V_j})}{\sqrt{\sum_{k=1}^{n}(V_{ik}-\overline{V_i})^2}\sqrt{\sum_{k=1}^{n}(V_{jk}-\overline{V_j})^2}} \quad (1) \qquad D_{ij} = \sqrt{0.5 \cdot (1 - C_{ij})} \quad (2)$$

Afterwards, to reduce the complexity of a fully connected graph but preserve the connectivity, a Minimum Spanning Tree (MST) (Graham et al., 1985) is extracted from the original graph to prevent any self-loop in the graph that may cause an unoptimised solution.

2.2.2. Community detection and analysis

A community in a graph can be seen as a group of nodes where members have stronger interactions with each other rather than with external nodes (Fortunato, 2010). This structure can help uncover hidden patterns in a graph, motivating us to adopt it to represent the changes in online learning behaviour patterns among students. Mai et al., 2022 found that students who share the same studying activities tend to have similar learning outcomes. Therefore, it is intuitive to expect that students represented by nodes within the same community might show similar results for both short-term and long-term learning outcomes.

The flow of graph construction and community detection is represented in Figure 1.



Figure 1. The flow of graph construction and community detection

To find groups of similar students in the graph structure, this paper employs the Louvain method (Blondel et al., 2008), a heuristic method that returns high accuracy with a good time complexity

$O(n\ log\ n)$. Afterwards, a voting process within each community determines the majority label for nodes inside them, leading to a prediction that all students in this community may either pass or fail together. We use the accuracy metrics to verify prediction values and then compare them to the results of five commonly used classification methods: Random Forest (RF), K- Nearest Neighbours (KNN), Support Vector Machine (SVM), XGboost and Logistic Regression (LR) (Jin et al., 2024) to ascertain whether graph-based community detection outperforms other methods to guarantee the analytic results. The key features are identified to reveal the most impactful student learning behaviours, thus highlighting the learning approach for each module before making conclusions on the similarities and differences of STEM and Social Sciences classes in this dataset.

3. Results and discussion

3.1. Community detection and representation

Overall, community detection results outperform those of other classification methods through the learning time, achieving the accuracy about 0.9 across all experiments. For example, Figure 2 shows the accuracy of community detection by the graph method for module DDD, through the 1-week interval, for both formative assignments and terminal result, compared to the results of other methods. Moreover, since the number of communities does not need to be pre-defined, graph methods can significantly outperform traditional clustering techniques on numeric data. Consequently, the result shows a great improvement from other conventional AI-approaches, leading to its reliability for assessing the impact of each feature on the prediction value, thereby highlighting the effect of each VLE interaction on the learning style of each module.

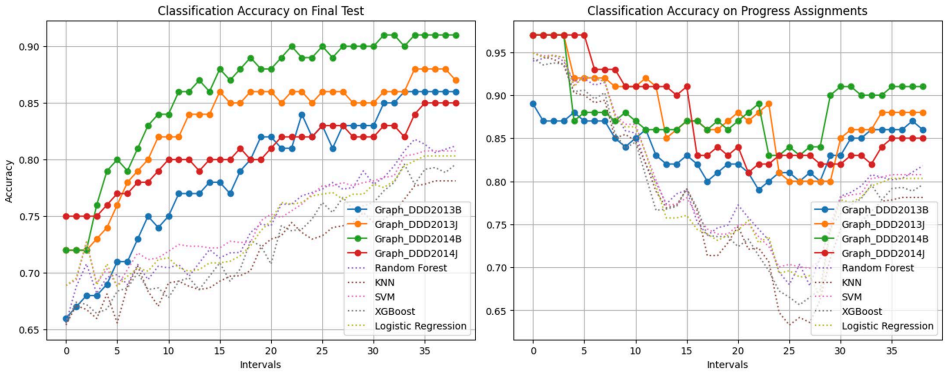


Figure 2. Community detection accuracy for 1-week intervals, versus other methods for 4 DDD modules

Another pedagogical outcome of this method is the representation of student communities for each learning interval, illustrated by the Kamada-Kawai method (Kamada and Kawai, 1988) in Figure 3. The communities detected can facilitate predictions and highlight the communities to

which students belong. Educators can utilise these insights to identify groups with similar study behaviours, enabling them to anticipate outcomes more accurately.

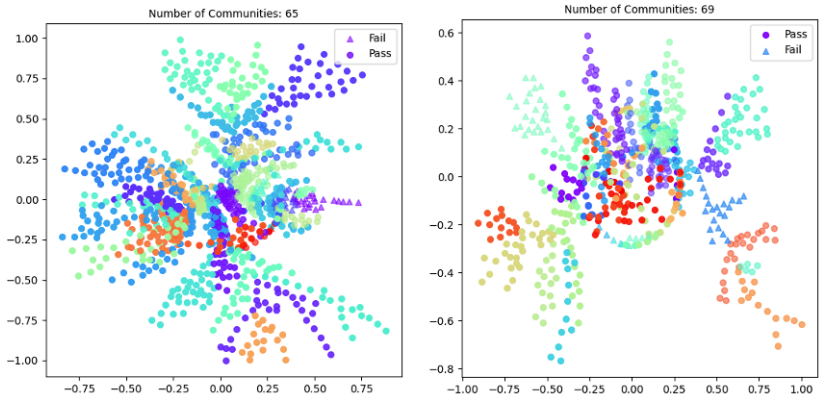


Figure 3. The community visualisation course module FFF, class 2013J in 2 different intervals

3.2. Behavioural interaction analysis for STEM and Social Sciences classes

From the community detection results, we find the most influential VLE elements for each community by using the majority voting and then aggregate them to identify the learning styles for each module. Table 2 presents it, regarding the outcome and comparing between STEM and Social Science types. Overall, the key module elements are "oucontent" and "homepage", indicating that students must engage with the modules' main contents to score well.

Table 2. Most Impactful VLE for Assignments (Bold for Both, Italics for Single Module Type)

Module type	Class	Most influential VLE elements	Most influentialVLE to pass-detected community	Most influential VLE to fail-detected community
Social Scie-nces	AAA	**oucontent**	**oucontent**, subpage, rl, dataplus	oucollaborate, *glossary*
	BBB	**oucontent**, *quiz*, **homepage**	**oucontent,** resources, *quiz*, **homepage**	ouelluminate, oucollaborate, sharedsubpage
	GGG	**oucontent**, *quiz*, forumng	oucontent, forumng, **homepage**, *quiz*	*glossary*, resource, subpage
STEMS	CCC	*subpage*, *forumng*, **homepage**	**homepage**, *subpage* *url*, *forumng*	**oucontent**, resource, oucollaborate
	DDD	*subpage*, resource, wiki	**outcontent,** glossary, wiki *subpage,* externalquiz, *forumng*	page, ouelluminelate, oucollaborate
	EEE	**oucontent**, *url*, **homepage**	**oucontent**, *forumng*, **homepage**, oucollaborate	quiz, page
	FFF	*subpage*, **oucontent**, folder	**homepage**, *subpage*, **oucontent**	htmlactivity, repeatactivity, ouelluminate, oucollaborate

For STEM modules, some VLE elements, e.g., "url," "forumng," and "subpage," significantly contribute to student success. This suggests that seeking information from multiple data sources and participating in forum discussions can lead to better outcomes for students. In contrast, students who focus primarily on resources like "ouelluminelate" or "oucollaborate" tend to struggle with assignments. For Social Science modules, "quiz" is crucial in good result (notably, module AAA lacks the "quiz" VLE), showing the value of completing homework to achieve high scores. Conversely, spending excessive time on elements like "glossary" or "subpage" may indicate that students are not adopting effective strategies for these modules.

4. Discussion and Limitation

Regarding RQ1, our graph-based method effectively models student learning behaviours, grouping students with similar behaviours and academic results into the same communities. In our experiment, it can be seen to outperform traditional methods in predicting academic performance from student learning behaviours. It can provide educators with deeper insights for further analysis. One such analysis is explored in our response to RQ2. We examine STEM modules that require students to conduct extensive research through multiple VLE elements, while Social Sciences modules tend to provide many practices as quizzes for students to improve their study results. Although class content is important for both types of modules, the variances in student learning behaviours show different approaches for students in each type of E-learning module. Overall, with the comparison to other classification methods, this modelling and analytics method shows significant potential application in classroom settings.

This research has limitations related to the dataset. First, student data is aggregated based on community detection for only one interval, which could be improved for better decision-making. Second, extensive data preprocessing and graph formation are needed, making it challenging to apply across classes with varying VLE elements. Third, the absence of other information from classes hinders generalisability, such as interaction with traditional elements like taking note. However, the unique features of OULAD dataset, such as multiple modules with a consistent framework and representation of both STEM and Social Sciences, confirm its reliability for analysis despite being available for several years. In the empirical educational setup, teachers and educators can employ this graph method, combining data from both E-learning environment and static elements to discover the suitable approach for students at every week of the learning period and make interventions for students.

5. Conclusion

In this paper, we proposed a data-driven graph method to model and represent the learning behaviours of students using virtual learning environments in E-learning classes, specifically utilising the OULAD dataset. This method demonstrates outstanding results compared to other

approaches and reveals hidden similarities in student learning behaviours across all modules. Based on this modelling, we can detect learning approaches that lead to either good or poor outcomes, highlighting trends in student engagement with specific modules. As a result, it uncovers distinct learning styles for STEM and Social Science classes within this E-learning environment: the former requires considerable effort in researching both the provided course materials and external sources, while the latter emphasises the importance of practising quizzes to achieve desired results. These meaningful insights also suggest that this method has significant potential for application to other learning analytics datasets, offering valuable contributions to pedagogical outcomes such as early detection of "at-risk" students or evaluation of the engagement of students to a specific E-learning object.

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References

Alfaro, L., Rivera, C., Luna-Urquizo, J., Castañeda, E., Zuniga-Cueva, J., & Rivera-Chavez, M. (2021). New Trends in e-Technologies and e-Learning. In 2021 IEEE World Conference on Engineering Education (EDUNINE) (pp. 1-6). IEEE.

Blondel, V. D., Guillaume, J. L., Lambiotte, R., & Lefebvre, E. (2008). Fast unfolding of communities in large networks. J. Stat. Mech: Theory Expt, 2008(10), P10008.

Chi, M. T., & Wylie, R. (2014). The ICAP framework: Linking cognitive engagement to active learning outcomes. Educational psychologist, 49(4), 219-243.

Downes, S. (2005). E-learning 2.0. ELearn, 2005(10), 1.

Duane, A. (2024). Can artificial intelligence complete my assessment? a student led initiative to stress test the academic integrity of university assessment using generative AI. In 10th Int Conf. on Higher Education Advances (HEAd'24). Editorial Universitat Politècnica de València.

Fortunato, S. (2010). Community detection in graphs. Physics Reports, 486(3-5), 75-174.

Graham, R. L., & Hell, P. (1985). On the history of the minimum spanning tree problem. Annals of the History of Computing, 7(1), 43-57.

Jin, L., Wang, Y., Song, H., & So, H. J. (2024, July). Predictive modelling with the Open University Learning Analytics dataset (OULAD): A systematic literature review. In International Conference on Artificial Intelligence in Education (pp. 477-484). Cham: Springer Nature Switzerland.

Kamada, T., & Kawai, S. (1988). A simple method for computing general position in displaying three-dimensional objects. Computer Vision, Graphics, and Image Processing, 41(1), 43-56.

Krugel, J., Hubwieser, P., Goedicke, M., Striewe, M., Talbot, M., Olbricht, C., ... & Zettler, S. (2020, April). Automated measurement of competencies and generation of feedback in object-oriented programming courses. In 2020 IEEE Global Engineering Education Conference (EDUCON) (pp. 329-338). IEEE.

Kuzilek, J., Hlosta, M., & Zdrahal, Z. (2017). Open university learning analytics dataset. Scientific Data, 4(1), 1-8.

Le, L. H., Nguyen, H. D., Crane, M., & Mai, T. T. (2024, June). Multimedia learning analytics feedback in simulation-based training: A brief review. In Proceedings of the 1st ACM Workshop on AI-Powered Q&A Systems for Multimedia (pp. 25-30).

Mai, T. T., Bezbradica, M., & Crane, M. (2022). Learning behaviours data in programming education: Community analysis and outcome prediction with cleaned data. Future Generation Computer Systems, 127, 42-55.

Mai, T. T., Crane, M., & Bezbradica, M. (2023). Students' learning behaviour in programming education analysis: Insights from entropy and community detection. Entropy, 25(8), 1225.

Ouadoud, M., Rida, N., & Chafiq, T. (2021). Overview of E-learning Platforms for Teaching and Learning. Int. J. Recent Contributions Eng. Sci. IT, 9(1), 50-70.

Porras Alfonso, S., Puche Regaliza, J. C., Casado Yusta, S., Sauvée, A., Antón Maraña, P., & Pacheco Bonrostro, J. A. (2023). Relationship between time management and class attendance in university students: clustering techniques for detection of profiles. In 9th International Conference on Higher Education Advances (HEAd'23) (pp. 851-859).

Qiu, F., Zhang, G., Sheng, X., Jiang, L., Zhu, L., Xiang, Q., ... & Chen, P. K. (2022). Predicting students' performance in e-learning using learning process and behaviour data. Scientific Reports, 12(1), 453.

Stanigar, J., & Carson, S. (2020). Adoption of evidenced-based teaching strategies in STEM and non-STEM courses after a common faculty development experience. In 6th International Conference on Higher Education Advances (HEAd'20) (pp. 173-181). Editorial Universitat Politècnica de València.

Sweeney, S. (2023). Academic dishonesty, essay mills, and artificial intelligence: rethinking assessment strategies. In 9th International Conference on Higher Education Advances (HEAd'23) (pp. 19-22).

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Hedonomic Pyramid to enhance Student Experience in Higher Education: A conceptual framework

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Abstract

This paper introduces the Hedonomic Pyramid as a conceptual framework for enhancing the Student Experience (SX) in Higher Education (HE). Based on Maslow's hierarchy of needs, it structures SX into five hierarchical levels: Safety and Accessibility, Functionality and Usability, Engagement and Connection, Personalization and Development, and Satisfaction and Fulfillment. Each level integrates personal, social, academic, institutional, and external dimensions that influence students' perceptions and outcomes. The framework was developed through a theoretical analysis and refined with insights from a focus group involving six master's students, who discussed key barriers and enablers in their academic journey. The Hedonomic Pyramid offers a comprehensive, student-centered perspective for understanding and addressing the complex, multidimensional nature of SX. It serves as a foundation for institutions seeking to foster more inclusive, motivating, and meaningful educational environments aligned with students' evolving needs and expectation.

Keywords: *Student Experience (SX); Higher Education (HE); Hedonomic pyramid; educational framework; hierarchy of needs; student satisfaction*

1. Introduction

In the dynamic landscape of higher education (HE), enhancing the student experience (SX) has become a priority. SX encompasses the full range of experiences students undergo throughout their academic journey, from individual course quality to broader interactions with university life (Baik & Kahu, 2023). These experiences are shaped by diverse factors, including teaching quality, clarity of instruction, and satisfaction with educational outcomes. Broadly, SX reflects both academic and non-academic dimensions, capturing the holistic nature of a student's time at university.

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The concept of SX shares foundational principles with User Experience (UX), defined by the ISO 9241-210 (2019) as the "perceptions and responses of a person resulting from the use or anticipated use of a product, system, or service". UX encompasses emotions, beliefs, behaviours, and achievements at various stages of interaction, forming an episodic narrative as described by Hassenzahl (2010). Applied to education, SX becomes a dynamic interplay between students and their environments—faculty, peers, learning materials, and infrastructure—that impacts not only academic success but also emotional and social well-being. In HE, SX spans application to post-graduation, influenced by academic, social, emotional, and administrative interactions. As Baik & Larcombe (2023) noted, the marketization of HE has redefined students as consumers, emphasizing not only the quality of education but also the value and services institutions provide.

According to Matus et al. (2021) the SX can be understood through several dimensions, each contributing uniquely to the holistic educational journey of a student: (i) personal dimension includes individual student characteristics, considering the needs and personal development, encompassing factors that affect their motivation, well-being, and personal growth within the university environment; (ii) the social dimension includes extracurricular activities, peer interactions, and the overall sense of community and belonging that students experience at the university; (iii) the academic dimension involves direct interactions with the academic content and teaching staff, engagement with the curriculum, and the intellectual growth opportunities available to students. The academic dimension is central to SX as it directly relates to the core educational outcomes and learning experiences. To finish, (iv) the institutional dimension includes Structural support, including health services, counselling, and administrative efficiency.

Understanding these dimensions requires a deeper exploration of human needs and motivations. Maslow's Hierarchy of Needs identified a progression from basic physical needs to self-actualization, emphasizing the necessity of addressing foundational needs like safety before higher goals can be achieved (Maslow, 1943). In HE, this perspective underscores the importance of creating environments that allow students to thrive both academically and personally. The Hedonomic Pyramid, developed by Hancock et al. (2005), builds on Maslow's framework by applying it to technology and UX, structuring interactions into functional, efficient, and satisfying experiences. In HE, this model provides a roadmap for designing learning environments that meet basic needs while promoting emotional and intellectual fulfilment.

This paper explores how the Hedonomic Pyramid can be adapted to HE, addressing the complexities of the SX. Originally developed for user interactions with technology, the pyramid's focus on functionality, efficiency, and satisfaction aligns well with students' academic, social, and personal needs. SX extends beyond academics to include emotional well-

being, social integration, and personal growth. Adapting the pyramid helps institutions address these layered needs, from ensuring safety and usability to fostering motivation and fulfilment.

2. Research method

This study followed a two-phase methodological approach combining theoretical analysis and exploratory qualitative research to adapt the Hedonomic Pyramid to the context of HE.

In the first phase, a theoretical framework was developed through an extensive review of literature on Maslow's hierarchy of needs (1943), the Hedonomic Pyramid by Hancock et al. (2005), and key models from UX and SX research. This analysis allowed for the identification and initial definition of the five hierarchical levels and associated dimensions that structure the proposed framework.

In the second phase, a focus group was conducted with six master's students (four women and two men) from varied disciplinary backgrounds and academic trajectories. Participants were asked to reflect on their academic journey, specifically discussing enablers and barriers related to engagement, satisfaction, accessibility, and personalization. The qualitative data collected served to refine the framework and validate the relevance and coherence of each level within real-life HE contexts. Ethical approval was obtained, and all participants gave informed consent.

3. The Hedonomic Pyramid for Student Experience (SX)

The Hedonomic Pyramid for SX is an adapted framework designed to provide a structured, hierarchical understanding of how HE institutions can address the diverse and evolving needs of students throughout their academic journey (Figure 1). Building upon Hancock's original Hedonomic Pyramid (2005) and informed by Maslow's hierarchy of needs, this model categorizes the factors that influence student satisfaction, engagement, and long-term academic success within a university setting. This adapted pyramid consists of five interdependent levels, each representing a progressive stage of experience optimization.

The Hedonomic Pyramid (Figure 1) incorporates two complementary lateral axes: Ergonomics to Hedonomics and Shifts in Focus from Academia to Value.

The right axis illustrates the progression from ergonomics to hedonomics. This transition moves beyond focusing solely on the functionality and efficiency of educational systems (ergonomics) to emphasize the creation of emotionally enriching and pleasurable experiences (hedonomics).

The left axis represents the evolution of focus within HE. Initially, institutions prioritize academic structures and operational efficiency, centering efforts on content delivery and institutional objectives. The next stage shifts toward a student-centric approach, addressing

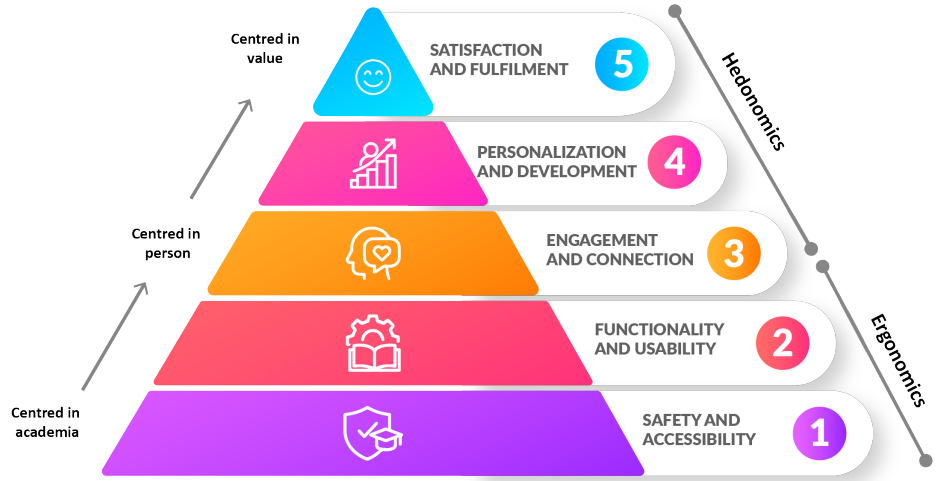


Figure 1: The Hedonomic Pyramid for Student Experience (SX). Adapted from Hancock et al. (2005).

individual growth, autonomy, and personalized support. Finally, at its highest level, the focus moves toward creating experiences that maximize value for students. This includes fostering transformative engagements that prepare students for professional success and meaningful societal contributions, ensuring long-lasting satisfaction and a legacy of impactful learning.

3.1. Level 1: Safety and Accessibility

The foundational level of the Hedonomic Pyramid for SX emphasizes the creation of an inclusive, secure, and barrier-free academic environment. Safety and accessibility serve as prerequisites for effective learning, as students cannot fully engage with their academic and social experiences if basic physical, emotional, or digital barriers exist. The key components in this level are:

- **Physical accessibility:** Infrastructure adjustments such as ramps, elevators, and accessible classrooms ensure equitable participation for all students, including those with physical disabilities (Nikolaraizi et al., 2023).
- **Digital accessibility:** Digital learning tools, such as learning management systems and virtual classrooms, must be designed for universal access, ensuring usability for students with varying levels of digital literacy or assistive technology needs.
- **Emotional and physical safety:** Environments free from discrimination, harassment, and violence, supported by institutional policies on psychological safety and inclusion.

In HE, safety and accessibility are shaped by multiple factors that directly impact students' ability to participate fully in their academic journey. On a personal level, factors such as socioeconomic status, disabilities, age, gender identity, and family background shape students' ability to participate (Aza et al., 2023; Cowley et al., 2024; Sax, 2009; Stewart et al., 2023;

Zhjeqi et al., 2024). Financial instability can hinder access to resources, while inadequate accommodations create barriers for students with disabilities (Aza et al., 2023; Stoll et al., 2023; Zhjeqi et al., 2024). Age also plays a role, with older students often balancing academic commitments with work and family, while younger students may face emotional insecurities in a new environment. The absence of inclusive policies can impact emotional safety, particularly for students navigating gender identity issues. Socially, fostering inclusive communities and ensuring environments free from discrimination enhance emotional well-being and a sense of belonging. Academically, equitable access to learning materials and inclusive curricula addresses diverse learning needs (Stowell, 2004). Institutions contribute through supportive policies, accessible infrastructure, and services such as counselling and career guidance, all of which improve accessibility and safety. External factors, such as geographic location and transportation accessibility, also affect students' engagement, particularly in underserved areas (Kahu et al., 2020).

3.2. Level 2: Functionality and Usability

The second level of the Hedonomic Pyramid focuses on functionality and usability, which are critical elements for ensuring that educational systems, methods, and resources are effective, and practical. This level ensures that students not only have access to the necessary tools but can also use them efficiently, fostering a smooth and optimized learning experience. Functionality and usability directly influence the quality of learning, as well-designed educational environments allow students to focus on content by eliminating technical or methodological barriers that could hinder their academic progress. This level includes three main components:

- **Resource functionality:** The quality, relevance, and effectiveness of pedagogical tools, academic management systems, and learning materials.
- **Platform and method usability:** Efficient navigation and seamless experiences in digital environments, such as virtual classrooms and collaborative tools.
- **Learning process optimization:** The adaptation of methodologies and technologies to ensure that the educational process is functional and practical, enabling effective student interaction with their environment.

Functionality and usability depend on several dimensions. At the personal level, digital skills, learning styles, and sense of self-efficacy are crucial (Browning & Bustard, 2024; Hanley & Wyatt, 2021; Moesarofah et al., 2023). Limited technical proficiency can exclude students, highlighting the need for inclusive designs and adaptable tools that support diverse learning styles. Intuitive platforms and clear guidance reduce anxiety and boost engagement. Socially, collaboration tools like shared documents and virtual discussions promote equitable participation and strengthen peer connections, while supportive relationships with instructors enhance learning (Browning & Bustard, 2024; Cowley et al., 2024; Stewart et al., 2023; Zhjeqi

et al., 2024). Academically, resources must align with curricula, be accessible, and motivate students through innovative methods like flipped classrooms and problem-based learning. Formative assessments offer feedback to guide progress (Kahu et al., 2020). Institutionally, accessible, intuitive platforms and streamlined systems simplify processes like enrolment. Policies must foster innovation and staff training to keep resources relevant. Externally, emerging technologies like AI and virtual reality expand possibilities, while students expect mobile-friendly, personalized tools that adapt to evolving trends.

3.3. Level 3: Engagement and connection

The third level of the Hedonomic Pyramid emphasizes the importance of emotional engagement and meaningful connection as fundamental pillars of a significant and satisfying educational experience. This level goes beyond functional interactions between students and their environment, aiming to cultivate emotional bonds that enhance active participation, a sense of belonging, and intrinsic motivation.

A university environment that fosters quality relationships, supportive communities, and shared purpose can transform the SX, promoting not only academic development but also emotional and social well-being. The following variables are associated with this level from a multidimensional perspective:

- **Meaningful interactions:** High-quality relationships between students, faculty, and academic staff that promote a collaborative and empathetic environment.
- **Sense of community:** Programs that encourage student participation in extracurricular activities, associations, or interest groups.
- **Intrinsic motivation:** Developing an environment that inspires genuine commitment and emotional connection to educational and professional goals.

Engagement and connection are shaped by various dimensions. On a personal level, intrinsic motivation is driven by curiosity, self-efficacy, and vocational clarity, helping students find purpose in their studies. Personality traits such as openness and emotional stability further encourage meaningful interactions and group participation. The social dimension highlights the role of relationships. Supportive interactions with peers, faculty, and family foster collaboration, resilience, and a sense of community, while belonging enhances students' connection to their environment. Academically, active participation through methods like problem-based learning and collaborative projects strengthens emotional involvement and reinforces the relevance of academic goals (Tinto, 2017). Feedback systems sustain motivation and a sense of progress. Institutionally, campus culture, extracurricular activities, and inclusive policies encourage engagement by promoting diversity, social integration, and institutional identity (Heilporn & Lakhal, 2021). Informal spaces and structured initiatives further support interaction and community-building. External factors, such as cultural norms and partnerships with local or

global communities, deepen students' sense of purpose and expand connections beyond the campus, enriching the overall educational experience.

3.4. Level 4: Personalization and Development

The fourth level emphasizes the importance of adapting the educational experience to the unique goals, needs, and abilities of individual students. Personalization ensures that the academic journey is relevant and meaningful for each learner.

- **Flexible learning paths:** Curricula tailored to students' aspirations.
- **Personal growth opportunities:** Initiatives fostering emotional, academic, and professional development.
- **Mentorship programs:** Personalized guidance supporting student success.

This level spans multiple dimensions. The personal dimension focuses on tailoring education to individual goals, learning styles, and emotional growth, fostering self-efficacy, resilience, and autonomy. In the social dimension, mentorship programs and collaborative flexibility provide tailored support and promote inclusion, while social networks ensure students feel connected and supported. Academically, personalized curricula, innovative assessments, and applied learning opportunities align education with students' strengths and career goals. Institutions play a key role by offering adaptable policies, infrastructure, and learning environments to accommodate diverse needs. Externally, personalization aligns education with professional and societal demands. Flexible learning modes, such as hybrid and remote options, ensure accessibility and equip students with skills relevant to their aspirations and the job market.

3.5. Level 5: Satisfaction and fulfilment

The final level represents the ultimate goal of the SX: achieving deep satisfaction, a sense of personal accomplishment, and long-term fulfilment from the educational journey.

- **Achievement of academic goals:** Completion of degrees and personal milestones.
- **Memorable experiences:** Transformative projects and impactful learning moments.
- **Holistic well-being:** Balance in academic, emotional, and personal dimensions.

On a personal level, fulfilment stems from emotional well-being, psychological stability, and the recognition of achievements. Celebrating academic milestones fosters pride and motivation, while the ability to navigate challenges enhances confidence and self-worth. The social dimension emphasizes belonging and shared successes. Supportive networks and collective achievements, such as group projects or initiatives, strengthen ties to the university community and provide emotional fulfilment. Academically, unique opportunities like transformative projects, international collaborations, and lifelong learning initiatives expand perspectives and equip students for personal and professional growth beyond formal education. Institutions play a key role through formal recognition programs, such as awards and ceremonies, which validate

students' accomplishments. Wellness initiatives addressing mental health and stress management further enhance satisfaction, creating a supportive and holistic environment. Externally, fulfilment extends to societal and professional contexts. Career readiness programs and opportunities for impactful contributions enable students to apply their knowledge meaningfully, fostering a sense of purpose and long-term achievement.

4. Conclusions and future lines

This paper introduces the Hedonomic Pyramid as a structured framework for enhancing the SX in HE. By addressing hierarchical needs from foundational safety to personal fulfilment, the model offers a comprehensive approach to understanding and improving SX. It emphasizes creating inclusive, human-centred educational environments that support students' academic, emotional, and personal growth while promoting engagement and long-term satisfaction. The pyramid's layered structure helps institutions identify and address gaps in areas like accessibility, usability, emotional connection, and personalization. This approach not only fosters better academic outcomes but also enhances student retention, equity, and readiness for life beyond university.

Practically, the framework can guide institutional improvement strategies, support co-design processes with students, and be used across various university departments. It also offers a foundation for the development of diagnostic tools such as questionnaires or evaluation instruments

However, this study remains a theoretical exploration, lacking empirical validation and practical application across diverse institutions and cultural contexts. The hierarchical nature of the pyramid may oversimplify the complexities of SX, where needs often overlap or evolve dynamically. Challenges related to operationalizing the framework—such as institutional resistance, resource limitations, and varying levels of technological readiness—also require further exploration. Additionally, the framework must adapt to the rapid evolution of educational technologies and the growing demands of remote and hybrid learning environments.

Despite these challenges, the pyramid offers practical implications. It can inform institutional policies on inclusion and well-being, guide staff training in human-centred educational practices, and support the design of learning environments that are flexible, accessible and emotionally engaging. Additionally, the model could serve as a conceptual foundation for the development of new assessment tools—such as questionnaires, diagnostics, or design guidelines—focused on evaluating or improving the SX in a structured and evidence-based way. Future research should focus on validating the framework through empirical studies, developing measurable indicators for each level, and exploring its application in diverse learning environments—including online and hybrid settings—to ensure its adaptability to the evolving landscape of higher education.

References

Aza, A., Guilera, G., Chai, C. A., Gómez-Benito, J., Guerrero, E., & Barrios, M. (2023). *The engagement in university students: preliminary psychometric analyses of the Spanish version of the engagement vs. disaffection with learning scale*.

Baik, C., & Kahu, E. R. (2023). What is "the student experience"? In *Research Handbook on the Student Experience in Higher Education* (pp. 2–12). Elgar Handbooks in Education.

Baik, C., & Larcombe, W. (2023). Student wellbeing and students' experiences in higher education. In *Research Handbook on the Student Experience in Higher Education* (pp. 74–87).

Browning, J. W., & Bustard, J. (2024). A systematic literature review of entrepreneurial education in electrical, electronic, and computer engineering curricula. *IEEE Access*.

Cowley, E. S., Goss, H. R., Mahon, C., Dunne, C., & Belton, S. (2024). Exploring the health and wellbeing landscape at a third level institution. *Wellbeing, Space and Society*, *7*. https://doi.org/10.1016/j.wss.2024.100221

Hancock, P. A., Pepe, A. A., & Murphy, L. L. (2005). Hedonomics: The power of positive and pleasurable ergonomics. *Ergonomics in Design*, *13*(1), 8–14. http://doi.org/10.1177/106480460501300104/ASSET/106480460501300104.FP.PNG_V03

Hanley, T., & Wyatt, C. (2021). A systematic review of higher education students' experiences of engaging with online therapy. *Counselling and Psychotherapy Research*, *21*(3), 522–534. https://doi.org/10.1002/capr.12371

Hassenzahl, M. (2010). Experience design: Technology for all the right reasons. *Synthesis Lectures on Human-Centered Informatics*, *3*(1), 1–95.

Heilporn, G., & Lakhal, S. (2021). Fostering student engagement in blended courses: A qualitative study at the graduate level in a business faculty. *The International Journal of Management Education*, *19*(3), 100569.

ISO 9241-210. (2019). Ergonomics of human-system interaction — Part 210: Human-centred design for interactive systems. In *International Standard: Vol. 2.Udgave*.

Kahu, E. R., Picton, C., & Nelson, K. (2020). Pathways to engagement: A longitudinal study of the first-year student experience in the educational interface. *Higher Education*, *79*, 657–673.

Maslow, A. H. (1943). A Theory of Human Motivation. *Psychological Review*, *50*, 370–396. http://psychclassics.yorku.ca/Maslow/motivation.htm

Matus, N., Rusu, C., & Cano, S. (2021). Student eXperience: A Systematic Literature Review. *Applied Sciences 2021, Vol. 11, Page 9543*, *11*(20), 9543. https://doi.org/10.3390/APP11209543

Moesarofah, Hitipeuw, I., Murwani, F. D., & Pali, M. (2023). Research on Factors that Influence College Academic Performance: A Structural Equation Modelling Approach. *European Journal of Educational Research*, *12*(1), 537–549. https://doi.org/10.12973/eu-jer.12.1.537

Nikolaraizi, M., Papazafiri, M., & Argyropoulos, V. (2023). Empowering Inclusion in Higher Education: The Case of a Multidimensional Peer Support Model for Students with Disabilities. In *The Routledge Handbook of Inclusive Education for Teacher Educators* (pp. 608–617). Routledge India.

Sax, L. J. (2009). Gender matters: The variable effect of gender on the student experience. *About Campus*, *14*(2), 2–10.

Stewart, J., Davis, G. A., & Peslak, A. (2023). Analysis of a student satisfaction exit survey of a graduate data analytics program. *Issues in Information Systems*, *24*(2), 60–70. https://doi.org/10.48009/2_iis_2023_106

Stoll, N., Jieman, A. T., Yalipende, Y., Byrom, N. C., Lempp, H., & Hatch, S. L. (2023). A Qualitative Evaluation of the Motivations, Experiences, and Impact of a Mental Wellbeing Peer Support Group for Black University Students in England and Wales: The Case of Black Students Talk. *SAGE Open*, *13*(4). https://doi.org/10.1177/21582440231218080

Stowell, M. (2004). Equity, justice and standards: assessment decision making in higher education. *Assessment & Evaluation in Higher Education*, *29*(4), 495–510.

Tinto, V. (2017). Through the eyes of students. *Journal of College Student Retention: Research, Theory & Practice*, *19*(3), 254–269.

Zhjeqi, V. B., Thaçi, D., Luta, J., & Cruz, L. (2024). Future Professionals: Student Satisfaction with the General Medicine Degree Curriculum at University of Prishtina. *Journal of Educational and Social Research*, *14*(3), 83–93. https://doi.org/10.36941/jesr-2024-0057

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Teamwork in higher education doesn't just happen: How an innovative online tool fosters students' collaboration and communication

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Abstract

In response to the growing importance of collaboration and communication skills in the digital era, this study investigates the efficacy of a novel digital toolbox designed to enhance teamwork among students. The toolbox, comprising self-study materials accessible via the institution's learning platform, was developed to improve team dynamics, communication and inclusion. A qualitative study involving 211 undergraduate students across 27 teams was conducted to assess the toolbox's impact on teamwork collaboration. Results indicate that teams utilising the toolbox experienced improved communication, conflict resolution and inclusion. However, inconsistent usage patterns revealed areas for improvement. The findings underscore the significance of thoughtful integration of digital tools in fostering effective and inclusive teamwork within higher education context. Furthermore, the study highlights the need for active support in developing these crucial skills, as they are not innate. This innovative learning approach offers benefits to students, faculty and institutions in addressing future skill requirements.

Keywords: *collaboration; communication; digital learning tool; teamwork; higher education.*

1. Introduction

Collaboration and communication skills have been identified as crucial "future skills" for higher education institutions (HEIs) (Ehlers, 2024). These competencies are essential not only for student success within academic settings but also for professional environments. In organisational contexts, creative innovation and productivity are dependent on effective teamwork; a subject that has been extensively researched (Tuckman, 1965) as well as described in management literature for decades (Katzenbach & Smith, 1993).

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Despite the recognised importance of these skills, its implementation in both organisational and educational settings often fall short of its potential. Grote and Kozlowski (2023) posit that many organisational leaders mistakenly perceive effective cooperation as an innate phenomenon requiring no additional effort (Grote & Kozlowski, 2023). Similarly, based on their experience as HEI lecturers, the authors of this study argue that effective team collaboration among students requires active promotion and support rather than occurring spontaneously.

The context of this study is an HEI where student collaboration in the undergraduate programmes has been a cornerstone for many years. Despite the emphasis on collaborative work, there was a notable gap in providing adequate support for students to enhance their effectiveness in collaborative processes. To address this deficiency, the authors, applying a user-centric approach, developed an online repository of self-study materials. This online resource, named "Toolbox TeamCollaboration", is structured to align with the various stages of student teamwork. The materials have been made available on the university's learning management system, providing students with easy access to tools and strategies for improving their collaborative skills.

This conference paper presents the authors' approach and findings from designing and implementing this online tool to enhance student team effectiveness. The research aligns with the growing demand for innovative teaching practices in higher education, responding to policymakers' emphasis on digital teaching strategies to foster active learning among students (European Commission, 2014). The study addresses the following key areas:

1. The design and implementation of the online collaboration tool
2. Evaluation of the tool's effectiveness in promoting student teamwork
3. Implications for future skill development in higher education

By examining these aspects, this research contributes to the ongoing discourse on future skills in higher education and provides practical insights for educators seeking to enhance collaborative learning experiences.

2. Encouraging collaboration in student teams through digital tools

Student-centred learning and teaching (SCLT) practices enable students to participate in, influence and take responsibility for their learning pathways and environments. They therefore have the potential for a transformative learning experience and deeper learning outcomes. The approach also helps to create more inclusive and supportive learning and teaching environments. SCLT ecosystems provide not only learning support for students but also teaching support for lectures (European Commission, 2020). When creating an SCLT environment to support student teamwork, such as problem-based learning (Barrett, 2010) or other types of project work, it is rather obvious that among the many relevant skills (O'Neil et al., 2003), the core skills to focus

on are communication skills (Melguizo-Garín et al., 2022). Identified as one of the "future skills" relevant to HEIs, communication skills go beyond language skills, enabling students to engage in dialogue, discourse and strategic communication (Ehlers, 2024). Students need to communicate ideas clearly to others (Melguizo-Garín et al., 2022) and are expected to articulate their level of expertise on a given topic and the nature of their intended contribution to the project. They are also required to articulate their concerns about the approach or other components of the project if they are not satisfied with them (De Prada et al., 2022). Giving and receiving peer feedback becomes a critical success factor (Lerchenfeldt et al., 2023). Peer feedback and communication in general becomes particularly challenging in the face of a diverse student body. SCLT alone does not adequately ensure participation and the need for inclusivity remains (European Commission, 2020). Student projects are made up of individuals with different cultural backgrounds, personality traits, skills, values and experiences. For instance, the gender of both the speaker and the partner influences the expression of emotions and conversational style (Tenenbaum et al., 2011).

As Børte et al. observe, one of the prerequisites for students to more actively engage in their learning process is a supporting infrastructure for both, lecturers and students with the adequate use of technology (Børte et al., 2023). In their requirements analysis for a digital training toolbox, Francalanza et al. (2021) made a noteworthy observation: students do not inherently favour digital tools. Rather, the efficacy of an e-learning tool is contingent upon its design. Their findings suggest that content should be systematically organised, linked to real-world applications, incorporate visual elements and facilitate active participation. Thus, it is not the digital nature of the learning method per se that is paramount, but rather the thoughtful implementation of these design principles in educational technology (Francalanza et al., 2021).

In conclusion, while SCLT practices hold significant potential for enhancing student engagement and learning outcomes, their success is contingent upon the effective integration of communication skills and the provision of a supportive infrastructure. Additionally, the design and implementation of digital tools must be carefully considered to meet the diverse needs and preferences of students, ensuring inclusivity and active participation.

3. Methodology

The primary objective of this study was to investigate whether the implementation of this toolbox improves students' collaborative skills in project-based learning environments. The following research questions have thus been formulated:

1. How does the toolbox influence team communication?
2. How does the toolbox influence inclusion of team members?

In order to answer these questions, the study employed an action research strategy, utilising qualitative methods based on deductive reasoning. Aligned with critical realism, the investigation focused on mechanisms of social change within educational contexts (Bhaskar, 2008; Parker et al., 2024).

The toolbox was developed though a participatory process involving all relevant stakeholders, including lecturers, students, programme managers and the university's management board. This process entailed conducting interviews and workshops, facilitating group discussions and administering a questionnaire. The resulting toolbox adopts a user-centred approach, incorporating various resources such as documents, instructional videos, self-assessment tools and collaborative templates designed to support task-oriented teamwork. Following development, the toolbox was implemented over one semester during a collaborative student project. Thereby. the toolbox was made available to the students and faculty members, who were permitted to access the information and templates at their convenience.

3.1. Data collection

Student feedback is gaining prominence in the design of educational programmes, as it can inform structural adjustments to courses by highlighting areas requiring improvement. In a semi-structured questionnaire featuring open-ended responses, which facilitated in-depth analysis, students were invited to evaluate the toolbox's utility and the behaviour of all team members within the context of the project work. This qualitative feedback addressed specific elements of the toolbox and provided more detailed insights into its strengths and limitations (Parker et al., 2024).

3.2. Sampling

The study encompassed a cohort of undergraduate students enrolled in a specific Management module at the university. Participants were in their first semester of the programme and were required to collaborate on a project due for submission near the end of the semester.

The survey was conducted as an integral component of the project submission process, i involving 211 students working in 27 teams - each comprising seven to nine members - who were tasked with reflecting on their collaborative experiences. Upon conclusion of the semester, the findings were discussed with all students. Members from all teams, irrespective of their utilisation of the toolbox, contributed to the feedback. The survey achieved a complete response rate as it was linked to the module assessment. Throughout the research process, the investigators adhered to ethical data protection protocols.

3.3. Data analysis

The study employed relational content analysis to examine the data, focusing on specific concepts and relationships within the text. The researchers reviewed their findings and subsequently discussed the results with students at the conclusion of the first semester. This feedback process enhanced validation and legitimised the findings, aligning with organisational pedagogical research ethics (Göhlich et al., 2014). Enhanced reflection, supervision and collaborative interpretation helped mitigate challenges associated with researcher subjectivity. The statements were deemed credible, reliable and confirmable, with emphasis placed on identifying relevant features for future investigations (Bhaskar, 2008).

3.4. Results

Analysis of the survey feedback indicates that five teams did not consistently utilise the toolbox or incorporated its documents and information into their collaborative processes. However, those teams that did employ the toolbox throughout the project acknowledged its contribution to enhancing their operational efficiency.

> Team 23: "…particularly positive was the good time planning and the clear structure of the meetings using the templates in the toolbox…"

Certain statements indicate that some teams accessed the toolbox solely to present the 'team charta' – an initial requirement – to the lecturers during the introduction to the toolbox at the commencement of the project work. The primary findings demonstrate that utilisation of the toolbox enhanced students' collaboration skills during their teamwork.

Students effectively utilised the toolbox's resources to enhance interpersonal communication and mitigate potential conflicts. When interpersonal challenges emerged, they were successfully negotiated and resolved.

> Team 3: "…by working closely together, we also learnt how to resolve conflicts constructively and define measures together to better manage such situations in the future. At the same time, the toolbox taught us how to move and communicate effectively in a larger group…"

Teams developed proficiency in providing constructive and substantive feedback.

> Team 20: "…working with the toolbox made us realise how much mutual feedback and communication within the team help to improve collaboration…"

Furthermore, students expressed confidence in the toolbox's utility and indicated their intention to employ it in subsequent collaborative projects.

> Team 8: "…we found the information uploaded to the toolbox very helpful, so we were able to ensure a high quality of work. This can be used as a basis for future projects…"

Regarding inclusion, the research findings underscore the critical importance of integrating all team members into the project work. Students have demonstrated awareness of various ways to achieve this objective effectively.

> Team 1: "…all team members were equally involved in the tasks ... To strengthen cooperation, we organised team events such as a joint lunch..."

> Team 18: "…certain members were often absent, which made decision-making more difficult. Especially in a larger group like ours, it is important that all voices and ideas are taken into account..."

This study concludes that students who did not consistently utilise the toolbox encountered typical collaborative challenges and struggled to address them effectively. These difficulties encompassed inadequate planning, ambiguous role allocation and heightened potential for communication-related conflicts.

> Team 5: "...communication and writing was rather one-sided... In a next project we would pay attention to a more direct confrontation about the problems and consult the information in the toolbox at an early stage..."

> Team 11: "...a clear structure for communication and deadlines should be established right at the start of the work. Regular meetings and a detailed work plan that clearly defines tasks and responsibilities can help to avoid delays and misunderstandings from the outset..."

4. Discussion and conclusion

The students were incorporated into an innovative teaching and learning practice, in which they participated actively in the learning process. They were provided with a modern digital tool. Moreover, the toolbox has a well-organised design and provides problem-based and practice-oriented contexts (Børte et al., 2023; Francalanza et al., 2021; European Commission, 2020). This pedagogical approach facilitated the development and enhancement of students' team collaboration skills, thereby leading to more efficient team performance. Students who used the toolbox regularly were able to improve their teamwork significantly. They strengthened their collaboration, recognised the added value of the toolbox and quickly found solutions to challenges. Their communication and understanding of equal participation improved. The toolbox effectively promoted an understanding of diversity and inclusion. In contrast, teams that did not make regular use of the toolbox either failed to overcome the challenges or did so with considerable difficulty.

In relation to the utilisation and composition of the toolbox, the researchers sought authentic feedback, as they are committed to the continuous enhancement of the toolbox. It is

hypothesised that the absence of critical feedback may be attributed to the students' first semester in their programme and the novelty of the subject matter. Furthermore, the mandatory nature of survey participation as a component of the module assessment may have introduced social desirability bias into the responses. The toolbox has been integrated into the existing learning platform and adds strategic value to the university (Ehlers, 2024). It is part of a student-centred learning ecosystem, promoting teamwork and communication skills. Students are prepared for professional environments by developing crucial collaboration, communication and inclusion skills. Whilst the toolbox facilitates self-directed learning, first-year students still need lecturer support to cultivate their collaborative skills. Consequently, lecturers have to familiarise themselves with the toolbox to effectively guide students. Achieving this objective requires students and lecturers to engage in a collaborative process of reciprocal learning and support.

References

Barrett, T. (2010). The problem-based learning process as finding and being in flow. *Innovations in Education and Teaching International*, *47*(2), 165–174. https://doi.org/10.1080/14703291003718901

Bhaskar, R. (2008). *A realist theory of science*. Routledge.

Børte, K., Nesje, K., & Lillejord, S. (2023). Barriers to student active learning in higher education. *Teaching in Higher Education*, *28*(3), 597–615. https://doi.org/10.1080/13562517.2020.1839746

De Prada, E., Mareque, M., & Pino-Juste, M. (2022). Teamwork skills in higher education: Is university training contributing to their mastery? *Psicologia: Reflexão e Crítica*, *35*(1), 5. https://doi.org/10.1186/s41155-022-00207-1

Ehlers, U.-D. (2024). Towards a Future Skills Framework for Higher Education. In U.-D. Ehlers & L. Eigbrecht (Eds.), *Creating the University of the Future* (pp. 21–60). Springer VS. https://doi.org/10.1007/978-3-658-42948-5_2

European Commission. (2014). *New modes of learning and teaching in higher education.* Publications Office. https://data.europa.eu/doi/10.2766/81897

European Commission. (2020). *Mapping and analysis of student centred learning and teaching practices: Usable knowledge to support more inclusive, high quality higher education*. Publications Office. https://data.europa.eu/doi/10.2766/67668

Francalanza, E., Borg, J., Rauch, E., Putnik, G., Alves, C., Lundgren, M., & Amza, C. (2021). Specifications for a Digital Training Toolbox for Industry 4.0. *FME Transactions*, *49*(4), 886–893. https://doi.org/10.5937/fme2104893F

Göhlich, M., Weber, S. M., & Schröer, A. (2014). Forschungsmemorandum der Organisationspädagogik. *Erziehungswissenschaft*, *25*(02), 94–105. https://doi.org/10.3224/ezw.v25i2.17212

Grote, G., & Kozlowski, S. W. J. (2023). Teamwork doesn't just happen: Policy recommendations from over half a century of team research. *Behavioral Science & Policy*, *9*(1), 59–76. https://doi.org/10.1177/23794607231192734

Katzenbach, J. R., & Smith, D. K. (1993). *The Wisdom of Teams. Creating the High-Performance Organization*. Harvard Business School Press.

Lerchenfeldt, S., Kamel-ElSayed, S., Patino, G., Loftus, S., & Thomas, D. M. (2023). A Qualitative Analysis on the Effectiveness of Peer Feedback in Team-Based Learning. *Medical Science Educator*, *33*(4), 893–902. https://doi.org/10.1007/s40670-023-01813-z

Melguizo-Garín, A., Ruiz-Rodríguez, I., Peláez-Fernández, M. A., Salas-Rodríguez, J., & Serrano-Ibáñez, E. R. (2022). Relationship Between Group Work Competencies and Satisfaction With Project-Based Learning Among University Students. *Frontiers in Psychology*, *13*, 811864. https://doi.org/10.3389/fpsyg.2022.811864

O'Neil, H. F., Wang, S., Lee, C., Mulkey, J. R., & Baker, E. L. (2003). Assessment of teamwork skills via a teamwork questionnaire. In *Technology Applications in Education* (S. 283–304).

Parker, M. J., Anderson, C., Stone, C., & Oh, Y. (2024). A Large Language Model Approach to Educational Survey Feedback Analysis. *International Journal of Artificial Intelligence in Education*. https://doi.org/10.1007/s40593-024-00414-0

Tenenbaum, H. R., Ford, S., & Alkhedairy, B. (2011). Telling stories: Gender differences in peers' emotion talk and communication style. *British Journal of Developmental Psychology*, *29*(4), 707–721. https://doi.org/10.1348/2044-835X.002003

Tuckman, B. W. (1965). Developmental sequence in small groups. *Psychological Bulletin*, *63*(6), 384–399. https://doi.org/10.1037/h0022100

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Reflect, Reason, Apply: Enhancing Learning and Cognitive Engagement in Maths and Statistics

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Abstract

This study explores the effectiveness of reflective practice, implemented through an e-Portfolio assessment, in a Mathematics and Statistics course. Reflective pedagogy was employed to enhance students' engagement, comprehension, and application of mathematical concepts. Using a qualitative approach, 25 student responses were analyzed through thematic coding and sentiment analysis to evaluate their perceptions. Thematic analysis revealed students perceived the e-Portfolio as a valuable tool for reinforcing knowledge and promoting active reflection, which contributed to deeper conceptual understanding and practical application. Sentiment analysis showed predominantly positive feedback, with challenges relating to time management and the clarity of instructions. These findings suggest that while the e-Portfolio is an effective assessment tool, its implementation can be further optimized by providing clearer guidelines, structured support, and phased submission strategies to mitigate potential difficulties. The study also highlights the significance of reflective pedagogy in quantitative disciplines to enrich the learning experience and strengthen cognitive engagement.

Keywords: *Cognitive Engagement; learning experience; metacognitive regulation; quantitative learning; reflective practice; STEM education*

1. Introduction

The challenges of 21st century education systems call for types of pedagogical approaches that go beyond the memorization of information, especially in areas like mathematics and statistics where students have difficulty translating theory into practice. Mathematics education has for a long time battled with the issue of how best to ensure that students not only learn procedures, but also comprehend the concepts behind the procedures (Boaler, 2016). Most pedagogical approaches in quantitative courses focus on problem solving, which often excludes other

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important aspects such as requiring students to explain their thinking, confront their misconceptions or relate theories to practice (Schoenfeld, 1992). Of note, reflective pedagogy acts as a counterbalance to this pedagogical model by demanding students to engage in a process of critical reflection on their learning processes, their thought processes, and their understanding of the world (Dewey, 1933; Schön, 1983). Despite the prominence of reflective practices in the humanities education (Moon, 1999), their application in mathematics classrooms is limited and under-theorised (Pugalee, 2001) and this is the gap this study seeks to bridge through the lens of student experiences.

This paper explores the implementation of reflective pedagogy in an undergraduate mathematics and statistics course and examine how it affects learners 'metacognitive awareness and engagement in complex quantitative concepts. Using action research methodology, the study employs qualitative case study design to answer two central questions: 1) *How does the defective practices contribute to students' engagement, learning, and understanding of mathematical and statistical concepts? 2)What are the primary challenges and perceptions of students regarding the reflective process, and how can it be improved?* By centering student voices through journals, open-ended surveys, and focus group dialogues (Creswell & Poth, 2018), the research illuminates the real-life experiences of learners as they try to balance reflective thinking with learning and applying mathematical concepts. Thus, rich, descriptive accounts of student experiences are foregrounded to offer practical insights to educators seeking to personalize mathematics education while maintaining academic rigor. In doing so, it argues for reflection as not a add-on to STEM curricula, but as a vital mechanism to produce adaptable, self-aware problem solvers in a complex world (National Research Council, 2012).

Research consistently shows that metacognition—thinking about one's own thinking—plays a crucial role in mathematical learning and problem-solving (Schoenfeld 1987, 1992). This paper proposes that when reflection is structured and intentionally incorporated into course design, it can make mathematical abstraction more understandable (Pugalee, 2004), decrease anxiety (Ashcraft, 2002), and enhance intellectual resilience (Mercer, 2011). Furthermore, the cyclic approach to action research offers a replicable model for educators who want to balance curricular demands with pedagogical innovation.

2. Background

2.1. Numerical Development, Executive Functions (EFs) and Reflective Pedagogy

Siegler's (2016) Integrated Theory of Numerical Development suggests that mathematical competence is the gradual development of the representation of numerical magnitude, with a crucial shift from logarithmic (dense) to linear (proportional) understanding of number lines. This fundamental representational change underpins advanced mathematical reasoning in

higher education: Linear magnitude comprehension enhances algebraic problem solving by revealing the relationships of proportions (Booth & Siegler, 2008); supports calculus through accurate interpretation of rates of change, and improves statistical reasoning by fostering natural intuition of probabilities (Peters et al., 2006). The theory's emphasis on strategy variability – learners 'use of multiple strategies (e.g., heuristic, symbolic) in a task – aligns with the strategic adaptive reasoning required in areas such as physics or computer science when students need to build models or analyze the efficiency of algorithms. Nevertheless, the existence of persistent gaps in magnitude understanding, which are typically ascribed to underdeveloped representational shifts, may hinder the understanding of abstract concepts like limits in real analysis or logarithmic scaling in data science (Weber, 2008). Interventions for these gaps, including number line visualization tasks or adaptive learning tools, show promise in closing the foundation deficits and improving outcomes in undergraduate STEM courses (Schneider et al., 2018; Hurst & Cordes, 2018).

Executive functions (EFs) - particularly inhibitory control, working memory, and cognitive flexibility - play an important role in numerical development and advanced mathematical learning of learners. These cognitive processes help learners to cope with complex numerical tasks, for instance, when solving multivariable calculus problems, interpreting statistical models or debugging algorithms by avoiding using irrelevant strategies (inhibitory control), keeping intermediate steps in mind (working memory) and shifting between the symbolic and graphical representations (cognitive flexibility) (Cragg et al., 2017; Blair et al., 2021). For example, in linear algebra, working memory helps students follow matrix transformations, while inhibitory control assists in avoiding errors such as applying logarithmic functions in the wrong context in exponential growth models. Deficits in EF are associated with numerical problems such as inadequate understanding of limits in calculus or inappropriate alignment of probabilistic understanding in data science (Weber, 2008; Obersteiner et al., 2020). Cognitive training modules, or problem solving frameworks that help to select strategies, have shown promise in improving numerical fluency and reducing attrition in STEM programs (Blair et al., 2021); however, the research has found that the development of EF skills is possible through the reflective and active re-processing of information that allows learners to maintain information in the working memory and to formulate more complex action oriented rules that provide for greater cognitive flexibility and inhibitory control (Lyons & Zelazo, 2011; Roebers, 2017).

Rooted in the work of scholars like Dewey (1933) and Schön (1983), reflective pedagogy is a theoretical and practical approach to the improvement of critical self-assessment, iterative learning, and metacognitive awareness to improve teaching and learning. Thus, the core principles of reflective pedagogy are:

- Cyclical Reflection and active Engagement – Teachers and students engage in continuous feedback loops.

- Self-Assessment & Metacognition – Help students learn to check their understanding and identify holes in their knowledge.
- Contextual Adaptation: Instruction is dynamically adjusted to meet the needs of learners, their cultural background, and the ever-changing challenges they face.
- Real-World Application – Make theoretical concepts more meaningful and applicable to real world problems to enhance motivation.

2.2. Reflective Practices in Mathematics and Statistics Education

The importance of reflective pedagogy in mathematics and statistics education cannot be overemphasized as this approach enhances metacognitive strategies and iterative feedback loops to improve conceptual mastery and critical thinking. Based on Schoenfeld's (1992) foundational work that demonstrated how guided metacognitive reflection can enhance problem solving by having students reflect on their reasoning, Kramarski and Mevarech (2003) pleaded cooperative learning combined with strategy justification to reduce procedural errors in geometry. These findings are supported by Lesser and Winsor (2009), who showed that reflective journals can help English language learners in statistics to overcome linguistic and conceptual gaps, and by Roscoe and Chi (2007), who proved that technology-enhanced peer feedback can refine data interpretation through collaborative critique. Beyond the classrooms, Savery and Duffy (1995) problem-based learning, and Gutstein (2012) socially situated pedagogy incorporated reflection in real world contexts where students could question ethical implications of statistical analyses or model societal inequities through algebra. Similarly, inquiry-oriented approaches, such as Rasmussen and Kwon's (2007) reflective discourse in calculus, demonstrate how iterative dialogue stabilizes abstract concepts like limits and derivatives. In conclusion, these studies affirm that reflective practices—whether through metacognitive prompts, peer collaboration, or culturally responsive frameworks—scaffold deeper quantitative understanding while fostering adaptive expertise and equity in STEM education.

3. Methodology

3.1. Research Approach and Participant Profile

This paper employs a mixed-methods action research design to examine the effectiveness of reflective pedagogy in a mathematics and statistics course. The cyclical approach of action research allowed for systematic inclusion of both the subjective experiences of the students and the actual outcomes in terms of student learning. A single-case study design was used to examine the outcomes in a specific course context. The participants in the study were undergraduate students enrolled in the mathematics and statistics course at University of Europe for Applied Sciences during a winter semester. A voluntary cohort of twenty-five students gave their views on the effectiveness of reflective pedagogy in their learning process.

3.2. Reflective Pedagogy Framework

- Guided reflection Exercises: Weekly reflections on conceptual understanding; problem-solving challenges and real-life applications.
- Collaborative Peer Dialogue: To share reflections and co-construct solutions in small groups.
- Individualized Feedback: Instructor critiques metacognitive growth and error analysis.
- End-of-Course Evaluation: Perceived learning outcomes in qualitative

3.3. Data Collection and Analysis

- Reflective Journals (e-portfolio): Entries documenting students 'conceptual struggles, breakthroughs, and self-assessments.
- Open-Ended Surveys: Written responses from students on their perceptions of reflective learning.
- Optional Focus Groups: Semi-structured discussions with a subgroup of students to gain deeper insights into their engagement with reflective practices.

The qualitative data from student reflections, survey responses, and discussions were analyzed using:

- Thematic analysis to identify recurring themes related to students 'perceptions of reflective learning and challenges faced in applying reflective thinking to mathematical concepts.
- Sentiment analysis to quantify the student perception and explore how they feel about the e-Portfolio—whether their feedback is positive, neutral, or negative

4. Results and Discussion

4.1. Thematic Analysis

The responses to the open-ended questions were coded thematically identifying the following three main themes:

Engagement and Learning: Students believed that the e-Portfolio was useful because it helped them to interact with the course content in a more productive way than through reading. The e-Portfolio was a good way of helping them to connect the theoretical concepts learned in class to the real world. Some students stated that through the process of creating the portfolio, they were able to determine the changes they have made and the knowledge they have gained. Students liked the practical, project-based e-Portfolio approach that encouraged them to think more critically about mathematical and statistical concepts and their applications in real world.

Challenges and Barriers: Some students did not have any major difficulties, however, some of them mentioned problems with organizing their thinking. A few responses indicated confusion with the process, which may have meant that more detailed directions were needed. Some students mentioned the problem of the time needed to develop the portfolio effectively.

Understanding and Retention: Several students stated that the e-Portfolio assisted them in consolidating the learning as they had to provide a summary of the concepts. The activity of describing their thinking process made them realize their strengths and weaknesses in mathematical reasoning. The portfolio format encouraged them to think critically and recall previously learned topics, reinforcing their retention of statistical methods they had learned in the past. Students found the e-Portfolio valuable for reinforcing learning and reflecting on their progress. While it supported concept retention, some students faced challenges related to time and process clarity.

4.2. Sentiment Analysis

The sentiment analysis of students' responses to the e-Portfolio assessment reveals a predominantly positive perception, with most of the feedback reflecting appreciation for its role helping them reinforce their mathematical and statistical knowledge, learn on their own, and retain concepts for a longer period through a systematic process of documenting them. A smaller proportion of responses were neutral, indicating that while students acknowledged the usefulness of the e-Portfolio, some may not have found it particularly transformative or impactful. These neutral responses could be used to make the assessment more definitive, for instance, by offering more specific directions or through the inclusion of other engaging elements. The negative feedback is limited; however, it highlights key challenges, primarily related to time constraints, unclear expectations, and difficulties in structuring reflections. Students who expressed negative sentiments may have struggled with the cognitive load of compiling the portfolio or found it difficult to align their reflections with course objectives. This suggests that while the e-Portfolio is generally well-received, clearer guidelines, improved scaffolding, and time management strategies could mitigate these concerns and enhance the overall student experience.

Table 1. Theoretical foundations, instructional focus, and key outcomes.

Theoretical Area	Key Focus in the Study	Observed Outcomes
Numerical Development (Siegler, Booth & Siegler)	Support numerical magnitude understanding through reflection on problem-solving and real-world math applications	Improved conceptual engagement; better linking of theoretical concepts to real-world math and statistics; strengthened strategy use
Executive Functions (Blair et al., Lyons & Zelazo)	Develop working memory, inhibitory control, and cognitive flexibility through guided reflections and adaptive tasks	Enhanced problem-solving accuracy; improved organization of thinking; recognition of procedural errors
Reflective Pedagogy (Dewey, Schön)	Foster cyclical reflection, self-assessment, and real-world application through e-Portfolio and collaborative dialogue	Increased critical thinking; stronger retention of mathematical/statistical concepts; positive attitudes toward reflective learning

Table 1 presents how the framework, informed by established theories of numerical development, executive functions, and reflective pedagogy, guided the design of instructional activities and assessments. The findings indicate that these practices not only enhanced students' engagement and conceptual understanding but also revealed areas for pedagogical refinement, particularly in relation to process clarity and time management within reflective learning tasks.

5. Concluding Remarks

The results of this study are in line with previous work on numerical development and EFs and the importance of reflective pedagogy in the development of cognitive flexibility and metacognitive regulation in quantitative fields. The e-Portfolio was used to provide students with a way of structured self-regulated learning, whereby students had to use working memory, inhibitory control, and cognitive flexibility EFs to reflect on mathematical concepts and solving strategies. The analyses of themes and sentiments showed that, in general, students benefited from the process and felt that it helped them improve their quantitative thinking and understanding of concepts, but the challenges with cognitive load and task articulation suggest that there is a need for better support. Thus, based on the current study, it is possible to suggest that enhancing the e-Portfolio approach to better support students' numerical cognition and executive functions can lead to improvements in mathematical problem-solving, critical thinking, and knowledge retention in STEM education. These findings further support the importance of developing appropriately chosen formative assessments that are informed by cognitive science for quantitative learning.

References

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. Current Directions in Psychological Science, 11(5), 181–185. https://doi.org/10.1111/1467-8721.00196

Blair, C., Knipe, H., & Gamson, D. (2008). Is there a role for executive functions in the development of mathematics ability?. Mind, Brain, and Education, 2(2), 80-89.

Boaler, J. (2016). Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages, and innovative teaching. Jossey-Bass.

Booth, J. L., & Siegler, R. S. (2008). Numerical magnitude representations influence arithmetic learning. Child Development, 79(4), 1016–1031.

Cragg, L., Richardson, S., Hubber, P. J., Keeble, S., & Gilmore, C. (2017). Direct and indirect influences of executive functions on mathematics achievement. Cognition, 162, 12–26. https://doi.org/10.1016/j.cognition.2017.01.014

Creswell, J. W., & Poth, C. N. (2018). Qualitative inquiry and research design: Choosing among five approaches (4th ed.). Sage Publications.

Dewey, J. (1933). How we think: A restatement of the relation of reflective thinking to the educative process. D.C. Heath.

Farrell, T. S. C. (2015). Promoting teacher reflection in second language education: A framework for TESOL professionals. Routledge.

Hurst, M., & Cordes, S. (2018). A systematic investigation of the link between rational number processing and algebra ability. Journal of Experimental Child Psychology, 166, 318–337. https://doi.org/10.1016/j.jecp.2017.08.014

Kramarski, B., & Mevarech, Z. R. (2003). Enhancing mathematical reasoning in the classroom: Effects of cooperative learning and metacognitive training. American Educational Research Journal, 40(1), 281–310. https://doi.org/10.3102/00028312040001281

Lesser, L. M., & Winsor, M. S. (2009). English language learners in introductory statistics: Lessons learned from reflective practice. Journal of Statistics Education, 17(1). https://doi.org/10.1080/10691898.2009.11889515

Lyons, K. E., & Zelazo, P. D. (2011). Monitoring, metacognition, and executive function: Elucidating the role of self-reflection in the development of self-regulation. Advances in child development and behavior, 40, 379-412.

Mercer, S. (2011). Understanding learner agency as a complex dynamic system. System, 39(4), 427–436. https://doi.org/10.1016/j.system.2011.08.001

Moon, J. A. (1999). Reflection in learning and professional development: Theory and practice. RoutledgeFalmer.

National Research Council. (2012). Education for life and work: Developing transferable knowledge and skills in the 21st century. National Academies Press.

Obersteiner, A., Dresler, T., Bieck, S. M., & Moeller, K. (2019). Understanding fractions: Integrating results from mathematics education, cognitive psychology, and neuroscience. Constructing number: Merging perspectives from psychology and mathematics education, 135-162.

Peters, E., Västfjäll, D., Slovic, P., Mertz, C. K., Mazzocco, K., & Dickert, S. (2006). Numeracy and decision making. Psychological Science, 17(5), 407–413. https://doi.org/10.1111/j.1467-9280.2006.01720.x

Pugalee, D. K. (2001). Writing, mathematics, and metacognition: Looking for connections through students' work in mathematical problem solving. School Science and Mathematics, 101(5), 236–245. https://doi.org/10.1111/j.1949-8594.2001.tb18026.x

Pugalee, D. K. (2004). A comparison of verbal and written descriptions of students' problem-solving processes. Educational Studies in Mathematics, 55(1), 27–47. https://doi.org/10.1023/B:EDUC.0000017666.11367.c7

Rasmussen, C., & Kwon, O. N. (2007). An inquiry-oriented approach to undergraduate mathematics. Journal of Mathematical Behavior, 26(3), 189–194. https://doi.org/10.1016/j.jmathb.2007.10.001

Roebers, C. M. (2017). Executive function and metacognition: Towards a unifying framework of cognitive self-regulation. Developmental review, 45, 31-51.

Roscoe, R. D., & Chi, M. T. H. (2007). Understanding tutor learning: Knowledge-building and knowledge-telling in peer tutors' explanations and questions. Review of Educational Research, 77(4), 534–574. https://doi.org/10.3102/0034654307309920

Savery, J. R., & Duffy, T. M. (1995). Problem-based learning: An instructional model and its constructivist framework. Educational Technology, 35(5), 31–38.

Schneider, M., Merz, S., Stricker, J., De Smedt, B., Torbeyns, J., Verschaffel, L., & Luwel, K. (2018). Associations of non-symbolic and symbolic numerical magnitude processing with mathematical competence: A meta-analysis. Developmental Science, 21(3), Article e12572. https://doi.org/10.1111/desc.12572

Schoenfeld, A. H. (1987). What's all the fuss about metacognition. Cognitive science and mathematics education/Lawrence Erlbaum Associates.

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense-making in mathematics. Journal for Research in Mathematics Education, 23(4), 334–370. https://doi.org/10.5951/jresematheduc.23.4.0334

Schön, D. A. (1983). The reflective practitioner: How professionals think in action. Basic Books.

Siegler, R. S. (2016). Magnitude knowledge: The common core of numerical development. Developmental Science, 19(3), 341–361. https://doi.org/10.1111/desc.12395

Weber, K. (2008). How mathematicians determine if an argument is a valid proof. Journal for Research in Mathematics Education, 39(4), 431–459.

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Supporting Self-Reflection and Educators: Towards a Digital Pedometer for Learning

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Abstract

Students often have little insight into their learning effort and progress. This is particularly an issue for learning that occurs outside of digital systems such as working on paper-based exercise sheets. Valuable information about the learning process is neither tracked nor evaluated systematically. This hinders students' self-regulated learning and also educators' abilities to intervene or adapt to student needs. A solution may be to actively involve students in collecting learning data themselves, however, it is still unclear what students need and how to motivate them. This paper provides insights from interviews with students on self-tracking to support their learning progress in non-digital environments. A concept of a digital tool is explored by discussing design principles, key features, and potential benefits of tracking students' learning activities. Two main features were suggested to show progress – time-tracking and self-assessment. Incentives like gamification features are also discussed.

Keywords: *Self-regulated learning; learning analytics; data collection; offline data.*

1. Introduction

In higher education, technology-enhanced learning (TEL) tools such as learning management systems (LMS), audience response or e-assessment systems are used for example to distribute materials, enable scalable learning and provide immediate feedback for students and educators (Strickroth & Bry, 2022). These digital approaches collect learning data during their use (e. g. live quizzes) and often provide insights into the learning process with a focus on the lecture. Lecture complementary activities (e. g. exercise sessions, tutorials) are still delivered face-to-face and not all learning activities are provided in a digital format. Thus, a structured data collection on the learning behavior is rarely done. This is also the case for accompanying tasks to deepen the knowledge from the lecture such as taking notes and working on voluntary homework or exercise sheets. Thus, a significant amount of learning takes place outside of digital environments, leaving e. g. issues with tasks and asynchronous activities during self-

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study untracked. This information is, however, likely to be helpful for students to gain insight into their learning progress and performance and to improve their self-regulated learning skills. Furthermore, this information can also be highly helpful for educators. However, current data collection and analyses rely on easily capturable data from digital systems.

Methods for simple data collection in "offline" contexts are required, focusing on the students. In such scenarios, students need to actively collect data that is not readily available. Educational technology can close this gap (Strickroth & Bry, 2022). A key challenge, however, is that such a data collection approach heavily relies on students. Hence, the gathering of data needs to be done in a non-intrusive way, consider student interests and provide direct benefits such as (new) insights into their learning progress. Although, various self tracking approaches are available in the context of the quantified self movement using smart phones (Rawassizadeh et al., 2015; Wac, 2018), but these are not tailored to track learning progress in non-digital contexts. Therefore, appropriate tools such as a "pedometer" for learning are missing. This paper aims to explore the requirements for an easy data tracking tool to collect so far untracked data based on students' preferences, and proposes concept ideas for a "pedometer for learning".

The research questions (RQ) are: (RQ1) What information is relevant to students to monitor their own learning experience? (RQ2) What are relevant aspects and incentives for users to motivate regular, active data tracking? (RQ3) How can an easy data collection be implemented?

2. Background and Related Research

Self-regulated learning (SRL) involves students to take control over their own learning processes to approach academic tasks in a targeted way. These processes fall into three cyclical phases (forethought, performance, self-reflection), which all benefit from detailed information about students' learning (Zimmerman, 2000). Therefore, data is necessary as well as appropriate instruments to measure SRL strategies (cf. Roth et al., 2016). In higher education, various TEL methods are available such as self-assessment approaches (e. g. quizzes, Alhazbi et al., 2024) or audience response systems (ARS; Mader & Bry, 2019) to collect feedback and provide insights in the learning process. However, specific educational technology is often only used by lecturers in lectures if it is provided by the university (e. g. to provide immediate feedback to the educator) and less often used in exercises and self-study to monitor student learning. Since not all learning activities, such as reading learning material or working on homework sheets, are fully transferable to a digital environment, these activities are not covered by the systems.

In their systematic review, Alhazbi et al. (2024) analyzed empirical studies that use existing online trace data e. g. from an LMS to measure learners' SRL skills. They identified various indicators and categorized them into specific SRL types, such as student engagement, often indicated by time spent online. However, these indicators can unlikely capture the complexity or multi-dimensional nature of the learning process and hardly represent the quality or intensity

of learning activities in non-digital contexts. In their paper, Egetenmeier and Strickroth (2024) discussed the inherent limitations of using only digital sources in analytics and proposed ideas to crowdsource the data collection in "offline" environments by using existing technologies. For example, QR codes can bridge isolated systems and different learning settings (e. g. hybrid/ face-to-face, asynchronous/synchronous) with a flexible, low effort approach. However, the authors only provided initial thoughts without a full concept to implement this. To go beyond easily accessible data such as logins or achieved points in digital quizzes, dispositional learning analytics considers different data sources (Tempelaar et al., 2017). For example, students' attitudes, perception or habits by analyzing data from self-report instruments (surveys). However, this approach can be problematic regarding correct interpretation, actionable intervention, or simply missing or incorrect data. To motivate students to participate in data collection, Judel et al. (2021) discussed various ideas, such as the demand for suitable tools that provide helpful insights and feedback. They discussed effective ways to engage students in LA and concluded, that concerns about data protection need to be addressed to build a trustworthy LA environment (cf. Ifenthaler & Schumacher, 2016). Another approach to raise participation is including gamification elements (cf. Deterding et al., 2011), which can make the collection process more enjoyable and boost initial engagement (e. g. in ARS, López-Jiménez et al., 2022). Despite unresolved factors that contribute to the success of gamification, empirical studies suggest the effectiveness of this approach (Sailer & Homner, 2020).

In summary, LA approaches often focus on easily available data which does not cover significant learning activities. Data collection beyond these approaches is challenging and dependent on students' willingness to participate. Hence, research is needed on how to minimize barriers to gathering data, what information are perceived to be helpful by students and what incentives will motivate participation.

3. Methodology

A requirement analysis using semi-structured interviews with focus groups was conducted to answer the RQs. The interviews were held during three weeks in summer term 2024 (May to June). Overall, 14 students participated in 4 groups (each with 3–4 people) from different fields of studies at LMU Munich, Germany. The majority of the interviewees (N = 11) were first-year bachelor students from STEM fields, but also second-year master and medicine students participated. All interviews were conducted in person on the campus at places where students meet and study. The interview included questions about desired insights into their learning (progress), possible incentives for self tracking data, and privacy. In addition, a Figma design prototype (see Figure 1) was prepared to facilitate discussion. Figure 1 shows two ideas for data tracking of two different metrics (successful finalization of a working sheet and learning time) and represents a small example of the larger design prototype which also contains e. g. a simple dashboard and various automated hints. The design prototype was shown at the end of the

interview (except for the first group). The interviews were qualitatively analyzed using Mayring's (2014) thematic analysis method.

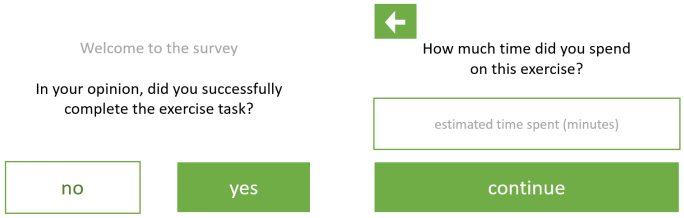


Figure 1. Two views of the prototype to self-report on performance (left) and learning time (right).

4. Requirement Analysis

This section presents the main results of the interviews. The purpose of the requirement analysis is to gather student perspectives for developing a prototype that collects and monitors currently untracked aspects of learning to foster self-regulated learning. The goal is to find features that are relevant to students for a tool that shows them their learning progress in self-study activities such as working on homework assignments. Most students expressed a strong desire for getting more feedback to evaluate their learning progress and especially their understanding to optimize their learning process. Dashboards with user statistics on learning activities, for example as a weekly review could support them to gain deeper insight into their learning. Voluntary self-assessments or short quizzes were suggested for this purpose, since the results of such tests could indicate what has been understood and what needs further attention. One focus group referred to an existing tool for index cards (Anki) which they use in their language studies. This approach was perceived as simple and understandable to see and track learning progress.

Three groups proposed a timer to track the learning time, e. g. how long does it take to complete a (homework) task. Furthermore, students suggested to combine the time needed with the completeness of the solution to build a useful metric for performance and progress. This may reveal patterns in daily or weekly learning activities that could indicate productive times to increase the learning efficiency. However, doubts were raised about the feasibility of the implementation to capture the performance or understanding of a task, especially when the correct solution is unknown to students.

Another relevant aspect concerns tool usage and motivational factors to engage with a tool. Students suggested general ideas which should be considered to motivate a recurring use of the tool to collect data. On the one hand, these include avoiding barriers to participation, e. g. by providing an easy registration process and access options to the tool, or implementing a "simple" timer to track the time. On the other hand, there was the idea of integrating the tool in lectures or exercises by the teaching staff. For example, a submission feature (for students'

homework) could be implemented within the application to encourage regular interaction. Furthermore, the tool could provide access to additional learning material, hints on exercises for students, or dedicated chatbots trained on the course material to answer questions in real-time. students also mentioned time-based gating to prevent gaming-the-system behavior by teasing a later interaction by providing access to solutions or in-depth hints or further tasks. To encourage active participation, two groups suggested gamification elements such as rankings, mini games, level systems or "little rewards" (e. g. animated pictures, learning progress visualizations, badges) as known from commercial applications such as Duolingo. Also, personalized messages such as "we missed you!" after a period of inactivity or positive/encouraging prompts during use were suggested. In general, the interview groups were divided in their opinions about gamified elements and suggested that participation in contests or rankings must be optional. Regarding privacy, most participants preferred anonymity (e. g. using nicknames) and sharing only aggregated data with the teaching staff.

Finally, students provided feedback on the design prototype. Keeping track on the time by entering it manually into a form (cf. Figure 1 on the left) was rated as not feasible, since they often miss to write down exact start and finish times. Instead, they suggested to use an automatic timer. Rating their performance without knowing a correct solution was seen as difficult, especially with only "yes" and "no" as options.

5. Concept

Based on the results of the interviews and from related work that inspired the Figma prototype, a tool concept was derived. The tool should supplement existing homework or exercise sessions in an approachable and motivational way, while enabling students to track their own learning. This is made possible by providing simple QR codes that can be integrated directly into learning materials to collect data. An analytics dashboard builds the main feature in the concept that provides students with detailed insights into their learning progress and understanding. Different visualizations of collected data can show information e. g. of a single exercise sheet or in a time-based overview (e. g. weekly, monthly). The time-based view provides insight into study habits, by showing the total number of tasks or sheets the student has worked on, as well as the time spent per day and when. A sheet overview may include charts showing time spent per exercise or the completeness of the task. This should build a basis to estimate the performance or efficiency in different ways. Filtering options in the dashboard could be used to identify difficult tasks, which could serve as a summary for exam preparation.

The collected data should be kept simple and easy to understand. Therefore, the concept focuses on two main aspects of tracking learning progress: First, a timer should be implemented, which automatically tracks time while learning and can be started/stopped for each task individually. Second, different self-assessments tools could be used to evaluate/track understanding and

learning progress. For example, predefined multiple-choice questions or quizzes could help to identify strengths and weaknesses in knowledge. Moreover, questions on perceived difficulty, performance, or understanding could be implemented using a simple rating system or an open-ended free text. Numeric ratings can be evaluated easily and combined with the time spent can identify difficult tasks, while free text enables the user to add details that may be helpful when preparing for an exam. This approach is more flexible and less time consuming than comparing students' exercise results to a sample solution by teaching staff.

To encourage recurring and continuous interactions, the tool must provide an additional value for the student. Besides providing a sample solution, additional learning material and targeted hints could support students in their learning task. This may be implemented in form of a simple "help" button to request assistance, hints, or a solution. Another idea includes incorporating gamification elements such as rankings, levels or time-based quests, which could encourage regular learning resp. participation in collecting data. To elevate offline activities with an online support, the tool should be accessible in both contexts. Here, QR codes offer a practical approach, providing a low barrier to start and participate. By scanning a code included on a working sheet access to further material or hints for this specific sheet can be provided. Furthermore, the user can start tracking the learning data. In addition, a simple URL to the tool's website can give independent access to the analytics dashboard. Using the universities' Single Sign-On avoids additional credentials and provides trustworthy authentication.

This concept offers many possible extensions such as providing an interface to the LMS or an existing submission system to simplify processes. Another idea to extend its use could focus on students' self-management and empowerment by setting up data collection for additional sheets by themselves, tracking learning goals or include an extendable configuration of data to collect.

6. Discussion, Conclusion and Outlook

This paper presents results from an interview study of freshmen to get ideas, on what information they are interested in, what are incentives for regular use, and how an easy data collection in offline activities of so far untracked data can be implemented. Students showed general interest in visualizing their own learning and understanding. They preferred data collection of easy to understand metrics (e. g., tracking-time and perceived understanding, RQ1). However, students expressed concerns on how to implement this as a tool. In general, low barriers to collect data were requested such as an automatic time tracking and simple (and short) questionnaires on, e. g. self-reported understanding (RQ2). Also, convenience features such as links to the LMS or direct submission was suggested. To incentivize regular use, gamification elements, further hints on tasks, and motivational prompts were suggested (RQ3). However, gamification was seen critically by some students and should therefore be optional.

Particularly, rankings based on time spent or correct answers were named to potentially demotivate students.

Based on these results, a concept for a "learning pedometer" is derived to provide additional insights to students with minimal effort. The concept includes a dashboard showing learning progress, time-tracking features, self-reporting of perceived performance, and (optional) gamification as well as extensions to existing exercise sheets (e. g., assistance to individual tasks, model solutions, and options for submitting a solution) as motivational factors. The concept uses QR codes to link worksheets to the tool so that task specific hints and measurements are possible. This approach empowers students to decide, what data should be included in their personal reports. Since students know what data they provided and the analyses are given to students for self-reflection, there should only be a minimal risk of incorrectly reported information.

The concept is designed to require little effort on the part of students to collect data using an automatic timer and simple self-assessments. A key aspect is to motivate students to participate regularly. Apart from simple gamification approaches, students suggested to provide hints or model solutions. This, however, requires some effort from educators, but may also provide them with more information on the (difficulty of the) tasks which would not be available otherwise. Analytics results for educators should be aggregated to pay attention to privacy concerns of students. The suggested features to include quizzes, index cards or to submit solutions need to be see critically and this may replicate functionality of existing systems and cause additional maintenance costs/effort. A solution may be to rely on SSO and to provide links to an existing LMS, or to integrate the concept such functionality into an existing LMS itself.

Limitations of the study concern the small number of interview partners, which are mainly freshman from bachelors' degree programs in the STEM field from one university in Germany. A saturation of the answers indicates at least that no fundamental different ideas are missing. Furthermore, this concept only covers a small part of student learning activities by focusing on learning time and self-assessments. The paper presents ideas of students on how to track learning in offline learning environments with a focus on self-study in exercises. Further additions such as tracking time of worksheet independent learning (e. g., learning for an exam) need to be considered to better understand individual learning experience and habits. The next step is to implement a fully working prototype based on the concept and evaluate this in an authentic learning environment.

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References

Alhazbi, S., Al-ali, A., Tabassum, A., Al-Ali, A., Al-Emadi, A., Khattab, T., & Hasan, M. A. (2024). Using learning analytics to measure self-regulated learning: A systematic review of empirical studies in higher education. *Journal of Comput. Assist. Learn.*, 40(4), 1658–1674.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: defining" gamification". In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments* (pp. 9-15).

Egetenmeier, A., & Strickroth, S. (2024). Data Collection in Traditional Learning Environments: New Opportunities for Analytics? In: *International Conference on Interactive Collaborative Learning* (pp. 385-393). Cham: Springer Nature Switzerland.

Ifenthaler, D., & Schumacher, C. (2016). Student perceptions of privacy principles for learning analytics. *Educational Technology Research and Development*, *64*(5), 923–938.

Judel, S., Drzyzga, G., Kiesler, N., Schetter-Schlag, S., & Strickroth, S. (2021). Anreizsysteme für studierendenpartizipation in Learning Analytics. In: *Delfi Workshops*, 96.

Long, P., & Siemens, G. (2011). Penetrating the Fog: Analytics in Learning and Education. *EDUCAUSE Review*, *46*(5), 31–40.

López-Jiménez, J. J., Fernández-Alemán, J. L., González, L. L., Sequeros, O. G., Valle, B. M., García-Berná, J. A., Idri, A., & Toval, A. (2022). Taking the pulse of a classroom with a gamified audience response system. *Computer Methods and Programs in Biomedicine*, 213, 106459. https://doi.org/10.1016/j.cmpb.2021.106459

Mader, S., & Bry, F. (2019). Audience Response Systems Reimagined. In: *Proceedings of the ICWL 2019* (*Vol. 11841*, pp. 203–216). https://doi.org/10.1007/978-3-030-35758-0_19

Mayring, P. (2014). *Qualitative content analysis: theoretical foundation, basic procedures and software solution.* Klagenfurt.

Rawassizadeh, R., Momeni, E., Dobbins, C., Mirza-Babaei, P., & Rahnamoun, R. (2015). Lesson learned from collecting quantified self information via mobile and wearable devices. *Journal of Sensor and Actuator Networks*, *4*(4), 315-335.

Roth, A., Ogrin, S., & Schmitz, B. (2016). Assessing self-regulated learning in higher education: a systematic literature review of self-report instruments. *Educational Assessment, Evaluation and Accountability*, *28*(3), 225–250.

Sailer, M., & Homner, L. (2020). The Gamification of Learning: a Meta-analysis. *Educational Psychology Review*, *32*(1), 77–112. https://doi.org/10.1007/s10648-019-09498-w

Strickroth, S., & Bry, F. (2022). The Future of Higher Education is Social and Personalized! Experience Report and Perspectives. In: *Proceedings of the CSEDU 2022* (pp. 389–396).

Strickroth, S., & Striewe, M. (2022). Building a Corpus of Task-Based Grading and Feedback Systems for Learning and Teaching Programming. *International Journal of Engineering Pedagogy (IJEP)*, *12*(5), 26–41. https://doi.org/10.3991/ijep.v12i5.31283.

Tempelaar, D., Rienties, B., & Nguyen, Q. (2017). Towards actionable learning analytics using dispositions. In: *IEEE Transactions on Learning Technologies, 10*(1), 6–16.

Wac, K. (2018). From quantified self to quality of life. *Digital health: scaling healthcare to the world*, 83-108. https://doi.org/10.1007/978-3-319-61446-5_7

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In: *Handbook of self-regulation* (pp. 13–41). San Diego, CA: Academic Press.

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Linking Reflection Practice with Marketing Competencies

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Abstract

The role of reflection for students' learning has been long recognised. However, drawbacks of many reflective tasks are missing assessment approaches. Additionally, the potential of using students' reflection for assessing subject competencies is often overlooked.

This conceptual paper provides (a) other lecturers with a case study, detailing the implementation and assessment of academic reflections in an undergraduate marketing course; and (b) researchers with preliminary data on students' improved self-reflection and marketing competencies.

Keywords: *Marketing; Course Design; Competence-based Assessment; Reflection; Rubric.*

1. Introduction

On a conceptual level, Higher Education (HE) Institutions have experienced a significant transformation in teaching and learning over the past decade. Competence-based education has replaced content-only based education, which allows lecturers to better prepare students for their future roles (European Commission, 2023). For business students, these competencies range from content-related (e.g. market research, new marketing technologies) to interpersonal skills, in particular reflection skill (Schön, 1983; Kets de Vries & Korotov, 2012; Reilly, 2018).

On an operational level however, simple examples of how to integrate and assess reflection skills in marketing classes, both for increased reflective practice but also content-related marketing competencies, are missing. Additionally, the perspective of lecturers (contrary to the student voice) is often not very central in many recent studies.

In this paper we present our multi-year project of how to integrate and assess academic reflections with the aim to increase students' marketing competencies. We present findings on increased reflective practice across various formats and on the development and application of

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assessment rubrics. Our research contributes to innovation in teaching and learning experiences, especially to the development and assessment of competence-based education in HE.

2. Theoretical Background and Method

Over the last decade, extensive research has focused on the usefulness and application of reflections for various learning experiences, starting with the experiential learning theory (Kolb, 1984). Kreber (2004) clearly summarised that although most learners report that they engage in self-reflection, they have different conceptions of what this means due to the broad possible scope and focus. For this paper, we follow the definitions of Reilly (2018) who identified three key learning objectives for business students in their reflective tasks: (a) connecting academic class concepts with personal experience, (b) reflecting on this experience to analyse what happened, and the potential to change and (c) developing self-awareness in recognising their role in the experience. When designing these reflection tasks, lecturers need to create a supportive learning environment which consists of examples, clear instructions, and regular feedback on the achieved depth of reflection (Bruno & Dell'Aversana, 2018; Veine et al., 2019).

Several studies expand on the measurement of depth of reflection (Kember et al., 2008; Cheng & Chau, 2009), with Bruno and Dell'Aversana (2018) suggesting the use of *mental language* by the students according to five categories, ranging from 0-non-reflective, 1-declarative reflective, 2-relational reflective, 3-interpreatitve reflective to 4-critical reflective. The depth of reflection was shown to increase over time when students had the opportunity to submit several reflections and receive feedback during one semester (Bruno & Dell'Aversana, 2018), as at the start students are not familiar with the reflection process and submit descriptive reflections.

The most common reflection format is a written reflection. Forms such as the creation of videos for the reflection (video reflection) or the discussion of individual reflections within a group (peer reflection) can be used and have been shown to result in deeper reflection due to the higher motivation of the students (Cheng & Chau, 2009; Veine et. al., 2019). When assessing students' reflections, the highest achieved level of mental language within the entire reflection is recommended to be used to indicate the students' reflective practice (Kember et al., 2008). This is consistent with the usual approach to allocating categories in qualitative research.

Students' reflection in HE can address different domains such as academic reflection, personal development, interpersonal engagement and professional development (Ash & Clayton, 2009), depending on the learning objectives. In many subject-related courses, such as marketing or finance, a reflection focussing purely on personal development is considered insufficient to assess the content-based competencies of the course. These subject competencies are usually broken down into specific learning objectives, addressing the different learning categories according to Bloom's taxonomy (Bloom, 1956). Assessing higher levels of learning objectives such as "Creating & Evaluating" cannot easily be done by end-of-semester formative

examination, and an assessment such as students' reflections can offer a valid alternative (Ash & Clayton, 2009; Kember et al., 2008; Reilly, 2018).

Providing clear instruction for students' reflections and assessing them afterwards is rather complex, and several suggestions for an assessment approach exist. Reilly (2018) presented a grading sheet with six criteria, of which the most important are "Evidence of Reflection" and "Connection to Course Content", totalling to 50% of the grade. In two dimensional rubrics, several categories relating to the learning cycle and linking to the course content, learning objectives and academic models are individually assessed in terms of depth of reflection. Research agrees that rubrics allow for quicker and more consistent marking. A well-defined rubric will also allow students to better understand key requirements for the reflection task (Brock University, n.d.; The University of Edinburgh, n.d.).

This conceptual paper shows how the creation of a supportive learning environment increased reflective practice of marketing students, even across different formats. Moreover, the paper provides a detailed assessment rubric for other marketing lecturers, allowing them to design and grade students' reflections which are linked to marketing competencies.

3. Innovation Project and Changes to Marketing Course

This study was undertaken at the University of Applied Sciences Northwestern Switzerland (FHNW), School of Business. The FHNW is a medium-sized teaching and applied research university with around 2500 undergraduate business students. Funding is provided for teaching innovations which allowed the authors to systematically research the introduction of students' reflections into an established marketing course. Whereas before 2020, the assessment of this marketing course consisted of a summative written exam, the lecturers were keen to use reflection papers to increase the reflection competence which is considered relevant for business leaders (Kets de Vries & Korotov, 2012; Reilly, 2018). Additionally, they wanted to investigate how to assess complex marketing competencies (e.g. evaluating different product development models, creating a value proposition) which they were unable to evaluate in written exams.

For this study, data was collected from classes of undergraduate students in the final semester of their BSc International Management degree (see Table 1). These students were in the final course of a 20 ECTS marketing specialisation and in spring 2020, 27 students attended this class. Subsequent cohorts of students consisted of 22 (in 2021) and 26 (in 2022) students.

During the semester students had to submit four different reflections, two in written format, one as a video and one as a summary of an oral peer reflection. Each submission focussed on different learning experiences such as class discussion or group projects. The overall assessment of this course consisted of a graded group project and an oral individual exam, with the reflections only providing students with 10% individual learning points. The lecturers created a

supportive learning environment which consisted of clear task descriptions, reflection examples, videos on the importance of reflection, and detailed personal examples. Additionally, lecturers provided students with written feedback after each submission. At the end of the semester, students completed a survey which addressed key questions about their learning style and their perception of the usefulness of the learning environment for reflection. The same survey questions were subsequently used for the cohorts in 2021 and 2022. The survey results from 2020 strongly confirmed that students consider a positive learning environment, which allows them to train their reflective practice, as essential for the successful implementation of reflection (Miller & Staley, 2021). A separate research part further analysed the students' perspective and additionally included in depth qualitative research of the submitted reflections (Miller et al., 2023). Note that the student voice is not the central focus of this conceptual paper.

Table 1. Overview of multi-cohort study including key information

	2020 cohort	2021 cohort	2022 cohort
Course	Specialisation Marketing, 27 students, switched to on-line teaching, 4 reflections	Specialisation Marketing, 22 students, online teaching, 3 reflections	Specialisation Marketing, 26 students, on campus teaching, 3 reflections
Study step & key focus	Start of research project, understanding of students' reflective practice over different formats	Optimisation of task description for three reflections and of learning environment	Linking of reflection to marketing competencies
Research method	Content analysis and categorisation of 4 reflections to identify critical reflective level	Qualitative research into students' perceptions (Miller & Staley, 2021) and into student engagement (Miller et al., 2023)	Comparison between survey results (longitudinal) of students' perception on usefulness of reflection
Key learnings	Students' reflection practice increased due to supportive learning environment; video and peer format indicate deeper reflection	Observed increased student engagement; students' perceptions indicating benefits of learning environment & varying preferences for formats.	Reflection practice, linked to marketing competencies; students' perceptions indicating increased deep content learning
Changes	Reduction from 4 to 3 reflections due to high workload for students	Introduction of assessment rubric including marketing competencies for 2022	Dissemination of rubrics to other lecturers

Systematic content analysis was performed on all submitted reflections of the 2020 cohort, which consisted of coding of written reflections (twice 2-page reports), videos (2-min videos) and summaries of peer reflections (1-page report) for 27 students. The categories of reflection depths according to Bruno and Dell'Aversana (2018) were used, with the highest achieved level

of mental language within the entire submitted reflection indicating the students' reflective practice (see Table 2).

Table 2. Number of students (2020 cohort) achieving different reflection levels per format

Reflection level	Description	Written paper 1	Written paper 2	Video reflection	Peer reflection	Total of 4
	Total # of students	27	27	27	27	27
0	Non-reflective	0	0	0	0	0
1	Declarative refl.	0	0	0	0	0
2	Relational reflective	11	2	4	5	22
3	Interpretative refl.	10	17	9	12	48
4	**Critical reflective**	**6**	**8**	**14**	**10**	**38**
	% of Critical refl.	22%	30%	52%	37%	35%
	Average level	2.8	3.2	3.4	3.2	
	Standard deviation	0.8	0.6	0.7	0.7	

4. Observations and Learnings

During the semester, students on average improved their reflective practice from under 3 (corresponding to "interpretative reflective") to above 3. Whereas at the beginning of the semester, 11 students only achieved as a maximum "relational reflective" depth, this number decreased strongly over the semester during which training and feedback on reflection were provided. Interestingly, the videos and peer reflections submitted by the students showed the strongest indication of deep reflection as measured by mental language, which could be linked to the higher motivation as predicated by Cheng and Chau (2009) and Veine (2019). A closer analysis of the type of student who submitted "critical reflective" content shows no dependency on gender or type of study (part-time versus full-time).

Table 3. Included learning incidents per format

Description	Written paper 1	Written paper 2	Video reflection	Peer reflection
Average # of learning incidents	31.5	78.0	20.4	24.5
Standard deviation	7.9	26.3	6.3	6.5
Critical reflective (see Table 2)	6	8	14	10

When coding the different reflections, we noted the number of "learning incidents", i.e. a student elaborating on a relevant learning experience in individual reflections (see Table 3). We only used these learning incidents for the categorisation according to levels introduced by Bruno and Dell'Aversana (2018) and excluded parts in the reflections where students had provided non-relevant descriptions. In the second written paper, students were able to better understand the task and clearly focussed on relevant learning experiences in their reflections (more than twice

as much relevant content in their submissions). Strikingly, the submitted videos and peer reflections consisted of fewer included learning incidents, however in these formats more students demonstrated critical reflective level. We interpret this finding as an indication of the suitability of the video and peer reflection format as it seems to allow more students to reflect deeply while demonstrating more relevance in the overall submission.

At the end of the spring 2020 course, students were examined in an oral exam. In our data we could not find indications, however, that students with stronger reflective practice achieved better exam results. We therefore tried to strengthen the link of the reflection to the course's learning objectives with a detailed assessment rubric (see Table 4).

Table 4. Assessment rubrics including marketing competences (based on Kember et al., 2008).

	Reflection on existing marketing knowledge	**Connection to academic marketing concept**	**Evidence of development**
Critical reflection	Critically reviews existing marketing knowledge, questions assumptions, and articulates new perspectives	Demonstrates superior connection between learning experience and class content (marketing concepts/theories) and literature; evidence of application of theory and reconstruction of perspective	Articulates transformation of their perspective about a particular marketing issue/concept/ problem as a result of learning experience.
Reflection	Active and careful consideration of existing marketing knowledge and articulates new understanding of knowledge because of learning experience	Demonstrates clear connections between experience and class content (marketing concepts/ theories); evidence of application of theory	Articulates new understanding/insights about a particular marketing issue/concept/ problem as a result of learning experience
Understanding	Makes use of existing marketing knowledge without an attempt to appraise knowledge; shows understanding but does not relate to learning experiences	Connects experience with class content (marketing concepts/theories) but remains superficial or abstract or too general	Limited/superficial insight about a particular marketing issue/concept/ problem as a result of learning experience
Non-reflection	Automatic responses with little conscious reference to existing marketing knowledge; responses are offered without attempting to understand them	Connections are not drawn between experience and class content (marketing concepts/theories) or literature	No evidence of insights about a particular marketing issue/concept/ problem as a result of learning experience

The motivation for this decision was also driven by the anticipated resistance from lecturers at the business school who might consider assessment by reflection as rather arbitrary with missing links to "hard" learning objectives and subject competencies. The rubric was developed in line with published research and examples from other universities (Kember et al., 2008; Brock University, n.d.; The University of Edinburgh, n.d.). Three learning steps, consisting of "Reflection on Existing Marketing Knowledge", "Connection to Academic Marketing Concept", and "Evidence of Development", are explained in the context of the course, with varying depths of reflection. The rubric was discussed with students of the 2022 cohort at the start of semester. The aim was to encourage students to increase links to marketing theory and course learning objectives and to differentiate this academic reflection from personal reflection.As in previous years, students of the 2022 cohort were asked in the end-of semester survey about the usefulness of reflection for both personal development and different learning activities represented by Bloom's learning categories (see Table 5). As expected, students from all cohorts saw reflection to be useful for personal development, however the introduction of the rubric for the 2022 cohort resulted in an increase of students who consider reflection useful for "Creating and evaluating new ideas and concepts", indicating deeper content learning. We interpret this finding as an indication of the usefulness of rubrics for encouraging business students to achieve complex marketing competencies.

Table 5. Students' perceptions of usefulness of reflection, based on survey for several cohorts

Usefulness of reflection for:	2020 cohort	2021 cohort	2022 cohort
Remembering and understanding theory	36%	55%	48%
Analysis and applying theory to new problems	36%	30%	35%
Creating and evaluating new ideas and concepts	32%	30%	57%
Personal development	80%	80%	78%

5. Conclusions

This paper confirmed the usefulness of reflection for students' learnings in HE. Specifically, our findings suggest that the use of reflections for assessment can improve achievement of learning objectives and foster a deeper understanding of course material. In addition, our project generated significant interest among other lecturers within the business school and reflective tasks and rubrics are now established in other courses. While we can show benefits of the use of reflection, this paper which focussed mainly on the perspective of the lecturers remains exploratory in nature.

Additionally, some methodological limitations, such as the small sample size and the absence of broader generalisability across subjects, need to be mentioned. Further research could

explore the application of our findings to various educational settings and subjects, while integrating the students' and lecturers' perspectives.

References

Ash, S. L., & Clayton, P. H. (2009). Generating, Deepening, and Documenting Learning: The Power of Critical Reflection in Applied Learning. *Journal of Applied Learning in Higher Education*, 1, 25-48

Bloom, B. S. (1956). *Taxonomy of Educational Objectives*. New York: David McKay

Brock University. (n.d.). Role of Reflection. https://brocku.ca/pedagogical-innovation/resources/experiential-education/role-of-reflection/

Bruno, A., & Dell'Aversana, G. (2018). Reflective practicum in higher education: the influence of the learning environment on the quality of learning. *Assessment & Evaluation in Higher Education,* 43(3), 345–358

Cheng, G., & Chau, J. (2009). Digital video for fostering self-reflection in an ePortfolio environment. *Learning, Media and Technology*, 34(4), 337–350

European Commission: Directorate-General for Education, Youth, Sport and Culture, Looney, J., & Kelly, G. (2023). Assessing learners' competences: policies and practices to support successful and inclusive education: thematic report. *Publications Office of the EU*

Kember, D., McKay, J., Sinclair, K., & Wong, F. K.Y. (2008). A Four Category Scheme for Coding and Assessing the Level of Reflection in Written Work. *Assessment & Evaluation in Higher Education,* 33, 369-379

Kets de Vries, M. F. R., & Korotov, K. (2012). Transformational Leadership Development Programs. In S. Snook, N. Nohria, & R. Khurana (Eds.), *The Handbook for Teaching Leadership: Knowing, Doing, and Being*, 263–281, Los Angeles: Sage

Kolb, D.A. (1984). *Experiential learning: Experience as the source of learning and development.* Englewood Cliffs, NJ: Prentice-Hall

Kreber, C. (2004). An Analysis of Two Models of Reflection and Their Implications for Educational Development. *International Journal for Academic Development.* 9. 10029-21

Miller, B. T., Göldi, S., & Lin. M. H. (2023). Increasing student engagement with COIL Padlet. In: *9th International Conference on Higher Education Advances* (*HEAd'23)*, 871-878

Miller, B. T., & Staley, L. (2021). Importance of feedback, training and media format for students' reflective practice. *International Journal of Management, Knowledge and Learnin*g, 10, 31–40

Reilly, A. H. (2018). Using Reflective Practice to Support Management Student Learning: Three Brief Assignments. *Management Teaching Review*, *3*(2), 129-147

Schön, D. (1983). *The reflective practitioner: how professionals think in action.* New York: Basic Books

The University of Edinburgh. (n.d.). Reflection Toolkit. Assessing Reflection. https://www.ed.ac.uk/reflection/facilitators-toolkit/assessment

Veine, S., Anderson, M. K., Andersen, N. H., Espenes, C., Søyland, T. B., Wallin, P., & Reams, J. (2019). Reflection as a core student learning activity in higher education - Insights from nearly two decades of academic development. *International Journal for Academic Development*, 25(2), 147–161

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Mock-up / junk lab: hands on practice as an experience in creating a new material

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Abstract

MOCK – UP / JUNK LAB is a semester experiment within the Architectural Workshop course (9th semester), aimed at encouraging research and expanding knowledge about sustainable materials and their potential use in contemporary architectural and artistic practices. The specificity of the task requires a specific method (hands-on practice), where students, by exploring materials, come to new insights and acquire new skills, which significantly differs from traditional educational methods. The new knowledge acquisition experience is based on interdisciplinarity, which integrates both technical and artistic knowledge. By investigating the local context, students map a problem that can become a resource for creating a new material sample. In this sense, reuse gains a new value as a building material, which, in the final stage of research, becomes a usable product. Throughout the research process, the focus is on sustainability methods, ecological principles, participation, social responsibility, as well as the evaluation of the afterlife period.

Keywords: *hands on practice; interdisciplinary practice; mock-up; experiment; circular design.*

1. Introduction

Architectural Workshop is a mandatory course in the fifth year of the Master's Integrated Studies at the Faculty of Architecture, University of Montenegro. The nature of the course requires continuous transformation and adaptation in order to provide students with specific practical knowledge and skills during their final year of study. The workshop format reflects a concept in which students are engaged in creating activities that go beyond conventional and established program frameworks. As a new teaching method, a hands-on practice and experimental approach is introduced, where students work in teams of two, continuously engaging in the execution of tasks. Today, when technological advancements dominate science, it is crucial to maintain the continuity of a practical/craft-based approach in architecture, while

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also emphasizing interdisciplinarity in practice. A teaching method grounded in practical activities plays a key role in engaging both cognitive and motor skills, contributing to the development of the psychomotor system. Such activities hold significant pedagogical value, combining artistic, creative, design, and technical abilities of students within each task. Given the multidisciplinary perspective of the educational goals, this learning process aligns with UNESCO's principles of education within a broad and holistic framework (UNESCO's 1996 Delors Commission Report on Education). Traditional educational principles are often detached from real-life problems; in this regard, the hands-on approach can better prepare future architects to think critically about the functional value of materials, connection details, material longevity, and overall sustainability.

This way of thinking may contribute to innovative approaches in architecture—where the local context is seen as an opportunity, and waste as a resource—while acquired knowledge and skills are viewed as applicable and valuable. Moreover, this custom-made approach fosters personalized and authentic design, which is increasingly valued over the uniformity of ready-made system solutions. This form of education can become a driver of positive change, requiring students to be open-minded and flexible in order to meet the demands of a competitive world. By emphasizing a multidisciplinary approach to analysis, problems are considered from multiple perspectives, integrating various types of knowledge and discoveries into a unified outcome. According to Casey Jones (2010), in modern curricula, the interdisciplinary approach is both essential and challenging. Accordingly, students engage in market research, problem mapping, participatory processes, and chemical and physical analysis of material properties. They integrate knowledge of design, usability, and product development, while also becoming familiar with ecological sustainability, social responsibility, and methods for evaluating final outcomes. Working at a 1:1 scale introduces an added layer of responsibility and attention to detail, allowing for a direct understanding of the actual properties and challenges of materials—knowledge that is only acquired through experience.

This method fosters creativity, enabling students to recognize their own abilities and preferences. It also strengthens self-awareness and helps uncover individual potential, which may later translate into business ideas and entrepreneurial ventures. This type of learning process should be grounded in the simultaneous integration of thinking and doing, where new skills are developed and new knowledge is generated.

2. Methodology – from problem to product

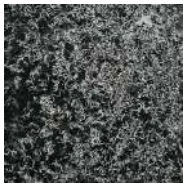
The key method adopted is the experiment, conceived as a continuous semester-long investigation of materials, their properties, transformation, technical characteristics, and aesthetic potential. Within the observational method, one of the key actions is the hands-on practice approach, where students are directed to obtain their material through various processes

such as chemical reactions, melting, mixing, cutting, etc., learning about the materials and their properties through the process, which will later play an important role in their professional practice.

The task is divided into three cycles, starting with mapping the problem (food waste, agricultural waste, plastic, textile waste, production waste, industrial waste, etc.), identifying the causes of the problem, the stakeholders, and understanding the context. This research phase involves collecting statistical data and analyzing the problem, which could turn into a new potential. Students map various materials as potential new resources: construction waste, food waste, plastic, rubber, cigarette butts, glass, sawdust from workshops, fabric waste from local production, cardboard and bags from large corporations and retail chains like Zara, as well as local authentic materials such as wool, olives, pomegranate, etc. Additionally, some students focus on issues such as frequent wildfires in Montenegro, which annually destroy large areas of forests, thus adding a critical perspective to their approach. During the process, stakeholders and potential partners are also mapped, emphasizing the participatory method as an essential social engagement, where every user/citizen can become part of the project. Rebecca Lawthom (2011), in her research, considers the inclusion of the community in the educational process to be crucial, as it both teaches and empowers the community. As part of one team, children from the Pavle Rovinski Primary School contributed their old plastic toys to be transformed into new materials. Local small industries producing juices, cereals, beer (the main state brewery Nikšićka Pivara), costumes, and retail chains like ICOS, Zara, and others also became official participants in the process. After the initial research phase, students draw conclusions that serve as an introduction to the second phase of the investigation.

Table 1. Exapmples of students ideas. Source: Students (2024).

material	**cooperator**	**pattern**	**product**
IQOS cigarette butt	ICOS		ICOS bag
fabric remnants from the production process (offcuts)	Local company for the production of construction suits		A bag for drawings

organic pomegranate bark	Local pomegranate juice factory		Organic label for bottles and jars
Construction waste	Local construction company		Bicycle parking and stand
construction plastic pipes	Local construction company		Substrate for children's playgrounds
sawdust from the production process	local printing house		Eyeglass stands
Cardboard boxes from online sales / ZARA	Boutique ZARA Mne		Shelves for ZARA boutiques
wool	local farm from Pljevlja		wall covering system

children's broken toys	Pavle Rovinski Elementary School, Class III7		Swing for children
corn	local households and flour producers		Children's toys / puzzles
seaweed	Beaches in Ulcinj		beach changing room
Rice that has passed its deadline	local Chinese restaurants		A base for Chinese chopsticks

In the second phase, students focus on analyzing the sample itself and the collected materials by working directly on experiments involving the processing of the material. In home-based, improvised laboratory conditions, students observe material changes (a table set), successively documenting all its transformations. The entire process is monitored and recorded. Students aim to create a new material that could present opportunities for innovative architectural design. In this way, they develop a "biography" of the material, documenting its characteristics (sustainability, fragility, durability, consistency, water resistance, pressure resistance, etc.). For the first time in their studies, students have the opportunity to engage with materials in this manner. This approach can be highly beneficial for their future practice, as the concept of working with materials and analyzing their new applications can significantly change perceptions of materials in architecture and inspire new, personalized approaches and practices. Their initial results are presented publicly in a Pin-up presentation, where all students display their 10x10 cm samples and discuss the process. This form of transparent presentation further enhances the understanding of different processes, facilitating the exchange of ideas and experiences.



Figure 1. Pin up student presentations. Source: Nemanja Milićević (2024).

After presenting the second research cycle and gaining new insights into the material, students move on to the final, third phase of the semester-long research. In this phase, students attempt to produce a final product design derived from the material they have developed. The outcomes depend on the physical and technical characteristics of the material and its properties. Many results are oriented toward creating new, authentic products, such as interior coverings, sound and thermal insulation, children's toys, surfaces for public playgrounds, labels, and interior elements like chairs, tables, and wall curtains. Other products include bags for architectural drawings, laptop bags, boxes for ICOS cigarettes, and similar items. As a measure of the semester's task success, students create a booklet in which they present their product design, technical specifications, assembly instructions, diagrams, and potential applications.

2.1. Evaluation criteria

One of the requirements of the semester assignment is that students must meet four criteria when selecting materials: usability, environmental sustainability, social sustainability, and afterlife, following the methodology employed by the global platform for collecting creative sustainable concepts, Future Materials Bank. Usability pertains to how feasible it is to work with the selected material in various forms and functions, as well as in different contexts. This also includes its potential presence in the market, distribution, and related aspects. Environmental sustainability primarily considers the health and safety of the researchers/students during experimentation, as well as that of the users and the environment where the material is integrated. It raises questions about the extent to which production processes affect or exploit natural resources. To fulfill this criterion, the ingredients should be organically grown or produced without negatively impacting the environment. Additionally, students are encouraged to source materials locally and consider if these resources are renewable in the short term. Special attention is given to ensuring that the process does not directly or indirectly harm animals and that energy savings are prioritized, favoring methods that minimize water and energy consumption. Equally important is addressing waste management: how much waste is

generated and how it is disposed of or mitigated. Social sustainability evaluates the degree to which society, communities, or individuals are involved in the entire process (social activism). It establishes itself as an essential criterion by ensuring that the process respects human rights and is free from child labor. Moreover, ideas based on crafts or techniques with significant cultural or traditional value are highly regarded in this category. Finally, the afterlife of the material considers its behavior and usability over time. Preference is given to materials that can be recycled, are biodegradable, or support multiple or long-term use.

3. Learning outcomes

At the end of the semester, a survey was conducted among students who attended the course to evaluate learning outcomes. The survey consisted of 15 questions covering the methodology, course concept, new experiences, skills, and knowledge acquired. Participation was anonymous, with 78% of attendees completing the survey. The questions allowed for both multiple-choice and open-ended responses. To the first question, "Did the course meet your expectations?" 96% of respondents answered affirmatively. On a quantitative evaluation of course quality, 76% of respondents rated it the highest score (5), 20% rated it 4, and only 4% gave it a medium score (3). All respondents (100%) rated the lecture concept, informativeness, and content with the highest score (5). Regarding whether the semester's research topic aligned with contemporary trends in architecture and design, 88% considered it relevant, while 12% rated it 4 out of 5. On the question about new experiences gained, 92% indicated a positive experience, while 8% stated they partially gained new experiences. Concerning experimental teaching and hands-on practice contributing to new knowledge, 92% responded positively, while 8% indicated partial contribution. Open-ended questions (7 and 8) asked about specific skills and knowledge acquired. The responses often overlapped, highlighting successful mastery of methodological and analytical processes, familiarity with materials and their properties, and the quality of experimental procedures as a new hands-on skill. Question 9 focused on the concept and dynamics of exercises (1+4 structure), noting that in the absence of laboratory facilities, most exercises were conducted in classrooms, in the field, or at home. For this, 68% rated the concept and dynamics with a score of 5, 28% rated it 4, and 4% rated it 3. Methodology evaluation (question 10): 84% rated it 5, 12% rated it 4, and 4% rated it 3. Open-ended responses to question 11 pointed exclusively to infrastructural limitations as the primary shortcoming. Question 12 addressed students' expectations at the semester's end, with all respondents anticipating successful product outcomes. On the topic of result promotion (question 13), most students favored social media and exhibitions as the best channels for showcasing semester research. Questions 14 and 15 inquired about continuing with this method and pursuing it as a potential business idea. A notable 92% expressed interest in continuing this research and exploring its business potential, while 4% were uncertain, and 4% did not wish to continue. Statistical analysis of the questionnaire responses highlights the importance of introducing a

new methodology based on hands-on practice, which results in progress in students' cognitive, communication, and metacognitive skills. Furthermore, taking into account the suggestions from the questionnaire — that the implementation of this method requires adequate spatial and technological conditions — this concept could be established as a leading infrastructural project in the development of the school. Additionally, the results of this experiment indicate that it is of vital importance to integrate the hands-on method and practical learning not only through workshops or laboratories but also to embed this approach more broadly within the curriculum of the School of Architecture.

4. Conclusion

In summary of the conclusions — confirmed by the highly positive results of the survey — if the goal is to achieve contemporary educational methods, architectural education must include practical work within the curriculum, which by nature demands interdisciplinarity. This semester-long experiment demonstrated many positive effects of practical learning through the hands-on method. Most importantly, it enabled a connection between theory and the practical aspects of education, suggesting that this method could contribute to providing a holistic architectural education. Architectural practice in this way enables the development of new knowledge and skills, relying fundamentally on various techniques as well as conceptual notions such as imagination, flexibility, and creativity. Through the hands-on semester exercise Mockup Junk Lab, students start from their own design experience, engaging with abstract concepts which they explore, learn from, and shape into results and new knowledge — in contrast to conventional teaching methods. This experiential method can enhance the application of knowledge and skills in practice and set a new standard in the creation of architectural concepts, while also increasing the number of custom-made, authentic products on the market. Such learning through personal experience gained via experimental hands-on practice ensures a sustainable educational concept and supports lifelong learning as a vision for the future. Considering the growing trend of startup projects and the expansion of EU-funded initiatives that promote innovation, such specific skills could help shape a new model of the creative economy in the market, where students could position themselves successfully in the future.

References

Delors, J. et al. (1996). Learning: The Treasure within. Report to UNESCO of the International Commission on Education for the Twenty-First Century, UNESCO Publishing. https://doi.org/10.7788/ijbe.1996.24.1.253

Emami, N., & von Buelow, P. (2016). Teaching structures to architecture students through hands-on activities. Canadian International Conference on Advances in Education, Teaching, and Technology.

Future Materials Bank. (n.d.). Retrieved from https://www.futurematerialsbank.com

Haury, D. L., & Rillero, P. (1992). Hands-On Approaches to Science Teaching: Questions and Answers from the Field and Research. In ERIC. ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Suite 310, 1200 Chambers Road, Columbus, OH. 43212 ($6. https://eric.ed.gov/?id=ED349185

Jones, C. (2010). Interdisciplinary Approach - Advantages, Disadvantages, and the Future Benefits of Interdisciplinary Studies. ESSAI, 7(1). https://dc.cod.edu/essai/vol7/iss1/26/

Kolb, D. A. (1984). *Experimental learning: Experience as the source of learning and development*. Prentice-Hall.

Lawthom, R. (2011). Developing learning communities: using communities of practice within community psychology. International Journal of Inclusive Education, 15(1), 153–164. https://doi.org/10.1080/13603116.2010.496212

Nikitina, S. (2006). Three strategies for interdisciplinary teaching: Contextualizing, conceptualizing, and problem-centring. Journal of Curriculum Studies, 38(3), 251–271. https://doi.org/10.1080/00220270500422632

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From Disassembly to Re-Assembly: An Innovative Pedagogical Approach to Architectural Design and Upcycling Practices

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Abstract

In the context of new curricula methodologies, experiential learning and theoretical skills are being blended to tackle real case scenarios. As a result, methodologies such as the research-by-design approach are gaining momentum for their student-centred and dialogic approaches, highlighting a required change of perspective both on the teaching and learning spheres. In this regard, the following paper discusses the potential of this approach in the architectural technology teaching practices dealing with new challenges such as upcycling, where the canonical schemes may not be applicable. Therefore, the research-by-design approach has been tested as the working method in the "UP+IT – How to Disassemble a Building?" workshop, in which professors, researchers and PhD students from four Italian universities worked together to study and propose upcycling strategies for a real case scenario.

Keywords: *Research-by-design; experiential learning; teaching methodologies; architectural technology; upcycling.*

1. Introduction

In recent years, new innovative teaching and learning methodologies have been introduced and implemented within some of the curricula of universities, in the quest of diverging from the traditional frontal lectures (Shah et al., 2024). In unidirectional teaching, knowledge is transferred from teacher to students without considering a hands-on application of the presented concepts, promoting a passive learning approach. On the contrary, methodologies and tools such as the use of Virtual reality (VR) (Lu, 2022), Learning-by-doing approaches, Gamification (Mehelmy; Zeini, 2024), etc. are based on alternative educative environments, student-centered and dialogic approaches (Pak & De Smet, 2023) in which the experiential learning is achieved by applying the theoretical skills gained within lectures, into real case scenarios where one or

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more of the components (context, actors and actions) of the dynamic system of learning, are modified, expanding the impact on the students' thought process (Mackintosh, 2014). This approach is well suited to the architectural field, since design research needs a variety of expertise, including art, cultural studies, anthropology, cognitive psychology, and communication (Koskinen et al., 2013). The MIT (USA) is a representative case, that has already adopted the learning-by-doing approach by introducing hands-on activities in their study programs (Paris, 2017).

The research-by-design approach, based on a continuously interactive setting, can be integrated into the curricula of Architectural schools. This approach expects participants of the design process to creatively exchange, collaborate and develop new knowledge together (Roggema, 2016). This stimulus allows students to increase their critical thinking, problem solving and decision-making processes (Giordano et al, 2019). Fundamental to these learnings is the "failure" aspect, as it is core to the learning and reflective cycles, aimed at being experienced through hands-on learning (Djabarouti, O'Flaherty, 2019). In particular, research-by-design is a suitable, yet necessary approach to face the so-called wicked problems: problems with no final solution, which need to be continuously treated and directed, with a counterintuitive thinking and the development of new knowledge (Roggema, 2016). It is in this context that the workshop[1] *"UP+IT – How to Disassemble a Building?"* took place adopting the research-by-design approach, to address the complex theme of upcycling.

2. Design workshop: systematization and collaborative design

The workshop hosted several research groups from four different Italian universities: Politecnico di Torino; La Sapienza Università di Roma; Tor Vergata Università degli Studi di Roma and Politecnico di Milano and aimed at conducting research with a team of varying competencies, approaches, and perspectives. The research methodology was based on a practical work under the theme of upcycling applied to a specific case study that is part of Italy's modern history.

2.1. Upcycling applied to a Heritage Case Study

Upcycling in architecture is an emerging concept, able to be applied to the challenges listed by the European Community's Green Deal in order to limit the negative environmental impacts due to the construction sector. The upcycling concept requires a change of perspective in both the

[1] The workshop has been promoted as part of the research project *"Upcycling Architecture in Italy. Forging and Promoting a Renewed Building Culture"* project – founded by European Union - Next Generation EU within the PRIN 2022 PNRR program (D.D.1409 del 14/09/2022 Ministero dell'Università e della Ricerca)

teaching and learning sides, this involves applying strategies, such as design for disassembly, to deal with objective limits, in terms of the performance, that reused building materials and components may have in their "second life".

Through a particular Italian case study rooted in architectural history, the discussion seeks to address the preservation of heritage identity through disassembled components, adding layers of complexity and innovation in the current upcycling debate. The case study examined was the Istituto Tecnico Industriale Statale (ITIS) Volta in Tivoli (Rome, Italy). This building, designed in the 1960s by the BDS team under the direction of architect Pietro Barucci, stands as an example of industrialized architecture from the mid-20th century. It is distinguished by a modular and dismantlable construction system, patented to integrate the use of lightweight prefabricated panels with innovative metallic joints. Therefore, it served as a significant case study thanks to two key features: the disassemblability of its structural components and the availability of extensive technical archival documentation. These two aspects provided an ideal basis for in-depth exploration of the construction process and for investigating the potential of architectural upcycling.

2.2. A multidisciplinary approach: combined expertise and teamwork

To address a complex topic such as the relationship between architectural heritage and the upcycling approach, a heterogeneous working group, both in terms of professional expertise, as well as hierarchical levels, was established. Professors, researchers and PhD students from various fields of architecture (Architectural and Urban Design, History of Architecture, and Technological and Environmental Design of Architecture) and engineering (Technical Architecture and Project Evaluation) closely collaborated during an intensive research workshop held in June 2024 at La Sapienza Università di Roma.

The workshop was organized into three groups, each engaged in the development of a distinct macro-theme while maintaining flexibility and interchangeability across tasks. In order to ensure that every member of the group contributed their expertise, each team was supervised and supported by at least one professor.

Moreover, specific roles with unique functions were identified during the workshop: *Scientific explorers, Highly qualified researchers* and *Facilitators*. *Scientific explorers* focused on studying and analysing basic statements of the case study, essential elements for constructing a comprehensive informational framework, both technical and theoretical. *Highly qualified researchers,* who led and coordinated activities within the macro-groups, providing specialized guidance on specific areas such as Building Information Modelling (BIM), structural considerations and economic and financial evaluation. Finally, *Facilitators* managed real-time communication between macro-groups, promoting systematic exchanges of information, ideas, and knowledge.

This collaborative and peer-to-peer interaction fostered a dynamic synergy among participants, leading to the development of a complex operational model based on interdisciplinary cooperation. Within this cooperation, each member's participation was fundamental for the research success, therefore, as a method to confirm the participants' contribution, daily discussions were held to share the work progress and the challenges faced.

3. Research framework

The workshop has been divided into three phases: *Individual research, Research-by-design* and *Systematization of the results*. A noteworthy aspect of the process was the collaborative methodology adopted: each member of the group contributed their expertise, resulting in a mature and coherent outcome that synthesized the diverse inputs (Fig.1). In this context, the synergistic collaboration between professors and students fostered a productive dialogue.

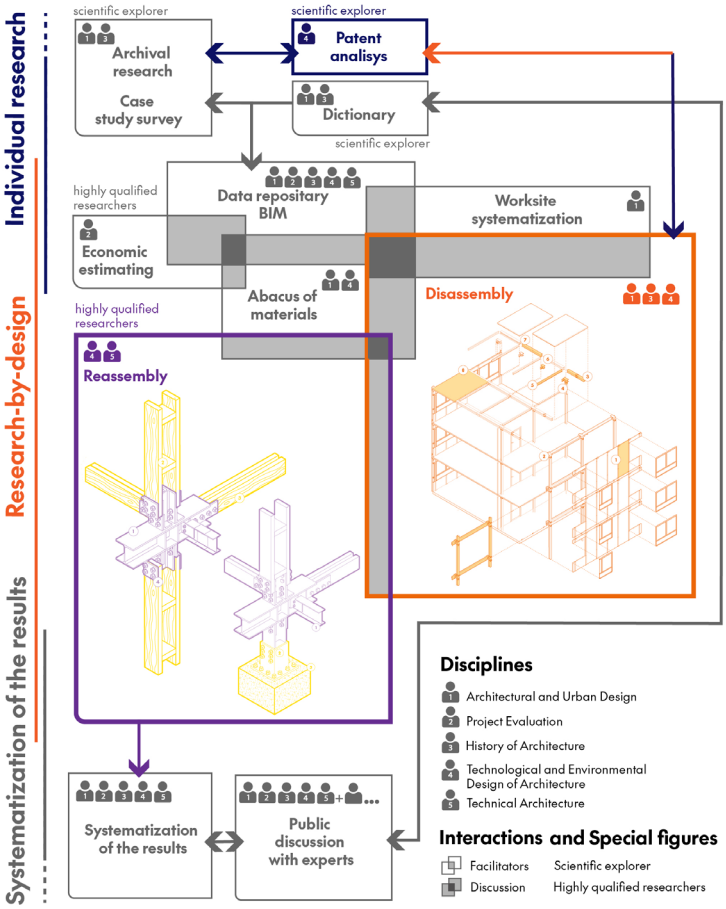


Figure 1. Methodological concept.

3.1. Individual research

In the first phase, a series of theoretical online lectures were held within the previous month to the workshop, during which, a group of experts presented a range of case studies on upcycling. Additionally, parallel to the lectures, the groups from each university were invited to explore specific aspects of the research:

- *Archival research.* Collection of original technical and historical documents of the ITIS Volta;
- *Dictionary development.* Critical synthesis of recent literature to provide a shared framework on keywords such as Upcycling, Recycling, Downcycling, Reuse and Superuse;
- *Survey and BIM modelling.* Development of a digital 3D model based on archival information and first on-site measurements as a base for the following working steps;
- *Architectural technology analysis.* Study of the patent and original technical drawings by Architect Barucci in order to gain a deeper knowledge of the case study and to understand the implemented technology of the building and sparked the first ideas of possible disassembly processes.

3.2. Research-by-design

Following the initial phase of analysis, an on-site investigation was essential for gaining a deeper understanding of the case study. During the site visit it was possible to examine the architectural elements and stratigraphy components that currently characterize the building and to observe how these differed, either partially or entirely, from those represented in the archival documentation. This discrepancy might be since, over the years, the school has undergone multiple maintenance operations, replacements and structural reinforcements.

Therefore, it became necessary to question the previous analysis and explore new intervention hypotheses. This process was both highly engaging and challenging, as it required the integration of diverse tools, including historical documentation, laser-scanner, survey data and the BIM model, to conduct an “in reverse” analysis. Specifically, in order to determine how to disassemble the building, it was essential to identify the most recently installed component and work backward to dismantle the various elements systematically. During this phase, efforts were made not only to preserve the largest possible quantity of materials, but also to pay particular attention to the building's defining features, such as the specific joints patented by Barucci. Significant discussion was undertaken among the participants to determine how to preserve their historical value even in the event of complete disassembly.

Additionally, graphical outputs such as diagrams, charts and exploded axonometric drawings were produced to better visualize the disassembly phases and identify components that could be

reused in subsequent stages. Particular focus was placed on the modular façade panels, floors and steel structural elements. These components were subsequently cataloged, enabling potential reuse in the development of new projects.

As the final stage, the working group focused on analyzing possible reassembly strategies aimed at defining examples of design prefiguration. This phase, characterized by a more creative approach, highlighted the diversity of perspectives within the group, fostering a constructive debate on potential spatial configurations and the appropriate scale of intervention. To explore the compatibility between the most significant components, an analytical tool in the form of a matrix was employed. This matrix, designed to systematize the various elements, facilitated the selection of the most emblematic components and allowed the identification of three hypothetical reassembly configurations. Additionally, the matrix played a crucial role in implementing the principle of upcycling, enhancing the value of existing materials and expanding their design potential. The three prefigurations provide specific design guidelines at a detailed scale, defining how to reassemble the elements and integrate them with new materials.

3.3. Systematization of the results

The results obtained during the two previously described phases were systematized into a dossier[2]. The workshop ended with a final discussion, that allowed the students to assimilate the main topics addressed during the research and to interrogate themselves on the questions still to be answered.

Furthermore, during the international conference *"Upcycling and Architecture in Europe. Towards a New Building Culture"* held at the Politecnico di Milano from September 20th to 21st of 2024, the workshop participants had the opportunity to present their findings and engage in discussions with esteemed experts in the field. This stimulating debate promoted the opportunity to confront multiple perspectives on upcycling, in order to consider the results achieved not as an endpoint, but as ongoing research.

4. Conclusions and future perspective

The workshop *"UP+IT – How to Disassemble a Building?"* has demonstrated the potential of research-by-design methodologies in addressing complex themes, such as the architectural upcycling in heritage preservation. By combining targeted seminars, theoretical research and hands-on activities, the project fostered a collaborative and interdisciplinary environment that not only advanced the study of upcycling from the existing building stock but also provided an

[2] Bologna. A., Garcia-Fuentes. J., Giannetti. I., Neri. G., Germanò. R., (2024). Upcycling Architecture in Italy. Design Workshop Results. https://www.upcyclingarchitecture.it/items/up-it-design-workshop-results-booklet

innovative framework for architectural education. The inclusion of experts and participants from various fields of architecture and engineering facilitated a rich exchange of ideas. Moreover, the interaction between professors, researchers and students proved to be a powerful tool for promoting critical thinking and creativity while advancing knowledge in the field.

This approach is characterized by its dynamic and interactive nature, lacking a defined beginning or endpoint. Instead, it evolves continuously and remains open to critical reassessment. Rather than producing definitive results, it generates opportunities for continuous reflections and dialogues.

In conclusion, the implementation of the research-by-design method, based on the dissolution of disciplinary boundaries, can represent a suitable tool for working groups that include inexperienced individuals or beginners. It is evidenced, that a possible limitation or strength of this approach is the challenge to quantify the individual contributions of each participant, consequently, in order to obtain high quality results, it is important that the involved students display a willingness to tackle the research topic.

Such approach enhances participants' skills and supports the development of research principles and methods while guiding them in navigating the research environment. By fostering engagement, this methodology transforms participants from passive recipients of knowledge into active and proactive contributors.

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References

Djabarouti, J., & O'Flaherty, C. (2019). Experiential learning with building craft in the architectural design studio: A pilot study exploring its implications for built heritage in the UK. Thinking Skills and Creativity, 32 (April), 102–113. https://doi.org/10.1016/j.tsc.2019.05.003

Giordano, R.; Montacchini, E.; Tedesco, S. (2019) Experiment, develop and provoke: the prototype as an instrument of design. Sperimentare, sviluppare e provocare: il prototipo

come strumento del progetto. TECHNE, (18), 89-98. https://dx.doi.org/10.13128/techne-7515

Koskinen, I., Zimmerman, J., Binder, T., Redstrom, J., & Wensveen, S. (2013). Design Research Through Practice: From the Lab, Field, and Showroom. IEEE Transactions on Professional Communication, 56(3), 262–263. https://doi.org/10.1109/tpc.2013.2274109

Lu, Y. (2022). Teaching Architectural Technology Knowledge Using Virtual Reality Technology. Canadian Journal of Learning and Technology / Revue canadienne de l'apprentissage et de la technologie, 48(4), 1–26. https://doi.org/10.21432/cjlt28253

Mackintosh, L (2014) Just Doing It: The Role of Experiential Learning and Integrated Curricula in Architectural Education. The International Journal of Pedagogy and Curriculum, 20, 67-78. https://doi.org/10.18848/2327-7963%2FCGP%2FV20I03%2F48969

Mehelmy, D. & Zeini, I. (2024) Experiential Learning Through Gamification in Interior Architecture and Design. International journal of Architecture, Arts and Applications, 10(2), 42-59. https://doi.org/10.11648/j.ijaaa.20241002.13

Pak, B., & De Smet, A. (2023). Experiential Learning in Architectural Education. Design-build and Live Projects (Routledge).

Paris, S., "Il rinnovamento della cultura tecnologica nel progetto, tra nuova tettonica e tecnologie digitali. Scenari internazionali dell'insegnamento e della ricerca". Techne, n. 13, pp. 194-203, 2017.

Roggema, R. (2016). Research by Design: Proposition for a Methodological Approach. Urban Science, 1(1), 2. https://doi.org/10.3390/urbansci1010002

Shah, T. M., Jannesarahmadi, S., Shokri-Kuehni, S., Ellinger, D., Brose, A., Or, D., & Shokri, N. (2024). Research-based learning as an innovative approach for teaching students of environmental engineering: A case study of the emerging field of microplastics in soil. Discover Education, 3(1), 97. https://doi.org/10.1007/s44217-024-00189-5

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Beyond the classroom: hands-on activities for a tactical action in a university campus courtyard

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Abstract

The paper reports the outcomes of a "circular" design and self-construction workshop developed with master's degree students in architecture and design at the Politecnico di Torino (Italy). The project is set in a real-world context, which the hands-on activities aim to transform and improve. The activities allowed experimentation with "circular" construction solutions, starting with the use of waste materials as a resource, which led to the creation of furniture in the courtyard of the university campus, transforming it from a fragile space to a place with a new collective value. The learning experience is aimed not only at the acquisition of practical skills by students, but also at reflecting on how to transform waste into a new material for projects, through a low-cost tactical action that started from a need of the students and was developed by the students themselves, involved in the construction of a community space.

Keywords: *hands-on activities; learning-by-doing; "circular" design sprint, self-construction, tactical action.*

1. Introduction

Schools of Architecture and Design around the world increasingly recognize the strategic value of hands-on activities as fundamental competence of their educational curricula. Some technical universities - such as the Massachusetts Institute of Technology in Cambridge (USA), the Eidgenössische Technische Hochschule in Zurich (CH), Auburn University in Alabama (AU), and the University of Central Lancashire in Preston (UK) - have long been investing in new teaching models that allow theory to be applied to practice and include experimentation and prototyping as a way of learning by doing, with the aim of developing students' practical skills and strengthening their understanding of the subject matter (Mackintosh, 2014).

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The paper reports the outcomes of a design sprint and self-construction workshop developed with master's degree students in architecture and design, as part of the course Designing and Developing the Circular Economy, conducted at the Politecnico di Torino in Italy.

The outputs and outcomes of this educational experience will be presented, and its goals will be discussed. In particular, the workshop aimed at:

- experimenting with a practical learning model to engage architecture and design students;

- working with students on the principles of the circular economy;

- operating on a real space with real needs by tactically transforming it into a collective place for students.

The originality of the contribution consists in presenting a learning experience not only aimed at the acquisition of practical skills by students but also at reflecting on how to transform waste in a new material for projects, giving it a new life. Schools of Architecture and Design must in fact invest in new educational models that can prepare students to become professionals capable of dealing with the potential and difficulties of applying circular economy principles in practice (Giannoccaro et al., 2021).

Moreover, the contribution illustrates a project that is set in a real-world context, which hands-on activities aim to transform and improve. This is a tactical action project that, through a temporary, low-cost intervention, aims to stimulate long-term changes (Sasser, 2017) by engaging students and teachers in the creation of installations for the physical and social regeneration of a public place.

The hands-on activities described in the contribution allowed experimentation with circular construction solutions, which led to the creation of furniture in the courtyard of the university campus, transforming it from a fragile space to a place with a new collective value.

2. Improving university outdoor space: the project brief

Activities correlating practice, circular economy, and tactical actions are strongly promoted by the Technology of Architecture and Design research group of the Politecnico di Torino, which has been conducting experiences for years in collaboration with the Innovative Technology Systems Laboratory (LaSTIn) of the same university. In particular, the article describes an activity conducted as part of the course “Designing and Developing the Circular Economy”, an interdisciplinary course involving students with different educational backgrounds from master's degree programs in Architecture and Design, with the aim of training new professional figures with transversal skills that can prefigure circular solutions for different building and design sectors (Montacchini et al., 2024).

As part of the course, students are involved in a 'circular' design sprint activity as an opportunity to practice applying some of the principles of designing for the circular economy, with a focus on reuse, repurpose, upcycling and disassembly of materials and products at the (supposed) end of their useful life.

The experience described in the article refers to the a.y. 2022/2023, when thirty students were called upon to design and create, in only eight hours of time, temporary furniture for the Morgari street's courtyard within the university campus, where the LaSTIn Laboratory is also based. The courtyard, although recently renovated, looked like an anonymous space, completely bare and devoid of furniture and equipment.

The project brief responds to a need that has long been felt by the student community: to equip this space with furniture to make it a usable place for all in which to carry out activities for study but also for relaxation, recreation, food consumption, meeting and socializing. To improve outdoor spaces on college campuses is a well discussed need to which it is important to respond. As some articles on the topic highlight, carrying out study and recreation activities outdoors has positive effects, perceived and objective, on students' health and well-being (Dadvand et al., 2016; Wilson, 2018).

3. 'Circular' materials

The challenge of the proposed brief is to combine a design goal in a real-world context with an unconventional design approach, in which waste materials drive solutions, inspire form and function. Axes, pallets, wooden boxes, signal nets and waste materials from the recently completed construction site, piled up in the campus courtyard itself, became the Km 0 materials from which to start educational experimentation, thanks to the immediate availability of "raw material" (Figure 1).

Such materials have become the new resources for design, have inspired concepts, have been the "medium" through which to learn and develop observational skills, particularly useful for redesigning second lives and new uses of the same.

Waste materials were also an opportunity to experiment "in the field" with the potential and difficulties of circular design processes.



Figure 1. The Km 0 waste materials used in the project: axes, pallets, wooden boxes, signal nets from the construction site became the available materials from which to start educational experimentation.

4. Hands-on activities and the 'circular' design sprint

The adopted approach was the design sprint, inspired by the Google Venture methodology used to solve critical issues through prototyping in a short time (Knapp et al., 2016). The term 'circular' refers to the fact that the design solutions identified during the process are closely linked to the availability of present materials destined for the landfill. Students had to design and self-construct tables, benches, chaise lounges, and stools taking into consideration the limited amount of waste and its defined shapes and sizes (Figure 2).



Figure 2. From yard waste to temporary furniture for the campus courtyard: tables, benches, chaise lounges, and stools self-constructed by students.

The workshop was divided into two challenging and intense half days of work, four hours each. The first half-day consisted of harvesting the materials and the technologies and tools available at LaSTIn, initial cleaning of the materials, concept definition and prototype creation. The second half-day was aimed at reviewing the prototype, finishing work and releasing the artifacts.

Students first observed and selected the source materials that guided the concept, sensing opportunities for new life from the waste. The students then became familiar with tools and equipment, performing initial machining and testing ways of connecting elements. For example, they experimented with unhinging pallets to make planks, sanding, drilling, cutting scrap materials, and joining them through dry connections such as screws, nails, and joints. At this stage, it was also possible for them to observe what are the difficulties of working with imperfect materials and semi-finished products that, unlike new ones, require quite a long time for technical processing of cleaning and sorting.

Concept definition was carried out by students divided into small groups. They each brainstormed on the possibilities of using the available materials, based on the dimensional, material and sensory characteristics of the materials and what they were able to evoke. For example, a construction net was imagined as a backrest for a seat because of its flexible characteristics and mesh-like appearance, just as a wooden box was imagined to be used as a base for a bench.

Finally, the implementation of the prototype allowed the concept to be verified and tested students on the effectiveness of the solution as a whole, enabling them to reflect on the adoption of non-traditional design solutions, based on a circular design approach, with a limited amount of time. In fact, the time factor is not secondary in the process. Having a limited amount of time to finish the project means taking care to limit the amount of processing and transformation required as much as possible. This implies that the project will be all the better the more it is able to enhance and integrate within it the materials in their original state. It means learning to interpret and see waste for its strengths.

5. Results and conclusions

The activity described in the article is not a single experience, but rather a component of a didactic experiment that is currently underway within the context of our academic courses (https://www.youtube.com/watch?app=desktop&v=hesmoTo2prc). Starting from specific project opportunities, the potential of reusing waste materials is investigated and the challenges involved in proposing a practical approach with technologies appropriate to the context and the actors are discussed.

The results of the experience described were multiple, and not just educational. Through the hands-on activities, students learned how to build, assemble, and make, and how to design, manage, plan, honing hard-skills related to materials, technologies, and equipment. In the meantime students increased soft-skills that will be fundamental to their future profession: team work, creative thinking, problem solving, organization (Figure 3).



Figure 3. Hands-on activities and students' soft skills.

The hands-on work, in addition to providing an opportunity for learning technical skills, fostered intense moments of relational exchange among the students, becoming an opportunity for participatory design, knowledge co-generation and experience sharing in a real project context. The teaching evaluation questionnaire - prepared by the Joint Teaching Committee (Comitato Paritetico per la Didattica – CPD) to check the quality of the teaching and the satisfaction of the student community - returned positive data on learning and skill enhancement. Students' comments emphasise the value of bringing theory and practice closer together and for the opportunity to engage in hands-on experimentation.

Specifically, the project contributes to the growing research on innovative educational modes in the field of circular economy, investigating the effectiveness of hands-on learning models that enable reflection on the new life of waste that can become part of the project as new materials. An educational mode that starts “from the bottom,” from discarded matter, from waste, to experiment and learn the principles of circular design, promoting reuse and waste reduction. This form of design practice has great potential not only as a learning method, but also as a solution for the transformation of weak spaces. In fact, in terms of physical-spatial outcomes, the activities conducted made it possible to enhance an underutilized but highly significant courtyard as a relational space outside. The qualitative assessment, carried out through direct observation, shows that this tactical, low-cost action, started from a need of the students and developed by the students themselves, led to the construction of a community space. Students have reappropriated an empty courtyard, equipping it to be used for leisure activities in the

intervals between classes, as a space for eating meals outdoors, and for moments of pause, relaxation and sharing. The teachers themselves are using the new equipment to organize outdoor lectures and informal gatherings with students (Figure 4).



Figure 4. Ways of use: outdoor lectures and moments of relaxation.

The space previously perceived as unhelpful and meaningless is now a “place” experienced and cared for by those who made it with their own hands, investing their own time and energy. In this sense, the design sprint activity was an opportunity to bring out, on the one hand, the potential of the space and, on the other, a way to provide immediate solutions to a felt need through prototypes. This also made it possible to raise the university's awareness of the issue and have it address it with more defining furniture solutions and perhaps, why not, designed according to the principles of design for the circular economy.

References

Dadvand, P., Bartoll, X., Basagaña, X., Dalmau-Bueno, A., Martinez, D., Ambros, A., Cirach, M., Triguero-Mas, M., Gascon, M., Borrell, C., Nieuwenhuijsen, MJ. (2016). Green spaces and General Health: Roles of mental health status, social support, and physical activity. *Environment international*, 91, 161-167.

Giannoccaro, I., Ceccarelli, G., Fraccascia, L. (2021). Features of the higher education for the circular economy: The case of Italy. *Sustainability*, *13*, 11338.

Knapp, J., Zeratsky, J., & Kowitz, B. (2016). Sprint: How to solve big problems and test new ideas in just five days. Simon and Schuster.

Mackintosh, L. (2014). Just doing it: The role of experiential learning and integrated curricula in architectural education. The International Journal of Pedagogy and Curriculum, 20(3), 67-78.

Montacchini, E., Tedesco, S., & Di Prima, N. (2024). Engaging students in Circular Design: teaching experiences with (future) architects and designers. In *Proceedings of Conference on Sustainable Energy Education–SEED 2024* (pp. 979-987). Editorial Universitat Politècnica de València.

Sasser, J. (2017). Tactical urbanism: Short-term action for long-term change, by Mike Lydon and Anthony Garcia: Washington, DC, Island Press, 2015.

Wilson, T. (2018). *Design Guidelines for Activating Outdoor Spaces of University Campuses*. Digitalcommons.calpoly.edu.

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Assemblage and Immersion in the Archive: New Formats for Architectural Education

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Abstract
The recently established Architecture Archives of the Future group at TU Delft explores new educational formats to activate architectural archives as sources of design knowledge and traditions. To this end, it collaborates with the Nieuwe Instituut in Rotterdam, which holds the Dutch national collection of architecture and urban planning. By combining methods of comparative plan analysis and digital VR and XR technologies, students learn how to operationalize historical data and knowledge, curate these, and present them to a larger audience. Two courses serve as examples: one is a history and theory course, and the other is an experimental research and design studio. Through assemblage (the history and theory course) and immersion (the studio), the students learn to synthesize their findings into a critical narrative, assessing data, cultural and social values, and speculative questions about future knowledge and design production.

Keywords: *Virtual Reality; Augmented Reality; Critical Pedagogies*

1. Curating the Past

Traditionally, architectural historians have used archives as repositories of disciplinary knowledge, with texts, drawings, and photographs as the focus of their analyses. However, new technologies greatly improve the accessibility to these collections and are already changing how architectural history is produced, learned, and experienced. The pandemic and its concomitant lockdowns have accelerated this process, forcing schools, museums, and archives to move their activities to the online realm. In this paper, we argue that integrating digital and curatorial practices into architectural education can transform how history, theory, and design are taught in the classroom. We share two experimental courses at TU Delft that explore new pedagogical formats that approach archives not as static knowledge repositories but as an active, generative space where history is interrogated, reinterpreted, and projected through new media.

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The first course, *Housing Studies: An Open Intersectional Archive*, is a history and theory seminar where we use the format of the exhibition as a pedagogical tool. Here, students work with historical records in architectural archives, using them to situate past housing projects within contemporary debates on social and spatial justice. Rather than studying these projects as isolated cases, we invite students to construct layered analyses to understand the social, political, and material conditions that produced the buildings. Through a process of selection, interpretation, and curation, students assemble the historical materials into a collective exhibition that juxtaposes drawings, media representations, policy documents, and oral histories with an awareness of how histories are constructed, contested, and reactivated in contemporary discourse. The final exhibition, which is their primary assignment, becomes a site of engagement with a public audience. In this place, architectural history is received as an accessible, discursive space where knowledge is co-produced. For this course, we use the concept of *assemblage* as an active process of reconfiguration, where students, as both historians and curators, perform a form of historical construction, revealing absences, mapping multiple sources, and producing new relationships.

The second course, *The Virtual Architecture Museum*, is a research and design studio that investigates the intersections of the virtual and the real, the physical and the digital. While *Housing Studies* reworks the archive through *assemblage* and curation, this course explores how digital tools can mediate architectural history. Students employ Virtual Reality (VR) to translate archival research into immersive environments, a process that requires analyzing original architectural drawings and reconstructing historical buildings that no longer exist or were never built. Beyond the reconstruction of the historical designs, however, the course asks students to rethink how architectural history is presented and experienced. The immersive nature of VR distances it from traditional representation techniques, emphasizing storytelling, embodiment, movement, and atmosphere. Moreover, the course also proposes a dialogue between virtual and physical space. Students need to design physical structures —a media pavilion in public space— as entry points to their virtual museum, thresholds between the material and the digital. In this manner, the studio explores how virtual and material spaces co-produce meaning. We approach this course through the concept of *immersion*, not only a technological effect but an epistemological condition that allows students to inhabit history as it were, moving from observation to experience and interpretation.

Despite their differences, the courses rethink architectural pedagogies through new formats of engagement with architectural history and archives. *Housing Studies* examines how exhibitions can help students construct historical narratives, and *The Virtual Architecture Museum* explores the potential of immersive technologies to reinterpret and spatialise architectural history. They share a triangulated methodological approach —historical research, critical reinterpretation, and audience engagement— to interrogate how architectural knowledge can be actualized, curating the past and projecting speculative futures.

2. Housing Studies: an open intersectional archive

Our intention with *Housing Studies*, an elective for 1st year master's students in Architecture, is to approach history as a dynamic field (re)produced by an assemblage of documents, voices, and perspectives. This course aims to introduce students to architecture archives, not as fixed repositories but active sites of investigation where historical knowledge is constructed through research and curation.[1] We understand the role of researchers/students as disruptors of such sites, reconfiguring knowledge to offer new narratives. As a pedagogical tool, the exhibition allows students to engage directly with archival materials to assemble them into new constellations that re-examine housing projects with broader social, political, and spatial concerns. A key theoretical foundation of the course is that of intersectionality.[2] Students are asked to reappraise, through such an intersectional lens, collective housing projects and their histories, from the commissioning and lives of their architects to their design, construction, and material afterlives, as well as the appropriation by inhabitants. Through this approach, the course invites students to question who has historically been included or excluded from architectural discourse, and how spatial practices reflect and reinforce broader structures of inequality. Students are thus introduced to collective housing projects and epistemological bases for debates over the nature of historical, oral, and archival research and curatorial practices.

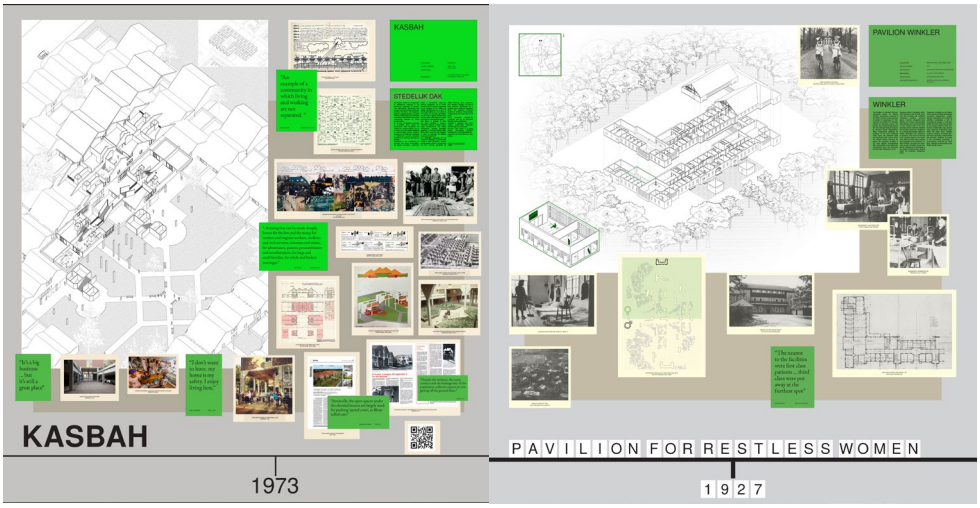


Figure 1. Examples from the second edition's exhibition. Work by Mathew Senarta, Emina Šehmehmedović , and Ana Poenariu; Mascha Gerrits, Robin de Wilde, and Axelle Maasen. 2024.

[1] There have been three editions of the course, with different teaching teams. The first edition was organized by Vanessa Grossman, Dirk van den Heuvel, Paula Lacomba-Montes, and Elena Martínez-Millana. The second, by Dirk van den Heuvel, Alejandro Campos-Uribe, Paula Lacomba-Montes, and Elena Martínez-Millana. The third, by Dirk van den Heuvel, Eytan Mann, Fatma Tanis, and Carla Sentieri-Omarrementeria.

[2] A framework of analysis originating in black feminism to consider the ways in which different forms and norms of social stratification —such as class, race, disability, migration status, or sexual orientation— interlock with gender as systems of power and inequality.

Housing Studies has been structured around thematic editions, connecting to intersectionality through different curatorial lenses. The first edition of the course (2023) focused on Dutch female architects, examining how gender shapes architectural production, both in terms of recognition and the kinds of spaces designed. The second edition (2024) continued within the framework of intersectionality to explore the notion of the non-compliant, a term used to describe individuals and communities who do not conform to normative expectations.[3] This second edition focused thus on housing projects for groups often overlooked in mainstream narratives, -- from psychiatric patients to single, older adults, to students, to community living -- looking at how their spatial needs challenged existing models of domesticity, accessibility, and public space. The exhibition, which the students titled "Beyond the nuclear family", highlighted alternative ways of living, emerging from these non-compliant positions.

Housing Studies, then, provides critical tools for analyzing non-normative collective housing projects and their hidden or overlooked histories, while examining the relevance and applicability of intersectionality to housing design. The activities are based primarily on group work and presentations of case studies, drawing on different research methods like literature study, plan analysis, archival research, site visits, and oral history interviews. Students begin with an exploratory phase in which they conduct archival research at the Nieuwe Instituut, selecting materials related to their case study. This initial exploration, however, is not limited to architectural drawings. We encourage students to consider a range of sources, from planning reports to letters, newspaper and journalistic articles, interviews, and popular media, recognizing that the production of housing is as much social and political as it is spatial. At this stage, *assemblage* becomes central to the pedagogical approach. Students learn to read materials relationally, how they intersect, or contradict, reveal biases and absences. Using hard and soft forms of evidence —from technical drawings to oral testimonies—they expose how histories are constructed, with decisions that are not neutral but interpretative, opening new perspectives on the housing projects. Through these assemblages, students reflect on the socio-economic, political, urban, and territorial contexts from which these case studies emerged, including governance frameworks and policymaking processes.

The outcome of the course is an exhibition collectively curated and designed by the students themselves, that showcases the analysed case-studies through research-based documentation, including drawings, models, or other objects, audiovisuals, and textual resources. This exercise complements traditional academic outputs, such as essays or reports, focusing on audience engagement and knowledge dissemination. The exhibition, physically held at the Faculty for the whole educational community, functions as a pedagogical and historiographic experiment, opening multiple entry points into the case studies through the narratives constructed by the

[3] The term 'non-compliant' was introduced into the architectural discourse by the American architect and queer theorist Joel Sanders. Sanders, J. (1996). Stud: Architectures of Masculinity. Routledge.

students. Simultaneously, it spatializes architectural histories and serves as the stage for the students' works and presentations, including a catalogue containing their essays. In this manner, the course reinterprets architecture archives as generative spaces for reflection and debate, inviting students to see the archive and the exhibition as spaces of production, where knowledge is assembled, reframed, and made public.



Figure 2. Assemblage of materials: newspaper articles, historical photographs, drawings, and quotes from interviews with inhabitants. Work by Bas Jonker, Paulina Düchting, and Yishu He, 2024.



Figure 3. Exhibition opening, April 2024.

3. The Virtual Architecture Museum: reconstructing history through immersion

If *Housing Studies* pushes students to construct historical narratives through *assemblage*, the *Virtual Architecture Museum* goes from curating archival materials to inhabiting history through *immersion*. In this course, structured as both a research and design studio, students use digital tools —specifically Virtual Reality (VR)— to reinterpret and reconstruct architectural history, but also to project and design new architectural devices that mediate between past and future, digital and material, archival knowledge and design speculation. Students do not merely reconstruct historical projects, but reinterpret them through spatial storytelling, creating VR experiences that communicate architectural ideas to a public audience. Rather than aiming for realism, we invite students to critically examine the cases to expand and transform them through digital media. In this manner, the course questions how immersive technologies can be used for historiography and spatial invention, developing new architectural interfaces.

The course is structured with two design assignments: the digital reconstruction of historical projects, reinterpreted through an immersive VR experience, and the design of physical media pavilions that function as entry points to this virtual world. Students begin by selecting a case study —often unrealized— and conduct archival research to gather plans, sections, elevations, and textual descriptions. This phase requires careful analysis to reconstruct fragmented realities and make decisions about spatial and material aspects of the design that remained unsolved. Once the research is finished, they must translate their findings into a storyboard for an immersive and interactive VR experience as a curated sequence of spaces, atmospheres, and interactions that communicate the project's ideas.



Figure 4. Exhibition with students' results, November 2024.
A digital version of the exhibition is online here: https://virtual-architecture.cargo.site/

The results from the first edition of the course illustrate how VR serves as a pedagogical tool and a historiographic intervention. For instance, *Echoes of Time* by Ziyue Yu reconstructs Aldo van Eyck's unbuilt *Wheels of Heaven* (1963), a church that was never realized. Her VR experience is structured around three levels: the archival level, where users visit a virtual exhibition of historical documents about the project —drawings, videos, texts…—; the realistic level, which reconstructs the design based on archival materials; and the imaginative level, where speculative interpretations expand on the building's original concept. Through this approach, Ziyue Yu invites visitors to the Virtual Architecture Museum to think of history as a multi-perspectival experience, blending research with spatial storytelling. This approach shows one of the main potentials of immersion: the ability to simulate lived experience.

Although an important teaching time of the course is dedicated to technical training —how to use VR tools, create interaction, apply textures, etc.— we don't understand digital

reconstruction as a purely technical exercise. Rather than producing exact replicas of historical projects, we believe that students should approach VR modeling as a curatorial act: choices about materials, textures, spatial sequencing, and interaction actively produce the historical reinterpretation. Digital reconstructions are never neutral; they are always mediated by the present conditions and require critical reflection on how history is narrated.

The course's second component is intended to explore the relationships between the virtual and the real, requiring students to design physical structures that act as thresholds between material space and the virtual museum. The students work within a real site (the Lijnbaan shopping street in the inner centre of Rotterdam) where they must design media pavilions that are not just functional interfaces for VR access, but themselves architectural statements. Located within an urban context, the pavilions should serve as functional and symbolic entry points, showing the tension between physicality and digitality and a new, immersive way of approaching architectural history.



Figure 6. Virtual session in Spatial.io, May 2024.



Figure 5. Students during the "Embodied virtuality" workshop led by Paula Strunden, May 2024.

Apart from these two assignments, we organized different kinds of explorative workshops and lectures by scholars and artists to help students engage with the potential and limitations of VR. Paula Strunden's workshop on 'Embodied Virtuality' introduced multisensory spatial perception in XR, using tools like Gravity Sketch and full-body motion capture to experiment with virtual avatars and performative digital spaces. Another workshop was conducted as a collaborative design environment using the Spatial.io virtual platform, with students and professors represented through their avatars, allowing them to place images on virtual walls, present their projects in a digital lecture room, and explore a shared virtual model of the studio's site. In addition, guest lectures offered different perspectives on VR as a historiographic tool by

researchers and professionals. Eytan Mann, for instance, who researches contested sites, integrating oral histories and archival materials within VR point-cloud models, lectured on how digital reconstruction intersects with memory and spatial politics. *The Virtual Architecture Museum* thus proposes again a triangulated methodological approach —archival research, digital reconstruction, and spatial storytelling. Here, immersion is not only a technical feature of VR but a pedagogical and epistemological condition, inviting students to inhabit history, moving from observation to experience, interpretation, and speculation.

4. New formats for Architectural Education

We believe that these pedagogical experiments can contribute to innovative architectural education in the digital age. Both courses show that historical materials can be approached as tools for speculative design and experimentation, responding to contemporary debates and global challenges, while grounded in historical analysis. In other words, architectural archives are conceived as generative memory spaces, as data producers themselves, and as an interface between publics and professionals. Historical knowledge is not only studied, it is activated. In addition, both courses also show how curatorial and digital practices complement traditional architectural methods focused on drawing. These were important reasons for creating the Architecture Archives of the Future group within the Department of Architecture at TU Delft.

Beyond archives, the courses raise awareness on the role of media technology in architectural pedagogy. Digital tools like VR and XR especially require a reflection on how space and history are mediated. The explorations of embodied virtuality and research on contested sites and oral histories demonstrate that students should not just uncritically use digital tools, but rather interrogate their epistemological and political implications. Through *assemblage* and *immersion*, we aim to open disciplinary boundaries between history, theory, and design. We seek to integrate curatorial, digital, and narrative methodologies to bypass traditional models and bridge past and future through creative engagements.

References

Bond, J. (2021). Foundations of Intersectionality Theory in *Global Intersectionality and Contemporary Human Rights*. Oxford: Oxford University Press, 6-26.

Keller, E.; Jarzombek, M.; Mann, E. (2021) Site-Archive-Medium: VR, Architectural History, Pedagogy and the Case of Lifta. *Footprint*, 14(2), 11-30. doi: 10.7480/footprint.14.2.4553

Mbembe, A. (2002). “The Power of the Archive and Its Limits”. In: Hamilton, C., Harris, V., Taylor, J., Pickover, M., Reid, G., Saleh, R. (2002). *Refiguring the Archive*. Springer.

Strunden, P. (2023), Touching, Licking, Tasting: Performing Multisensory Spatial Perception Through Extended-Reality Models. *Architectural Design*, 93, 48-55. doi: 10.1002/ad.2993

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Bridging Theory and Practice: The Role of Language Quality Assessment in Translation Technology Training

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Abstract

In today's globalized economy, delivering high-quality translations is essential for effective cross-cultural communication and professional localization. Machine Translation Evaluation (MTE), supported by Language Quality Assessment (LQA) frameworks within Translation Management Systems, provides systematic methods for evaluating the accuracy, fluency, and contextual relevance of machine-generated translations. This study explores the integration of LQA workflow into Translation Technology education at the University of Aveiro, where 14 Master's students in Specialized Translation were tasked with evaluating machine-translated texts. Through hands-on activities, students identified, categorized, and assessed translation errors, gaining critical competencies in quality assessment and error analysis. The findings highlight the importance of integrating LQA training into academic curricula to prepare future translators for the demands of a rapidly evolving industry.

Keywords: *Translation Technology; Language Quality Assessment; Machine Translation Evaluation; error analysis.*

1. Introduction

Translation quality management has long been a cornerstone of both professional practice and academic research. Yet, as Vela-Valido (2021, p. 95) notes, the field is characterized by terminological inconsistency, with overlapping and sometimes ambiguous terms such as "translation quality evaluation," "translation quality control," "translation quality assurance," and "translation quality assessment." These variations reflect differences in approach, context, and purpose—whether academic or professional, product-focused or process-focused—often resulting in conceptual discrepancies.

This study bypasses the ongoing terminological debate to focus on a practical classroom project conducted with Master's students specializing in Translation Technology. At the University of Aveiro, 14 Master's students participated in a project involving Linguistic Quality Assessment

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(LQA) using the Phrase TMS tool. The project aimed to evaluate machine translation (MT) output by categorizing predefined errors, providing students with hands-on experience in linguistic review and quality evaluation.

Training students in LQA is essential for preparing them to meet the modern translation industry's demands. Through error annotation, students develop critical analytical skills by systematically identifying, categorizing, and addressing translation issues such as mistranslations, terminological inconsistencies, omissions, and contextual mismatches, while ensuring domain-specific relevance.

Integrated into computer-assisted translation (CAT) tools like Phrase, MemoQ, and Smartling, LQA provides a structured workflow for assessing machine-translated content. This not only helps students evaluate translations systematically but also equips them with critical thinking and industry-relevant skills in quality assessment and error analysis.

This study explores how integrating LQA into translation technology education enhances learning. By incorporating LQA workflows into the curriculum, students gain valuable hands-on experience with industry-standard tools, preparing them to meet the evolving demands of the profession.

2. Machine Translation Evaluation

The advent of machine translation (MT) systems has transformed the translation industry while introducing the critical need for robust quality evaluation. The primary goal of Machine Translation Evaluation (MTE) is to ensure that the MT output meets the required standards of accuracy, fluency, and contextual appropriateness for professional use.

MTE methods can be divided into manual and automatic evaluation. According to Moorkens et al. (2025, p. 84), "Manual evaluation can provide a detailed view of MT quality, depending on the skill of the evaluators, but is likely to be slow and expensive." Its subjective nature also makes consistency a challenge. To address this, Inter-Annotator Agreement (IAA) measures the reliability of error annotation across evaluators, ensuring a standardized approach (Artstein, 2017). However, as Lommel (2018, p. 120) observes, "When evaluating a translation, it is typically not enough to know how many errors are present. Evaluators also need to know (a) how severe they are and (b) how important the error type is for the task at hand. Severity and importance are distinct concepts in MQM".

For automatic evaluation, MT output is typically compared to a human-generated reference translation. Metrics such as BLEU, METEOR, and COMET are widely used for this purpose. Among these, COMET (Rei et al., 2020) stands out for leveraging pre-trained neural models to evaluate semantic similarity and fluency, aligning more closely with human judgments.

This study focuses on manual annotation of MT output, within the context of a classroom project. Master's students participated in hands-on quality evaluation, annotating errors in MT output using the structured framework provided by Phrase's LQA tools. This process included identifying, categorizing, and assessing errors, offering students practical exposure to the complexities of translation evaluation.

3. The Role of Quality Assessment in Translation Technology

LQA offers a structured workflow for evaluating both machine-translated and human-translated texts. In this way, it plays a crucial role in ensuring translation quality, regardless of whether the output is produced by machines or humans. Translation Management Systems like Phrase, Memoq, and Smartling incorporate LQA features to streamline error detection and quality control. As described by Phrase (s.d.), "LQA provides visibility on translation quality based on pre-configured criteria. LQA can be added as a workflow step to help linguists review translations (i.e., human translations, machine translations, or machine translations with edits) according to predefined error categories applied in the project." The LQA process typically involves three stages: a) Defining and customizing error categories; b) conducting translation reviews to identify and evaluate errors; and c) automatically calculating LQA scores to measure overall translation quality (Phrase, s.d.). This systematic approach allows for a more objective, data-driven assessment of translation quality, enabling both translators and reviewers to identify areas for improvement efficiently.

By incorporating LQA into translation workflows, professionals can significantly enhance the reliability and accuracy of machine-generated translations. In educational settings, LQA plays a critical role in preparing future translators for industry demands.

4. Study Design and Methodology

The classroom project began with an introductory session on LQA, emphasizing its importance in translation technology and workflows. Students were already familiar with the translation processes in Phrase and were subsequently introduced to its built-in LQA features.

Central to the project was the adoption of the Multidimensional Quality Metrics (MQM) framework (Lommel et al., 2014), which was designed to "be applicable to any sort of translated text (human or machine translated) and to any type of text" (Lommel et al., 2014, p. 456), not aiming, however, to be a "one-size fits-all model for evaluating translation quality". The MQM framework is versatile, offering predefined categories and subcategories that can be customized based on project-specific needs.

Each student was assigned a machine-translated text for evaluation. The selected text was a news article reporting on severe snowfall in South Korea's capital, which led to significant

disruptions in transportation. Originally published by *The Guardian* on November 28, 2024, the article was machine-translated and analyzed using Phrase, where a LQA was conducted based on the MQM framework. A news text was chosen for its use of general language, making it accessible to students while also offering a range of linguistic features that are valuable for translation quality assessment. The students' task involved systematically identifying and categorizing errors within the translation according to the MQM framework in Phrase. While the MQM framework includes predefined categories, its flexibility allowed students to adapt and refine these categories and subcategories to address the specific challenges posed by their assigned text (Figure 1).

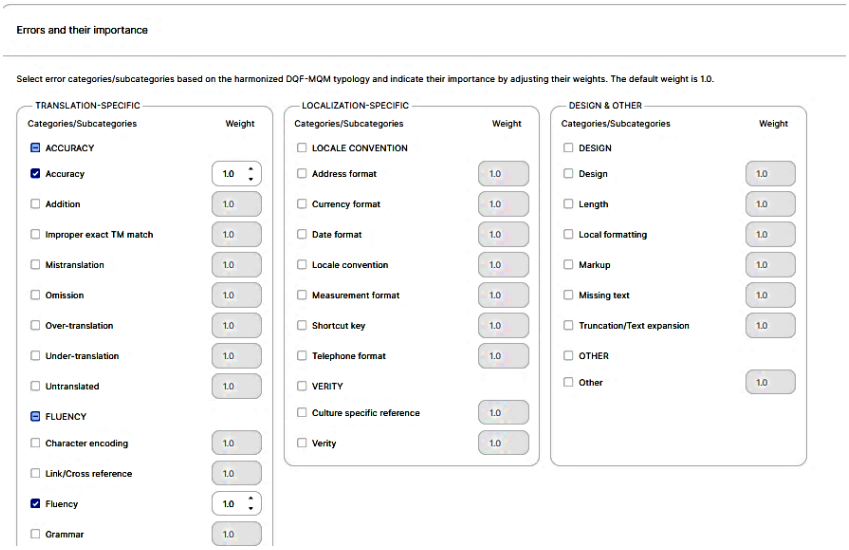


Figure 1: Predefined MQM Categories in LQA

This hands-on approach exposed students to error types such as accuracy, fluency, terminology, and style, while encouraging critical thinking about the most appropriate classifications for various translation issues. During the evaluation process, students were instructed to critically assess the quality of machine-generated translations. They classified errors, assigned severity ratings, and proposed corrections, thereby applying theoretical knowledge in a practical setting.

The study design prioritized project-based learning, aiming to bridge the gap between classroom instruction and real-world industry practices.

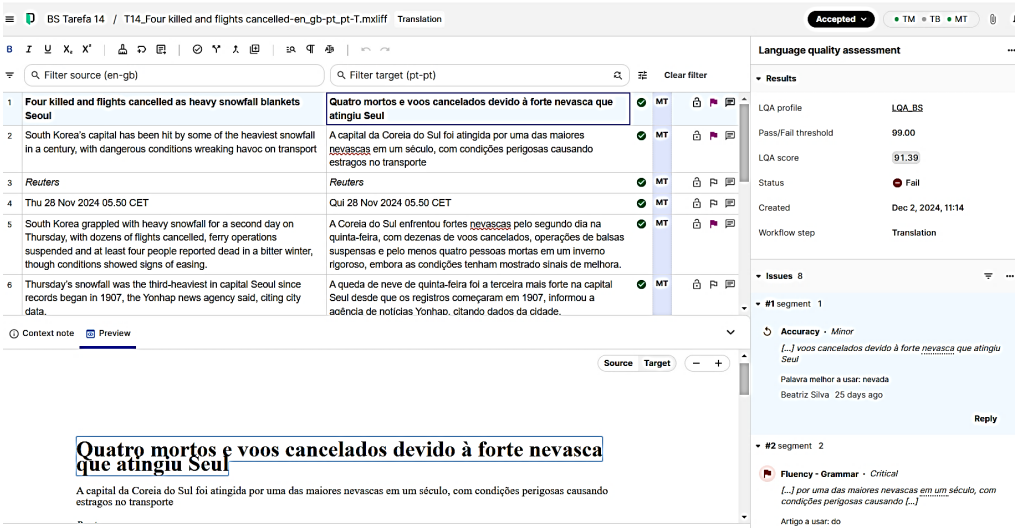


Figure 2. Example of LQA annotation by an MA student using the Phrase editor.

Following the completion of the LQA task, the annotations were reviewed for consistency in error categorization and severity assignment. Discrepancies were addressed through a structured feedback session where students explained their reasoning. These annotations were then analyzed for patterns in categorization and severity assessment, with particular attention given to variations across students.

5. Results and Discussion

The analysis of student performance in LQA revealed both strengths and challenges faced by the participants. One of the most notable discoveries was the variability in how students selected and applied subcategories within the MQM framework. While the MQM framework provides predefined categories for error classification, its flexibility allows for adaptation to the specific characteristics of the text being evaluated. This adaptability, while beneficial for customizing the framework to different contexts, also resulted in inconsistencies in how students interpreted and applied category definitions.

In general, students demonstrated competence in identifying key translation errors. However, there was significant divergence in how they rated the severity of these errors. For instance, an error classified as "Minor" by one student was sometimes rated as "Major" by another, suggesting that the severity of errors was often a subjective judgment.

Furthermore, the choice of error categories was not always consistent. Some students focused primarily on linguistic and grammatical issues, while others gave more weight to stylistic or cultural adaptation concerns. This divergence emphasizes the need for aligning category

selection with the intended purpose and context of the translation. Table 1 provides a detailed summary of the final LQA scores and Pass/Fail statuses for each evaluated text, highlighting these inconsistencies.

The Pass/Fail results in this study were determined using a scoring model based on the MQM framework, with a pre-established threshold of 99.0%. According to this model, a text must achieve a final score of at least 99% to pass. The scoring formula incorporates:

$$\text{Score} = 1 - \frac{\text{Penalty Total}}{\text{Word Count}} \quad (1)$$

Here, the Penalty Total is calculated based on the number of errors, their severity, and the associated weights assigned to error categories. For example, critical errors may carry higher penalties compared to minor errors. These penalties are summed to determine the total impact on the score.

- Pass: Achieved when the final score is equal to or greater than the threshold (≥ 99.0%).
- Fail: Occurs when the score falls below the threshold (< 99.0%).

The only text in the dataset that achieved a "Pass" status was Tarefa_14_DC. This result reflects its minimal error count and relatively high accuracy, resulting in a score that met the 99% target. All other texts failed due to either a high number of errors or a greater penalty-to-word ratio, which caused their scores to drop below the required threshold.

Table 1: Summary of LQA Scores and Statuses

Report #	Project Name	Final Score	Status	Total Errors	Accuracy Errors	Fluency Errors	Terminology Errors	Style Errors
1	Rvo_Tarefa14	96.63	FAIL	9	3	0	0	2
2	tarefa 14	92.13	FAIL	21	0	0	15	0
3	T14 - Four killed and flights cancelled	97.38	FAIL	7	1	1	0	2
4	Tarefa 14 - GL - Korean Snow News	71.91	FAIL	75	1	1	35	0
5	BS Tarefa 14	91.39	FAIL	23	5	2	0	1
6	tarefa 14 liane	95.88	FAIL	11	10	0	1	0
7	Tarefa 14 Sara	66.67	FAIL	89	5	0	78	1
8	Tarefa 14 AMRP	90.64	FAIL	25	15	3	0	0
9	Tarefa 14 MN	98.13	FAIL	5	5	0	0	0
10	Tarefa_14_DC	99.63	PASS	1	0	1	0	0
11	T14_MG	98.88	FAIL	3	2	1	0	0
12	Tarefa 14 LX	94.78	FAIL	18	8	2	6	2
13	Tarefa 14 J	94.12	FAIL	12	6	1	3	2
14	Tar 14 QT	97.76	FAIL	8	3	0	0	1

While there was general agreement on the types of errors present in the machine-translated texts, the application of severity ratings and subcategory assignments varied considerably. These findings emphasize the need for more structured guidance and practical exercises to help students apply error categorization frameworks and improve overall consistency.

6. Conclusions

This study highlights the critical role of LQA in translation technology education, underscoring its importance in preparing students to meet the expectations of the professional translation industry. Incorporating LQA training into academic curricula not only provides students with the skills to evaluate translation quality but also familiarizes them with industry-standard tools and methods for assessing both machine-generated and human translations. The analysis of students' LQA performance indicates a general trend in the types of errors identified, with most students consistently recognizing issues such as accuracy, fluency, and style. However, there was noticeable variation in the total number of errors and the assignment of error categories, particularly regarding the severity levels. This variability suggests that while students were aligned on some key aspects of translation quality, further training and calibration are needed to ensure a more consistent application of error categorization across the group. To address these challenges, the development of standardized reference materials, such as annotated examples or calibration exercises, could be instrumental. These resources would provide students with a clear benchmark for applying error categories, helping them align their evaluations with established best practices.

In professional translation workflows, LQA is becoming increasingly indispensable, ensuring that all outputs meet client expectations and uphold rigorous quality standards. Future research could explore and compare the effectiveness of LQA workflows provided by different Translation Management Systems, focusing on their impact on the accuracy, consistency, and efficiency of translation quality assessments.

References

Artstein, R. (2017). Inter-annotator Agreement. In: Ide, N., Pustejovsky, J. (eds) *Handbook of Linguistic Annotation.* Springer, Dordrecht. https://doi.org/10.1007/978-94-024-0881-2_11

MemoQ (s.d.). https://docs.memoq.com/current/en/Concepts/concepts-linguistic-quality-assurance.html Accessed: 13.01.2025.

Lommel, A. (2018) 'Metrics for Translation Quality Assessment: A Case for Standardising Error Typologies', in J. Moorkens et al. (eds) *Translation Quality Assessment.* Cham: Springer International Publishing (Machine Translation: Technologies and Applications), pp. 109–127. Available at: https://doi.org/10.1007/978-3-319-91241-7_6

Lommel, A., Uszkoreit, H., & Burchardt, A. (2014). Multidimensional Quality Metrics (MQM): a Framework for Declaring and Describing Translation Quality Metrics. *Tradumàtica*, Núm. 12, 455-463.

Moorkens, J., Way, A., & Lankford, S. (2025). *Automating Translation.* Routledge.

Phrase (s.d.). https://support.phrase.com/hc/en-us/articles/5709599557020-Language-Quality-Assessment-TMS. Accessed: 13.01.2025.

Rei, R., Stewart, C., Farinha, A.C., & Lavie, A. (2020). COMET: A neural framework for MT evaluation. In *Proceedings of the 2020 Conference on Empirical Methods in Natural Language Processing (EMNLP)* (pp. 2685–2702). Association for Computational Linguistics.

Vela-Valido (2021). Translation Quality Management in the AI Age: New Technologies to Perform Translation Quality Management Operations. *Revista Tradumàtica. Tecnologies de la Traducció*, 19, 93-111

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Do Diagnostic Measures in Calculus Work?

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Abstract

At universities around the world, quality assurance standards define learning outcomes for Calculus I and II. An often-debated question is how to predict learning outcomes in STEM courses with high withdrawal rates and poor performance. The present study was intended to determine whether faculty-developed diagnostic tests, which assessed the readiness of students' knowledge and skills, and engagement measures could predict learning outcomes in Calculus I and II. Attendance in the first six weeks of the semester served as a measure of behavioral engagement, whereas self-efficacy served as a measure of dispositional engagement. In this study, the diagnostic test of Calculus I predicted skill-related learning outcomes, whereas most measures predicted skill-related learning outcomes in Calculus II. Within an action research protocol, our findings suggest that readiness is to be enhanced to improve students' chances of academic success as defined by quality assurance standards.

Keywords: *Diagnostic test; Calculus; engagement.*

1. Introduction

Before, during, and after enrolling in Calculus, students frequently joke that the road to the completion of the Calculus sequence is a bumpy one. Their joke is an explicit recognition that the acquisition of knowledge and skills in Calculus may be difficult. The present study is motivated by the need to determine whether students' attainment of the learning outcomes set by quality assurance standards for Calculus can be predicted early in the semester. The goal is to identify at-risk students at the time remedial actions can be most effective.

Across courses and disciplines, a great deal of research has been done on the predictive validity of a variety of tools to understand the sources of students' academic success (e.g., Ismail & Yusof, 2023). Yet, individual differences in student populations exist, which require local answers to broad questions if tools are to be useful to the particular population of interest. Thus, in our study, we focus on a unique population of female students who only recently have been granted rights similar to those of men. In a society emerging from patriarchy, female students

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pursuing STEM (i.e., Science, Technology, Engineering, and Mathematics) degrees are challenged to not only learn science-related matters but also dispel archaic gender stereotypes (Alghamdi & Almazroa, 2024). These stereotypes discourage them from pursuing STEM fields by questioning their abilities and suitability (Alghneimin et al., 2024). Given the recency of gender-equity legal standards, archaic gender stereotypes may be particularly robust among the women of our study, thereby having the potential of jeopardizing their academic success.

Students' successful learning and performance in academic courses, including Calculus, is generally conceived as arising from two key factors: students' pre-requisite competencies, as defined by knowledge and skills, and engagement. Concerning pre-requisite Calculus competencies, the extant literature has highlighted weaknesses in students' foundational knowledge, which is necessary to work with functions, and their ability to perform algebraic manipulations (Lawson, 2003). Thus, the fundamental goal of assessment at the start of a Calculus course is to identify, through the administration of a diagnostic test, areas of weakness that can impede students' learning of Calculus materials. Yet, students' likelihood of success in Calculus also depends on their engagement (Waheed et al., 2024). According to self-determination Theory (SDT), students' academic engagement is fostered by self-efficacy (Goldman et al., 2016). The latter is a disposition that reflects students' confidence in their abilities to get things done and overcome obstacles by finding remedies. Thus, students with high self-efficacy may see Calculus as a challenge to be mastered. Instead, students with low self-efficacy may view Calculus as a threat, thereby increasing their chances of withdrawing from the course and switching academic majors. A correlate of self-efficacy is behavioral engagement, which exemplifies the amount of time and effort devoted to course activities (Hofverberg et al., 2022). Not surprisingly, it has been reported as capable of influencing students' attainment of learning outcomes (Doo & Kim, 2024; Hyofverberg et al., 2022).

Of course, in many fields, including Calculus, controversy exists regarding the relative contribution of cognitive factors (i.e., pre-existing competencies involving knowledge and skills) and motivational factors (e.g., engagement) to learning outcomes (Abín et al., 2020; Fonteyne et al., 2017). One of the reasons is that a variety of diagnostic assessment measures exist, including standardized and locally developed tests. Tools used to measure academic motivation, which defines students' engagement in a course, may also vary from population to population. Thus, assessment tools need to be selected or developed to suit the student population that educators at a given university serve (Pilotti et al., 2022). With such tools, the present study asks whether diagnostic measures of knowledge and skills before the start of either Calculus I or Calculus II predict the learning outcomes of each course above and beyond measures of engagement.

The STEM female students selected for the study are pursuing an undergraduate degree in either Engineering or Computer Science taught in a foreign language (English), thereby adding language to the challenges arising from gender stereotypes. Detracting from such challenges is

the mode of instruction, which is student-centered, encouraging teamwork and peer support. Yet, the selected students perceive Calculus II as much more difficult than Calculus I, questioning whether perceived difficulty may shape the predictive validity of readiness and engagement measures. For this unique population, the following questions are asked, each followed by a hypothesis to be tested:

Q1 Do Calculus I and II differ in readiness, engagement, and attainment? If the subjective difficulty of the materials taught in Calculus I and II is relevant, readiness and attainment should be higher for Calculus I, whereas behavioral engagement may display the opposite pattern (H1a). That is, the more a course is perceived as challenging, the more students will devote time and effort to it. No differences should be recorded in engagement as a disposition because students in either course come from the same pool (H1b).

Q2 What is the contribution of knowledge and skill readiness (as measured by a diagnostic test) as well as engagement to learning outcomes in Calculus I and II? It is reasonable to hypothesize that the perceived difficulty of the courses may render the readiness and engagement measures more sensitive to performance. Thus, the contribution of readiness and engagement to learning outcomes may vary between Calculus I and II (H2).

2. Method

2.1. Participants

The participants were 315 female undergraduate students who were enrolled in either Calculus I (n = 128) or Calculus II (n = 187). They were pursuing a STEM degree in either Engineering or Computer Science. Their age ranged from 18 to 25. Students' first language was Arabic. English, which was used for Calculus instruction, was their second language. Prior to university enrollment, students' English proficiency had been judged equivalent to that of modest or competent users (as per IELTS).

2.2. Materials and Procedure

At the start of the Fall semester, students enrolled in either Calculus I or Calculus II were given a 10-problem diagnostic test related to the foundational knowledge and skills that participants were expected to possess. Students had 20 minutes to solve the problems of the diagnostic test. Three PhD-level instructors who had been teaching these courses for more than a decade selected the problems from the diagnostic sections of the textbooks that students would be using for either course (e.g., Stewart, 2016). For Calculus I, problems entailed the following Algebraic concepts: (a) equations and inequalities, (b) graphs of linear equations and inequalities, (c) exponents and polynomials, (d) factoring, (e) rational expressions, and (f) roots and radicals. For Calculus II, problems covered the following concepts: (a) functions and models, (b)

differentiation rules, and (c) integrals. The reliability of each diagnostic test, as measured by Cronbach's Alpha, was 0.72 for Calculus I and 0.82 for Calculus II. The face validity of each diagnostic test was assessed in pilot work through 9 students who had completed both courses.

In addition to the diagnostic measure, students completed the self-efficacy questionnaire of Chen et al. (2001). The questionnaire contained 8 statements about confidence in one's abilities. Before considering each statement, students were asked to focus on their performance in Mathematics courses so that their confidence reports would specifically concern Mathematics. Then, students indicated the degree of agreement with each statement on a 5-point scale from strongly disagree (0) to strongly agree (4). Self-efficacy values were used as indices of students' disposition to be engaged. Attendance records in the first 6 weeks of the semester were also collected to serve as indices of behavioral engagement (i.e., the amount of time and effort devoted to course activities; Pilotti & El Alaoui, 2023).

Students' performance was assessed through 3 tests (45%), quizzes (15%), in-class and homework activities (10%), and the final test (30%). At the end of the semester, students' performance was organized into three learning outcomes per course: knowledge (K), Skill (S; i.e., application of knowledge and interpretation of outcomes), and Teamwork (T; i.e., demonstration of collaborative skills for problem-solving applied to in-class and homework activities). In the student-centered instructional context of Calculus classes, collaboration among students in class activities was fostered by instructors to diminish the anxiety that frequently accompanies learning. Thus, the T dimension was included as one of the learning outcomes to measure the extent to which collaboration was pursued by students. For all variables, raw scores were translated into percentages to ensure uniformity in the values submitted to statistical analyses.

2.3. Assessment of Course Difficulty

An additional group of 15 students who had completed Calculus I and II in earlier semesters was asked to rate the difficulty of each course. A 5-point scale from very easy (0) to very difficult (4) was used for evaluation. On this scale, the neutral value was 2. Students' ratings of Calculus II ranged between 3 and 4 [$M = 4.14$; $SEM = 0.11$]. Instead, for Calculus I, ratings were more variable, ranging from 1 to 3 [$M = 2.27$; $SEM = 0.15$]. In sum, Calculus II was judged as more difficult than Calculus I [$t(14) = 11.50$, $p < 0.001$].

3. Results

Only 101 Calculus I students and 165 Calculus II students completed the course (79% and 88%, respectively). Thus, the analyses described below involve 266 students. The descriptive statistics (mean, *M*, and standard error of the mean, *SEM*) are presented in Table 1. Overall, students' readiness was poor. Except for teamwork, equally poor was the attainment of learning

outcomes measuring knowledge and skills at the end of both courses. In contrast, at the start of the course, students' engagement, measured as either a disposition or a behavior, was adequate.

Table 1. Descriptive statistics of key variables (scale range: 0-100)

Variables	**Indices**	*Calculus I*		*Calculus II*	
		M	*SEM*	*M*	*SEM*
Diagnostic Test	Readiness	62.34	2.18	57.67	1.98
Self-Efficacy	Engagement (Disp.)	80.05	1.23	77.04	1.13
Attendance	Engagement (Behav.)	87.28	0.85	87.41	0.68
LO: Knowledge		66.54	1.75	74.37	1.42
LO: Skills		69.49	1.90	71.63	1.28
LO: Teamwork		98.19	0.71	97.71	0.47

Below, the results of inferential statistics are displayed. Statistics are considered significant at the 0.05 level. To understand whether Calculus I and II differed in readiness, engagement, and attainment, one-way ANOVAs were computed. Students' readiness and engagement did not differ [Fs ≤ 2.09, *ns*]. However, at the end of the semester, Calculus II students exhibited higher attainment of knowledge than Calculus I students [$F(1, 264) = 11.85$, $MSE = 324.01$, $p = 0.001$, *Partial Eta*^{2} $= 0.04$]. The other learning outcomes were not significantly different between Calculus I and II [Fs <1, *ns*]. H1a or H1b were not supported.

Did indices of readiness and engagement predict course learning outcomes? Table 2 displays the Pearson correlation coefficients (r) illustrating the binary relationships between predictors and learning outcomes (LO). The selected predictors accounted more broadly for learning outcomes in Calculus II than in Calculus I.

Table 2. Correlation coefficients

Variables	**Indices**	LO Knowledge	LO Skills	LO Teamwork
Calculus I				
Diagnostic Test	Readiness	*ns*	+.23	*ns*
Self-Efficacy	Engagement (Disp.)	*ns*	*ns*	*ns*
Attendance	Engagement (Behav.)	*ns*	*ns*	*ns*
Calculus II				
Diagnostic Test	Readiness	*ns*	+0.35	+0.34
Self-Efficacy	Engagement (Disp.)	+0.18	+0.20	+0.17
Attendance	Engagement (Behav.)	*ns*	+0.30	+0.29

Table 3 displays the results of linear regression analyses with skill learning as the outcome variable, which was considered the most relevant learning outcome by the faculty teaching Calculus. In contrast to correlations, regression analyses assessed the relative contribution of predictors (i.e., readiness and engagement as either a disposition or a behavior) to learning outcomes. Multicollinearity was ruled out (average VIF ≤ 1.11 and tolerance ≥ 0.86). We found

that readiness, as measured by the diagnostic test, predicted the skills acquired in both Calculus I and II. However, attendance (indexing students' engagement as behavior) also predicted the skills acquired in Calculus II. When skill learning was treated as the only outcome variable, H2 was partially supported as the contribution of self-efficacy (an index of dispositional engagement) was null.

Table 3. Regression analyses with skills as the learning outcome

Predictors	**Indices**	*Beta*		*t*	Sign. (*p*)
Calculus I	(R =0.28)				
Diagnostic Test	Readiness	0.217	.082	2.06	0.035
Self-Efficacy	Engagement (Disp.)	0.154	.129	1.58	*ns*
Attendance	Engagement (Behav.)	0.009	.204	0.09	*ns*
Calculus II	(R =0.45)				
Diagnostic Test	Readiness	.301	.043	4.21	< 0.001
Self-Efficacy	Engagement (Disp.)	.127	.076	1.77	*ns*
Attendance	Engagement (Behav.)	.239	.130	3.32	0.001

4. Discussion

The results of the present study can be summarized in three points. First, although Calculus II was judged by students to be more difficult than Calculus I, readiness was poor in both. Evidence that students are struggling in Mathematics courses is not novel (Bakr Khoshaim & Ali, 2015). In our study, however, there were also no differences in engagement early in the semester. Second, when predictors were considered separately (as per correlation analyses), they were more effective in estimating learning outcomes in Calculus II than in Calculus I. Their effectiveness was selective though. Namely, they mostly predicted learning outcomes concerning skills and students' ability to work together. In debriefing sessions, students unanimously described Calculus II as a very difficult course. As such, they often reported relying on each other and the instructor for advice and guidance. They voiced an appreciation for collaborative activities viewed as fostering learning and decreasing anxieties. In Calculus I, such reports were rare. Thus, the relative perceived difficulty of the two courses may have made Calculus II more sensitive to the value of teamwork. Third, when predictors were examined together, readiness (as measured by the diagnostic test) was found to forecast students' attainment of skill-related competencies in both courses. However, in Calculus II, behavioral engagement (as measured by early attendance records) also predicted students' attainment of skill-related competencies. Thus, when a course is perceived as difficult, behavioral engagement can make a difference in students' ability to succeed.

Our study took a local approach to the prediction of Calculus learning outcomes. The goal was to not only increase educators' understanding of this unique sample of women pursuing STEM degrees but also develop suitable interventions. After completing the first step of this action

research (Sáez Bondía & Cortés Gracia, 2022), which intended to understand students, the next step was to implement remedies for readiness rather than engagement.

Currently awaiting administrative approval, several remedies were proposed to enhance the attainment of the learning outcomes set by quality assessment protocols. For instance, to address students' poor readiness, proposals entailed offering more opportunities for practicing skills and reiterating knowledge across all Math courses (including Calculus prerequisites). Another proposed intervention consisted of making the assessment of performance in earlier courses more uniform and stringent. The re-design of Mathematics materials and tutoring services was also considered to foster learning across the entire duration of a Calculus course.

Our study has limitations that may be addressed in future studies. The cross-sectional design of our study does not provide information about how individual students change from Calculus I to Calculus II. Thus, our study does not have the advantages of a longitudinal design. However, it compares groups taught by the same instructors, thereby preserving consistency in instructional idiosyncrasies. The characteristics of the sample of young women who participated in the study may limit the generalizability of its results. Calculus is taught in students' second language, which adds a layer of challenges that other students may not experience. Furthermore, participants are from a society undergoing societal and economic changes that are transforming a patriarchal order into a system affirming gender equity. These women have only recently been granted educational and professional opportunities similar to those of men (Mozahem, 2021). Thus, our findings may not apply to male students from the same society who are now competing with women for educational and professional opportunities (Barry, 2019). Evidence exists that past privileges may have fostered males' underachievement.

References

Abín, A., Núñez, J. C., Rodríguez, C., Cueli, M., García, T., & Rosário, P. (2020). Predicting mathematics achievement in secondary education: The role of cognitive, motivational, and emotional variables. *Frontiers in Psychology, 11*, 876. https://doi.org/10.3389/fpsyg.2020.00876

Alghamdi, A. K., & Almazroa, H. (2024). Saudi women STEM pioneers: Penetrating the mud ceiling. *Frontiers in Psychology*, *15*, 1347944. https://doi.org/10.3389/fpsyg.2024.1347944

Alghneimin, J., Varga, A., & Kovacs, M. (2024). Gender disparities and potentials in STEM approach in Jordan and Saudi Arabia–An analytical literature review. *Hungarian Educational Research Journal, 14*(2), 217-230. https://doi.org/10.1556/063.2023.00236

Bakr Khoshaim, H., & Ali, T. (2015). Students' struggle with first-year university mathematics courses in Saudi Arabia. *College Student Journal*, *49*(4), 588-598. https://eric.ed.gov/?id=EJ1095432

Barry, A. (2019). Gender differences in academic achievement in Saudi Arabia: A wake-up call to educational leaders. *International Journal of Education Policy and Leadership*, *15*(15), 1-17. https://eric.ed.gov/?id=EJ1240561

Chen, G., Gully, S. M., & Eden, D. (2001). Validation of a new general self-efficacy scale. *Organizational Research Methods, 4*(1), 62-83. https://doi.org/10.1177/109442810141004

Doo, M. Y., & Kim, J. (2024). The relationship between learning engagement and learning outcomes in online learning in higher education: A meta-analysis study. *Distance Education*, *45*(1), 60-82. https://doi.org/10.1080/01587919.2024.2303484

Fonteyne, L., Duyck, W., & De Fruyt, F. (2017). Program-specific prediction of academic achievement on the basis of cognitive and non-cognitive factors. *Learning and Individual Differences*, *56*, 34-48. https://doi.org/10.1016/j.lindif.2017.05.003

Goldman, Z. W., Goodboy, A. K., & Weber, K. (2016). College students' psychological needs and intrinsic motivation to learn: An examination of self-determination theory. *Communication Quarterly, 65*(2), 167-191. https://doi.org/10.1080/01463373.2016.1215338

Hofverberg, A., Winberg, M., Palmberg, B., Andersson, C., & Palm, T. (2022). Relationships between basic psychological need satisfaction, regulations, and behavioral engagement in mathematics. *Frontiers in Psychology*, *13*, 829958. https://doi.org/10.3389/fpsyg.2022.829958

Ismail, N., & Yusof, U. K. (2023). A systematic literature review: Recent techniques of predicting STEM stream students. *Computers and Education: Artificial Intelligence*, *5*, 100141. https://doi.org/10.1016/j.caeai.2023.100141

Lawson, D.A. (2003). Changes in student entry competencies 1991-2001. *Teaching Mathematics and Its Applications, 22*(4), 171-175. https://doi.org/10.1093/teamat/22.4.171

Mozahem, N. A. (2021). Gender, education, and career in the Arab world: A literature review. *Research in Education, 111*(1), 141-163. https://doi.org/10.1177/00345237211034883

Pilotti, M. A., Abdelsalam, H. M., Anjum, F., Daqqa, I., Muhi, I., Latif, R. M., Nasir, S., & Al-Ameen, T. A. (2022). Predicting math performance of Middle Eastern students: The role of dispositions. *Education Sciences, 12*(5), 314. https://doi.org/10.3390/educsci12050314

Pilotti, M., & El Alaoui, K. (2023). Lessons Learned from Online and Face-to-Face Courses: To What Extent Is Students' Academic Success Just a Matter of Showing Up? T*he International Journal of Assessment and Evaluation, 30*(1), 15-32. https://doi.org/18848/2327-7920/CGP/v30i01/15-32

Sáez Bondía, M. J., & Cortés Gracia, A. L. (2022). Action research in education: A set of case studies? *Educational Action Research*, *30*(5), 850-864. https://doi.org/10.1080/09650792.2020.1866631

Stewart, J. (2016). *Calculus: early transcendentals 8th edition*. Cengage Learning.

Waheed, S., Pilotti, M. A., & Abdelsalam, H. M. (2024). Am I prepared for Calculus? An action-research study of female students emerging from patriarchy. *Frontiers in Education*, *9*, 1405571.

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Supporting the Transition to University Calculus using MathMatize

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Abstract

*This paper reviews the development and implementation of low-stakes optional quizzes for an introductory calculus course (MATH*1200: Calculus I) at the University of Guelph using the education technology platform Mathmatize (mathmatize.com). These quizzes were created as a diagnostic tool that also provides support to students during the transition to university-level mathematics by reviewing crucial background concepts in a low-stress and accessible way. Quiz uptake was high, and responses provided insight on incoming students' background and ability. Furthermore, there are indicators that students who completed the quizzes found them helpful and reassuring. Student feedback was encouraging of the new format and points toward the potential for increased support by improving and expanding on these new resources.*

Keywords: *Math education, education technology, diagnostic testing.*

1. Introduction

The transition to university can be challenging and intimidating for many students. Mathematics anxiety, defined as feelings of tension and apprehension that can interfere with student performance in mathematics courses and tasks, is particularly common among first-year university students. The sources and impacts of mathematics anxiety have been investigated in the literature. For example, Luttenberger, Wimmer and Paechter (2018) identify a number of antecedents for math anxiety and explore its onset and presence across all age groups, from primary through post-secondary education. Khasawneh, Gosling, and Williams (2021) provide a meta-analysis that reveals intrinsic barriers related to math anxiety for university-level mathematics students. Other research has identified anxiety-related challenges specific to the transition from secondary to post-secondary education (for example: Ruberman, 2014; Thompson, Pawson and Evans, 2021; Worsley, Harrison and Corcoran, 2021). It is now pertinent for first-year instructors to implement strategies for mitigating mathematics anxiety and other transitionary challenges. As a preliminary step, first-year instructors may seek to better understand the knowledge and skills that students are equipped with as they enter their courses,

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and corresponding diagnostic testing has been explored in a variety of formats. For example, Levere and Demers (2017) explored a first-year Warm-Up test format to specifically focus on prerequisite concepts and emphasizing feedback. Of course, any additional testing creates a risk of exacerbating mathematics anxiety, so it is worthwhile to consider diagnostic formats that prioritize student well-being.

Recent years have come with unexpected challenges as the COVID-19 pandemic necessitated a sudden shift in the way we teach and learn. In the semesters following the full return to campus, it was widely observed that the mathematical backgrounds among incoming first-year Calculus students at the University of Guelph were markedly less consistent than in previous years. These observations run parallel to studies that highlight some of the learning difficulties that may have been introduced or exacerbated among various groups of students during the pandemic (Whitley, Beauchamp & Brown, 2021; Colvin, Reesman & Glen, 2022; among many others). With more students leaning on an increased presence of hybrid or online learning, there was an opportunity to develop a more supportive approach to measuring the abilities of students entering into university calculus. This paper details and justifies resources that were developed in 2023 for MATH*1200 (Calculus I) at the University of Guelph using MathMatize.com (an education technology platform), shares student feedback following implementation of these resources during the Fall 2023 and Fall 2024 semesters, and explores ideas and opportunities for how this tool could be expanded.

2. Setting and Resources Used

We will begin by describing the context of this work, which was performed at the University of Guelph, in Guelph, Ontario, Canada during the Fall 2023 and Fall 2024 semesters. The study involved three sections of Calculus I (MATH*1200) and the focal point for this manuscript is discussion surrounding the introduction of course modules utilizing MathMatize, software that offers a variety of teaching and learning tools.

2.1. Calculus I (MATH*1200) at the University of Guelph

MATH*1200 is a standard first-year calculus course for university students. The course description is available online at www.uoguelph.ca, and reads as follows:

> This is a theoretical course intended primarily for students who expect to pursue further studies in mathematics and its applications. Topics include inequalities and absolute value; compound angle formulas for trigonometric functions; limits and continuity using rigorous definitions; the derivative and derivative formulas (including derivatives of trigonometric, exponential and logarithmic functions); Fermat's theorem; Rolle's theorem; the mean-value theorem; applications of the derivative; Riemann sums; the definite integral; the fundamental

theorem of calculus; applications of the definite integral; the mean value theorem for integrals.

Students in MATH*1200 are typically those in STEM programs wherein math will remain a central topic throughout their degree. Indeed, most students in MATH*1200 are enrolled in Engineering, Computer Science, Finance, or Mathematical Science degree programs.

In the Fall 2023 semester, there was a total enrolment of 814 students at the beginning of the semester; this number dropped to 699 by the end of the semester (a drop rate of about 14.2%). This drop rate is fairly typical of recent offerings of the course. In the Fall 2024 semester, there was a total initial enrolment of 1341, and 1264 completed the course (a drop rate of about 9.4%, lower than is typical). Both the Fall 2023 and 2024 offerings of this course featured three "traditional" lectures per week following a custom course manual. These lectures were offered alongside a weekly lab in which extra practice problems or extensions to concepts were presented. Attendance for students was not mandatory nor recorded outside of exams, tests or quizzes.

2.2. MathMatize

MathMatize is an education technology platform that offers polling, assessment, and content creation tools with a particular focus towards math instruction. MathMatize has a community exercise catalog of over 20,000 exercises created by instructors around the world. Instructors can collaborate on question banks with their colleagues. Polling and assessment features offer a variety of settings to meet different pedagogical use cases. Importantly, MathMatize has gamified learning materials, which can encourage student engagement while bridging the gap from high school to university mathematics. These gamified materials are scaffolded, with progress updating as students answer questions giving them a better understanding of their areas of weakness.

MathMatize was made available to students in the course for a small fee of approximately $7 per student after a two-week free trial period. Despite the modest fee, it was made clear to students that accessing the software was strictly optional, given the extra cost. Students electing not to create an account were given an alternative grading scheme that did not include any Mathmatize-based assessments.

3. Quizzes

3.1. Quiz Structure and Generation

Important quiz criteria were established to create an online assessment framework that students would find both accessible and helpful. The thirteen quizzes:

- Were quite short, including just five problems or less (sometimes as few as two or three);
- Were unsupervised (and therefore, students were free to access their notes or other materials as they wished);
- Had no time limit;
- Were made available from the beginning of the semester for students to access when ready and interested;
- Could be taken at any time during the semester, and as many times as a student wished, with the deadline being the night before the final exam;
- Were low stakes, with each quiz accounting for roughly 0.77% of a student's grade;
- Always focused on materials prerequisite to the course and foundational to concepts within the course. Importantly, quizzes never featured new concepts presented at the university level, and entirely consisted of practice problems for relevant concepts from Grades 9 through 12;
- Were randomized, so that a different set of problems were included in the quizzes with each attempt;
- Were algorithmically generated, so that within any given problem, numbers or variables would differ from attempt to attempt;
- Featured a variety of styles of problems, including multiple choice, matching, and symbolic entry, and revealed the correct responses after the completion of each quiz.

Each quiz centered on a particular topic. For example, one quiz focused on Piecewise Functions, another on Graphs of Trigonometric Functions, and another on Factoring, etc.

3.2. Course Grading Scheme

Both the 2023 and 2024 offerings of the course offered MathMatize quizzes at a weighting of 10% of their overall grade; and a second grading scheme that did not include these quizzes. Grades were calculated using each scheme, and at the end of the course, the greater of these two grades was automatically assigned to each student in the course. The two grading schemes were designed so that students would feel minimal pressure to purchase access to MathMatize. For example, Scheme II shuffles the quiz weight across all other grades, rather than just moving weight to the Final Exam. Students were told about the software through class announcements and the course website and were encouraged to purchase access to MathMatize if they saw a potential benefit.

Table 1. Grading Schemes for Fall 2023 and Fall 2024 Calculus I.

Assessment	Scheme I Weighting	Scheme II Weighting
MathMatize Quizzes	10%	0%
Lab Tests	20%	25%
Midterm Test	30%	32.5%
Final Exam	40%	42.5%

3.3. Uptake and Grade Data

The same sets of quizzes were offered with the same format in both the Fall 2023 and Fall 2024 semesters.

Table 2. Uptake for MathMatize Quizzes in Fall 2023 and 2024

Semester	Total Number of Students	Students Accessing Quizzes	% of Students Accessing Quizzes	Average Grade
Fall 2023	699	622	89.0%	96.3%
Fall 2024	1264	982	77.7%	97.7%

A large majority of students opted to access the MathMatize quizzes in each semester, though significantly more in Fall 2023. This could be due to the larger enrollment in Fall 2024; anecdotally, it can be difficult to disseminate information effectively to larger numbers of students. For those students who did access the quizzes, the grades were high both semesters.

Table 3. Grade Comparison Between Students Choosing to Access MathMatize Quizzes, and Students Electing not to

Semester	Final Grade for Students Accessing Quizzes	Final Grade for Students Opting not to Access Quizzes	Final Exam Grade for Students Accessing Quizzes	Final Exam Grade for Students Opting Out
Fall 2023	68.2%	59.5%	62.5%	51.3%
Fall 2024	73.5%	70.1%	68.8%	68.6%

Students accessing the quizzes performed at a significantly higher level than those that did not in Fall 2023, but these results were less pronounced or generally absent in Fall 2024. Comparing final grades should be approached with caution, since final grade data incorporates the MathMatize quiz grade itself, and it is true that the average grades for the MathMatize Quizzes were much higher than the average grades for the other tests and exam; this would introduce a bias in the comparison. Nevertheless, when the final exam averages alone are compared in isolation, we can see that considering the Fall 2023 semester, there exists a significant difference in student performance between those who accessed the quizzes and those

who did not, with students accessing the quizzes (earning an average grade of 62.5%) outperforming those who did not (earning an average grade of 51.3%). This was not well-demonstrated in Fall 2024, with quiz-taking students performing only marginally better than those opting out.

Importantly, in both offerings of the course, there were no problems on the final exam that mimicked the format or material of any of the MathMatize quiz questions. Additionally, the instructor was different for each of the two offerings of this course, which could help shed some light on the differences in results from semester to semester.

Ultimately, it will be useful to continue to gather data in future years to determine any more consistent patterns, as just two semesters of results will necessarily limit any conclusions that could be reasonably drawn with regards to performance and grades.

3.4. Student Feedback

Student feedback was collected through the usual Student Feedback Questionnaires at the end of the semester. Class reviews were generally quite positive, though MathMatize quizzes were infrequently mentioned. Feedback specifically regarding the course structure was also largely positive, with few suggestions or criticisms toward MathMatize specifically. Some specific critiques and feedback are provided here:

- The mathmetize [sic] is a great addition, it offers the possibility for students to earn points other than on tests. Great initiative (Fall 2023)
- Nice refresher on previously taught content, while going more in depth and smoothly integrating new content (Fall 2024)
- Mathmatize not challenging enough to be considered practice. (Fall 2024)
- Mathmatize could have been harder and on course materials. (Fall 2024)
- Not sure what was up with mathematize [sic] but it just felt a little odd as it was never used after the first week, despite it being a great way to provide feedback to students who wished to practice their skills. Utilization of this platform would be great for weekly assignments that could reduce the importance of the two lab tests and exam upon which so much of the course mark is based, and help to give students weekly feedback on their understanding of the course material. (Fall 2023)

Additional to these specific points, a common suggestion among students was to increase the number of course assessments in general, providing more opportunities for grades while perhaps reducing the stakes of each assessment.

3.5. Potential Future Developments

As only two semesters of information have been gathered associated with this new component of the course, it is disingenuous to draw any broad or general conclusions based on our experience. Nevertheless, reflecting on some of the student feedback, we pose some ideas for potential incremental changes in future semesters:

- A greater number and variety of quizzes could be developed.
- Some more difficult problems could be incorporated in different ways. For example, each quiz could have an introductory-level version (the existing quizzes and problems), and a more challenging version, with the completion of both contributing toward student grades.
- Students may benefit from some additional and clearer communication as to the motivation behind the quizzes: To exist as a supportive environment to practice background skills, rather than providing a source for regular testing of new course concepts (of course, there is the opportunity to explore both approaches during the same semester).

4. Conclusions

This paper presented an alternative approach to diagnostic testing and foundational practice for a first-year calculus course, using low-stakes optional quizzes on the MathMatize platform. Student uptake of these quizzes was positively associated with final exam performance and final grades in the Fall 2023 semester, but less significantly so in the Fall 2024 semester, and further data is needed before any broad generalizations can be made. Considering the generally positive student feedback with a few suggestions for improvement, it may be possible to implement some small adjustments to the scheme that has been employed to better support students in their transition to university calculus.

References

Colvin, M. K. (Molly), Reesman, J., & Glen, T. (2021). The impact of COVID-19 related educational disruption on children and adolescents: An interim data summary and commentary on ten considerations for neuropsychological practice. *The Clinical Neuropsychologist*, *36*(1), 45–71. https://doi.org/10.1080/13854046.2021.1970230

Khasawneh, E., Gosling, C. & Williams, B. What impact does maths anxiety have on university students?. *BMC Psychol* **9**, 37 (2021). https://doi.org/10.1186/s40359-021-00537-2

Levere, K., & Demers, M. (2017). Effects of Warm-Up Testing on Student Learning. *International Journal of Learning, Teaching and Educational Research,* 16(4), 91-103.

Luttenberger, S., Wimmer, S., & Paechter, M. (2018). Spotlight on math anxiety. *Psychology research and behavior management*, *11*, 311–322. https://doi.org/10.2147/PRBM.S141421

Ruberman, L. (2014). Challenges in the Transition to College: The Perspective of the Therapist Back Home. American Journal of Psychotherapy, 68(1), 103–115. https://doi.org/10.1176/appi.psychotherapy.2014.68.1.103

Thompson, M., Pawson, C., & Evans, B. (2021). Navigating entry into higher education: the transition to independent learning and living. *Journal of Further and Higher Education*, *45*(10), 1398–1410. https://doi.org/10.1080/0309877X.2021.1933400

Whitley, J., Beauchamp, M. & Brown, C. (2021). The impact of COVID-19 on the learning and achievement of vulnerable Canadian children and youth. *FACETS*. **6**: 1693-1713. https://doi.org/10.1139/facets-2021-0096

Worsley, J. D., Harrison, P., & Corcoran, R. (2021). Bridging the Gap: Exploring the Unique Transition From Home, School or College Into University. *Frontiers in public health*, *9*, 634285. https://doi.org/10.3389/fpubh.2021.634285

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Leading Expanding Pre-Sessional Programmes Successfully: An International Case Study Analysis

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Abstract

Pre-sessional programmes can be highly rewarding to design and deliver, but they can also be extremely demanding and challenging for those tasked with running them. This paper considers the case of one pre-sessional programme that developed from an online eight-week postgraduate course in 2022, attended by 43 students, into a significantly larger undertaking. Within a couple of years, the programme expanded to offer two, four and eight-week onsite options, along with a three-week undergraduate pathway. The 8-week course in 2024 was completed by 347 students. In 2025 the projected enrollment figure is approximately 450 students, and a new three-week course also set to begin. This study will present the contextual background for the pre-sessional programme and a brief literature review, before discussing the programme's effectiveness, the challenges alongside the future plans. The paper should be of interest to course designers, faculties, and institutional administrators and managers, amongst others, from both pedagogic, administrative, leadership and income generating perspectives.

Keywords: *Pre-sessional, Programme, Leadership, Management, CPD.*

1. Introduction

Pre-sessional courses play an important role for many higher education institutions, as they enable students who have not met all of the language enrollment requirements with the opportunity to demonstrate that they have achieved the desired level of language proficiency for postgraduate study upon course completion. In some cases, institutions offer a suite of courses designed to help students who have met the entry enrollment requirements and hold conditional offers to enhance their language, study and research skills, as well as acclimatise to the new prior to the start of their postgraduate studies, thereby providing them with a competitive edge.

Designing pre-sessional courses is a challenging endeavour. It necessitates meticulous attention to all areas of curriculum development for each individual course. This includes features such as the establishment of intended learning outcomes (ILOs) based on the needs analysis

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outcomes, devising a structure, adopting a methodology, building materials and the implementation of robust assessment mechanisms. Considering those facets advocated by scholars such as Brown (1995) and Richards (2001) over the past three decades has proved to help better ensure students achieve the required level of mastery. The designing also entails facilitating reflection practice post-course, which might be in the form of the suppositions of Klob (1984), Gibbs (1988) or Brookfield (1998). Ultimately the intention is ensuring that learners attain the necessary proficiency through systematically designed courses and programmes that enable deliberate practice of the core skills (Ericsson & Pool, 2016).

This can be a complex and demanding task from a logistical perspective. In terms of mandatory courses, it requires programmes to be meticulously designed and built of firm foundations in the form of well-defined ILOs and the assessment validity and reliability, ensuring that achievement is acting as a representative measure of attainment. This is where references to standardised language tests such as IELTs and CEFR levels may be relevant, and in the case of optional courses, especially at the postgraduate level, TOEFL iBT and PTE (Academic) may also be considered. Besides the challenges of aligning language levels, or at least attempting to, other challenges include liaising with stakeholders such as faculties and external examiners, attaining annual validation or accreditation (for example, through CIOL), and ensuring that the logistics of delivery and accommodation need to be effectively managed for on-site delivery. Furthermore, payment and insurance measures are the prerequisites to appoint adequate numbers of staff for the course delivery.

This paper thus considers the case of a transnational higher education provider that experienced an eight-fold increase in enrollment within two years, transitioning from online to on-site offering. These developments occurred concurrently with a doubling of study options. Given the challenge of accommodating increased student numbers, expanding provisional offerings and shifting delivery method, this case study seeks to highlight the lessons learned from administering pre-sessional programmes and courses at a transnational higher education provider in China, and to provide insights. It should be of interest to curriculum designers, administrators, programme leaders and faculty, alongside heads of department tasked with budgeting.

2. Contextual Background

The transnational higher education provider at which this suite of pre-sessional courses was implemented is located in eastern China. The university is also home to more that 10,000 students from over 70 countries and regions around the world as the university website notes. The university provides both undergraduate and postgraduate study routes and is part of a tri campus set up operating in the UK, China and Malaysia. In order to better support some of the incoming students, especially at postgraduate level, a variety of pre-sessional courses are

offered. These are designed to help students improve their language and academic competencies, as well as adapt to what may be a different study environment than the students have previously been familiar with. In terms of pricing, the China based campus in question offered four pre-sessional courses in 2024. There were eight, four and two-week postgraduate options. There was also a bespoke three-week undergraduate course. The eight-week pre-sessional course which cost 28,000 RMB per student (as advertised on the institutional website) would have generated close to 10,000,000 RMB.

3. Methodology

To consider the effectiveness of the pre-sessional courses, a comprehensive range of data collection methods and tools were employed. These include student feedback on the various courses, alongside feedback provided by the academic manager, who gathered insights from the team responsible for running the programme, the course instructors and the external examiner and CIOL. Student feedback at this transnational higher education provider is generated at the end of every taught course through a questionnaire administered anonymously on Microsoft Forms. This data collection instrument exhibits satisfactory levels of face, construct, and content validity. In terms of reliability, it is deemed to be reasonably robust, however, it is acknowledged that the timing of administration may potentially influence the feedback provided. Consequently, the utilisation of alternative sources of feedback is essential to corroborate the findings. Staff feedback is collected via a range of mediums and conducted in a critically reflective, 360-degree manner. Pragmatic limitations necessitate that not all of the data can be presented in this instance, so the voice of the staff member who was responsible for leading the programme has been considered to cover the various sub areas. This paper also adheres to stringent safeguarding protocols, aligning with BERA's (2024) suppositions including, anonymity and confidentiality amongst others.

4. Results

4.1. The Eight-Week Course

Revalidated in 2024 for the academic year by CIOL (The Chartered Institute of Linguists), the eight-week course, which consisted of two modules, received excellent mean average feedback from the students who completed it. Indeed, the feedback improved in seven of the ten categories, remained the same in two areas and dipped by 0.01 points in the final area. Some of the notable feedback included 96% of students strongly agreeing with the statement the programme helped them prepare for postgraduate study, 94% strongly agreeing that the programme had enhanced their confidence, and a mean score of 4.80 out of 5 for the statement 'I received a lot of academic and non-academic support during the programme'. Regarding the

Reading, Writing and Research Skills (RWRS) module, the mean average was 4.63. For the Listening, Discussion and Presentation (LDP) module, the score was 4.74. By all accounts, these are outstanding results to return.

4.2. The Shorter Courses

4.2.1. The Four-Week Course

The four-week course catered to one class of less than twenty students. Due to the morning and afternoon sessions, two staff members were required to teach the course for the duration of the four weeks. RWRS received a mean average of 5.00 as did LDP. The Academic Manager remarked:

> ***The two staff members did an excellent job and the student feedback was outstanding with both receiving incredibly high mean averages from the class. I was aware that the course needed refining and future proofing, which is why ultimately it was phased out and replaced the following academic year after consultation with all of the stakeholders and a 360-degree evaluation.***

4.2.2 The Two-Week Course

In contrast, the two-week course failed to run in its inaugural year. Despite initial interest, the enrollment threshold was not met, meaning that it would have operated at a loss had it run at a time when resources were already stretched due to the impressive growth of the eight-week course as the CIOL review highlighted. As a result, a strategic decision was made to offer students who had expresses an interest the opportunity to enroll in the four-week course instead. The two-week course was subsequently merged with the four-week course. The Academic Manager commented:

> ***There was a slight sense of relief when the decision was made to not run the course. Despite it being a really interesting course to teach, and a short one in terms of duration, time and resource wise we were already stretched and this would have just added another layer of pressure which would have been far from ideal. It also wouldn't have made financial sense to operate it at a loss.***

An additional staffing challenge had also arisen in the need to build and deliver a three-week undergraduate pre-sessional course in the Summer of 2024, stretching staffing resources to the limit.

4.2.3 The Three-Week Course

The unexpected, and late addition, of another pre-sessional course for incoming undergraduates from select localities which would necessitate another four staff for delivery. An experienced faculty member and team unit were drafted in to support with the construction and management of this provisional offering in consultation with the Academic Manager. Unlike the other postgraduate courses, which focused heavily on language and academic skills, this one had more of a language and digital literacy focus, designed to align with the skills these students would need going forward, but would likely require developing in the interim given their relative staring point. The Academic Manager noted:

> ***Having another very experienced team leader take ownership of this new and last-minute course addition was really helpful. I'd already been asked to teach over the summer due to the expansion of the eight-week programme, as had the two module conveners, and the stakes were significantly higher with so many more students sitting the longer mandatory course as well as the staff working on it. I had to trust my colleague with the three-week course, although some leeway existed for contingency support if needed. He really did an amazing job and was acknowledged for his delivery success the next semester with an award.***

5. Discussion

5.1. The Importance of Teamwork

The success of the pre-sessional courses can be largely attributed to the effective teamwork observed throughout the programme, as highlighted by discussions with the Academic Manager and supported by the academic output of the team (Kozuch et al., 2023; Morris et al., 2024). Each team member was well aware of their role and responsibilities, and clear procedures and processes were established, alongside timelines agreed upon well in advance. This structured approach allowed for flexibility and responsiveness, even when facing the challenges of not knowing exactly how many students the programme had to cater to until late in the planning process. Strong leadership at all levels and a supportive and collaborative culture enabled a flexible and responsive approach to exist. A systematic approach to change management, including job shadowing and deliberate practice, as advocated by Ericsson and Pool (2016), further enhanced the likelihood of a high-quality end product outcomes. For example, new Academic Managers or Module Conveners (MCs) would job shadow their predecessors for 6-12 months to ensure a smooth transition and continuity, and this was based on reflective experiences of what had and had not worked so well previously when taking on new management and leadership roles. Teamwork was also highlighted by the External Examiner based at Polytechnic University as a strength and the pre-sessional team have continued to

engage with institutional training in operational leadership as well as assess their own strengths through considering the findings from Gallup Strengths Finder and MBTI to support more personalised CPD.

5.2. The Necessity of Trust and Collaboration

Kozuch et al. (2023) stress that well-designed pre-sessional courses, adequately staffed with balanced workloads, are crucial for success. Effective relationships management, open communication, and the willingness to incorporate external feedback are also vital. This programme exemplifies these principles through high levels of collaboration in evidence with staff from all areas working together, actively reflection and the sharing of insights. In many ways it is a case of practicing what is being preached with the team embracing research both in terms of course deign and through their own working endeavours. The programme's commitment to transparency and distributed leadership fosters trust and ensures that all stakeholders, including staff, students and all invested parties, can share insights at any point, through any staff member. This open communication and collaborative approach are key to the programme's success. One area in which further improvements could be made revolves around faculty consultation given an emerging opportunity at the institution. With the preliminary year content modules moving back into the departments after a ten-year hiatus as part of the pedagogic restructuring it is possible for even stronger ties to be facilitated. This would also support BALEAP accreditation designs as the eight-week course seeks external recognition to sync with CIOL validation already in place.

5.3. Present Challenges

There are a wide variety of potential challenges that can arise when teaching pre-sessional courses. Evans (2022) drawing on his experiences of teaching pre-sessional courses a Cardiff, Durham, Newcastle Universities highlights how rapid the growth in student numbers, course changes and overhauls, alongside stakeholder consultations and constructive component feature alignment (features identified by Biggs and Tang, 2011) presented difficulties. In this instance, concerning the UNNC pre-sessional programme, the MCs noted the challenges in the eight-week course content. For LDP, some of the most notable challenges included making the tasks as authentic as possible, whilst diversifying the listening material and assessments. For RWRS, key challenges were deemed to be the new methods of learning incoming students had to adapt to in a short period of time and the workload on an intensive module that the students felt stretched them and extended their learning. The varying language levels of the incoming students were becoming more pronounced. Administratively, the continued growth placed strain on the delivery in terms of sustainability due to staffing limits, alongside teaching and learning spaces and student support. The external examiner also highlighted the need to consider the integration of Generative AI into the curriculum.

5.4. Forward Thinking

By systematically and intentionally building a culture that supported measured risk taking, such as devising a three-week course combining an under subscribed two-week course, and a four-week course in need of a review the team clearly took a proactive approach to their courses as opposed to resting on their laurels and opting for the easy option. It might be cautioned that change fatigue could result, but there were also strategic designs to the changes, namely reducing provisional offerings which might stretch staffing beyond acceptable limits. Clearly in this respect, there were elements of critically reflective practice in evidence as advocated by Brookfield (2005) as the best features of both shorter courses were being carried into the new three-week offering, as well as forward thinking as this shorter course was also being used to trial features that might carry over into the eight-week course, but in a setting in which the stakes were lower. For example, more authentic tasks were being built as central tenets of the course, and the use of GenAI revisited. This also built on broader faculty developments in which language assessment was being scaled back on EAP modules in light of technological developments and the enhanced digital literacy of the students. Practical changes were also being enacted based on some of the 360-degree feedback, with the number of assessments reduced in cases where the ILOs were already arguably being assessed in a similar duplicate manner. Staff were also engaging with reflective practice through sharing their learning with others, adhering to the premise that learning is facilitated through teaching (Duran, 2016) or knowledge transfer as the work of Kozuch et al., (2023) and Morris et al., (2024) highlight.

6. Conclusion

This paper has considered the case of a transnational higher education provider that has experienced rapid expansion in its pre-sessional offerings in terms of student numbers and course variety over the past few years. It has considered how the various courses were received, the factors contributing to the programme's success, and the challenges that have had to be resolved and which remain at the forefront of thinking. Some key metrics of success include the rapid growth of the programme in terms of student numbers and, hence supporting the various institutional faculties with ensuring students are prepared for future study needs. In addition, as a financial source of revenue, the programme is also fulfilling a useful role for the Centre when many departments face financial difficulties as Leeming (2024) draws attention to. Future proofing the course to ensure that it is sustainable has also received attention.

References

BERA. (2024). *Ethical Guidelines for Educational Research, Fifth Edition*. London: British Educational Research Association.

Biggs, J.B. & Tang, C.K.C. (2011). *Teaching for Quality Learning University: What the Student Does.* Maidenhead: McGraw-Hill

Brown, J. (1995). *The Elements of Language Curriculum. A Systematic Approach to Program Development.* Boston: Heinle and Heinle.

Brookfield, S. (2005). Critically reflective practice. *Journal of Continuing Education in the Health Professions*, 18(4), 197–205.

Duran, D. (2016). Learning-by-teaching. Evidence and implications as a pedagogical mechanism. *Innovations in Education and Teaching International*, 54(5), 476–484.

Ericsson, A. & Pool, R. (2016). *Peak: Secrets from the New Science of Expertise*. London: Mariner Books.

Evans, S. (2022). The Evolution of XJTLU's Pre-sessional English Programme. *Language Teaching in China.* Available from: LTiC - Xi'an Jiaotong-Liverpool University

Gibbs, G. (1988). *Learning by Doing: A Guide to Teaching and Learning Methods*. Further Education Unit.

Kolb, D. (1984). *Experiential Learning: Experience as the Source of Learning and Development (Vol. 1).* Englewood Cliffs, NJ: Prentice Hall.

Kozuch, S., Buckley, D., Seserman, M., Gao, G. & Morris, G. (2023). How to Create and Run Pre-Sessional Courses to Enhance Future Success. *The Times Higher Education Campus*. Available from: https://www.timeshighereducation.com/campus/how-create-and-run-presessional-courses-enhance-future-success

Leeming, J. (2024). *UK University Departments on the Brink as Higher-Education Crisis Deepens.* Nature. Available from: https://www.nature.com/articles/d41586-024-03079-w

Morris, G., Jeidani, M., Wang, A., Buckley, D., Gao, G., Xiang, S., Abulaiti, C. & Good, D. *Managing Rapidly Expanding Pre-Sessional Programmes Successfully in a VUCA World*. CELE Tri-Campus Conference, University of Nottingham, November 2024.

Richards, J. (2001). *Curriculum Development in Language Teaching*. Cambridge: Cambridge University Press.

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Exploring the Impact of E-learning Initiatives on Staff Development in Higher Education: A Quantitative Analysis

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Abstract

The popularity and prevalence of e-learning and distance learning in higher education has increased in recent years. Learning from developments in student education, and based on the experiences of the pandemic, university staff has also started providing and utilising online platforms for self-development. This study examines the use of one such e-learning platform at a transnational higher education provider in Asia. It considers 100 staff members learning initiatives over a two-year period, including teaching and non-teaching staff. This study aims to identify the most popular topics and skills based on enrollments, completions, and learning hours, to explore the impact of these initiatives on staff development, and to provide actionable insights for Learning and Development (L&D) practitioners, administrators and leaders.

Keywords: *E-learning, Staff Development, Training Needs Analysis, Higher Education*

1. Introduction

E-learning has played an increasingly prominent role in higher education in the past couple of decades. Indeed, in the past five years in particular education has transitioned increasingly towards provision, which is delivered online, either asynchronously or live, and via distance learning. These approaches have also facilitated and promoted the development of communities of practice in many localities (Singh et al., 2024). These approaches have also facilitated and promoted the development of communities of practice in many localities. Despite staff development traditionally relying on in-house training programmes there is now a growing demand for more flexible options, such as online MOOCs (Massive Open Online Courses). These may be delivered in real time or be prerecorded, but the flexibility they provide means that the provision can be accommodated within busy teaching schedules. It is important to note that while MOOCs are typically pre-recorded, some platforms also offer live, interactive sessions to enhance engagement (Wang et al., 2022).

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On that note，this paper examines the use of an online studying platform at a transnational higher education university in China, focusing on 100 individual datasets. The staff include both administrative and academic faculty members, and the data has been collected over a two-year period. The study also identifies the specific areas staff find most interesting and spend the most time studying and explores the impact of these e-learning initiatives on staff development. Given the significant shift towards online learning, it is crucial to assess the effectiveness of these initiatives in addressing the developmental needs of both teaching and non-teaching staff. It highlights key areas for staff development to focus on and reveals which areas staff value most for their personal development.

2. Literature Review

Developing staff is a key feature of any enterprise. One way to realise this is through training programmes. Arguably given the emergence of Gen AI，and the legacy of the pandemic，which has led to institutions operating in what is regarded as an increasing VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) world, university staff need to be equipped with the skills which will enable them to thrive and promote agility (Baran & Haley, 2020). Example of essential skills and competencies needed to remain competitive include cultural awareness, leadership, change management and research (Nikolaeva & Savchenko, 2024). To achieve this goal, university policy makers and leaders also need to engage with development initiatives. By doing so, they can effectively advocate for the importance of continuous professional development and serve as role models for their institutions.

Given the influence of leadership, and the appeal it holds, Day (2000) advocates that it is not an innate trait, but rather a skill that can be developed through various competencies such coaching, mentoring, decision making, strategic thinking, stress and team management. These skills are often honed through specialised management courses designed to enhance leadership capabilities. The appeal of these courses is that many academics have reported challenges when they transit into leadership roles, such as being appointed to be the head of a department or school While it is rewarding and indicative of recognition, it is difficult to balance managerial and administrative tasks with research and teaching responsibilities meaning that what led to the promotion in the first instance has to be sidelined in the new capacity. New leadership figures also often report struggling to manage the developments happening in the institutions and to effectively promote the changes among their team members.

In addition to the challenges, historically, the focus of staff development has focused on teaching staff, and non-teaching staff development needs are sometimes overlooked (Antiado et al. 2020). Administrators have expressed concerns about the lack of a clear career development pathway, which contrasts with the more defined trajectories available to academic staff. Other concerns arise from the training often being regarded as generic and lacking a clear developmental goal

which aligns with administrators' specific roles and responsibilities. Despite the differences, non-teaching staff members share the same overarching institutional goals as their academic counterparts. However, the skills they need to develop should be tailored to reflect the unique demands of their positions, even though they work within the same university environment (Matlakala & Bezuidenhout, 2024).

Moreover, the use of e-learning platforms has become increasingly prevalent in higher education, offering flexible and accessible options for staff development (Shahzad et al., 2023). These platforms provide a wide range of courses and resources that can cater to diverse learning needs and preferences. The flexibility of e-learning allows staff members to engage in professional development activities at their own pace and convenience, which is particularly beneficial given the busy schedules of both academic and administrative staff. E-learning platforms also have the potential to foster communities of practice, enabling staff members to collaborate and share knowledge across different locations (Zamiri & Esmaeili, 2024).

Despite the challenges, identifying developmental needs is important. Training needs analysis (TNA) is often used to determine the focus and training activities. Indeed，learning and development (L&D) teams usually collaborate with different stakeholders and consultants, both internally and externally, to decide upon the training provision. Typically, surveys are sent out to collect individual training needs, and departmental heads and the management board are consulted for the institutional developmental needs aligning with the institutional vision and missions. Though the effectiveness of the traditional methods needs to be assessed, there is a lack of mechanisms to do so comprehensively. E-learning platforms, which offer a wide range of resources and topics can help to shape decision making and determine how effective the training offerings have been and to what extent these align with staff needs and preferences based on the data they generate.

3. Methodology

This study adopts a quantitative research design, focusing on analysing data collected from an e-learning platform. The objective is to identify the trending courses and topics based on enrollment numbers and the learning hours and provide actionable insights for L&D practitioners. The data is collected from the past two years and includes information on: Course Enrollments, Completion, Learning Hours, Course Categories, and Skills. The initial step taken for data analysis involves cleaning the data to handle missing values, duplicates, and inconsistencies.

Basic statistical measures are used to summarise the data. Visualisation techniques, such as histograms are employed to identify trends and patterns in course enrollments, learning hours, and skills involved in the courses. All personal information and the university information are anonymised to ensure the privacy and confidentiality of staff members. The data was not

segmented to compare the developmental needs and preferences of faculty and administrative staff. All data was analysed together, providing a general overview of the most popular courses and skills among the entire staff population. While this approach offers valuable insights into overall trends, it does not allow for a detailed comparison between the two groups. Future research could benefit from segmenting the data to compare the developmental needs and preferences of faculty and administrative staff separately. This would provide a more nuanced understanding of how different types of staff engage with e-learning initiatives and what specific areas they focus on for their professional development.

The chosen methodology allows for a comprehensive analysis of the e-learning platform data, providing clear insights into the topics that university staff focus on the most for self-development. To avoid any commercial conflicts, the specific name of the e-learning platform used in this study has not been mentioned. However, it is a widely used commercial MOOC provider that offers a diverse range of courses on different topics relevant to higher education staff development. By using quantitative data analysis techniques, the study can offer objective and measurable results that are valuable for L&D practitioners. The insights gained can help in designing more effective staff development programmes and optimising the use of e-learning resources, based on real data, supporting evidence-based decision-making in staff development initiatives.

4. Results and Findings

During the two years, a total of 170 courses were completed, accumulating 1,945 learning hours and 3,759 instances of daily learning activities by the 100 participants. These figures underscore the active engagement of staff members in continuous professional development on top of the in-house training programmes being undertaken through highlighting the important role that e-learning is playing. The analysis of the courses enrolled in by the staff members reveals a clear recognition of the importance of specific skills. The top skills identified from the courses include Leadership, Communication, Management, Data Analysis, Research, Data Science, Artificial Intelligence, Python, Writing, and Psychology (See Figure 1). This indicates a broad spectrum of competencies that staff members are actively seeking to develop.

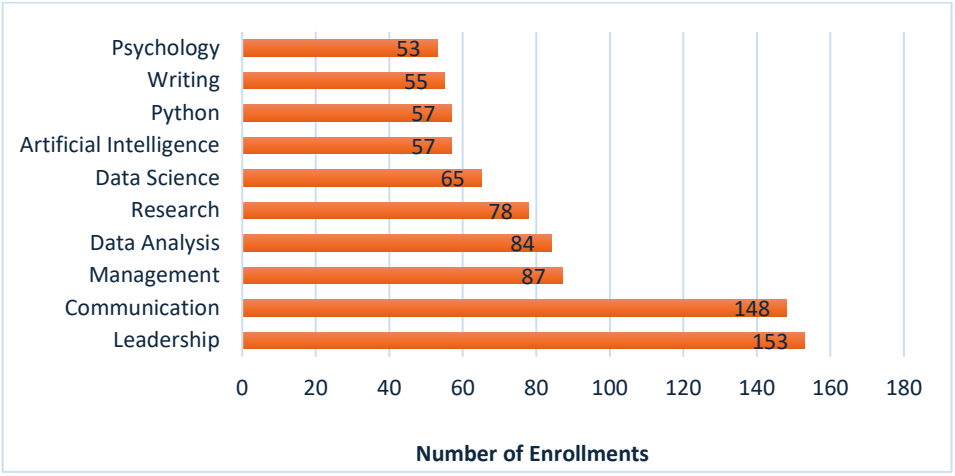


Figure 1. Top Skills by Enrollments

Further examination of the courses completed by the staff members highlights the following top skills: Leadership, Communication, Management, Research, Data Analysis, Artificial Intelligence, Psychology, Data Science, Machine Learning, Social Sciences (See Figure 2). These findings suggest a strong emphasis on both traditional management skills and emerging technological competencies, reflecting the evolving demands of the higher education landscape. Notably, there is a noticeable gap between Number of enrollments and completions. This indicates that though some participants are interested and actively seek out resources to improve certain skills, the commitments to completing the course are lacking. Potential reasons for this gap could include time constraints, difficulty levels of the courses, or competing professional responsibilities.

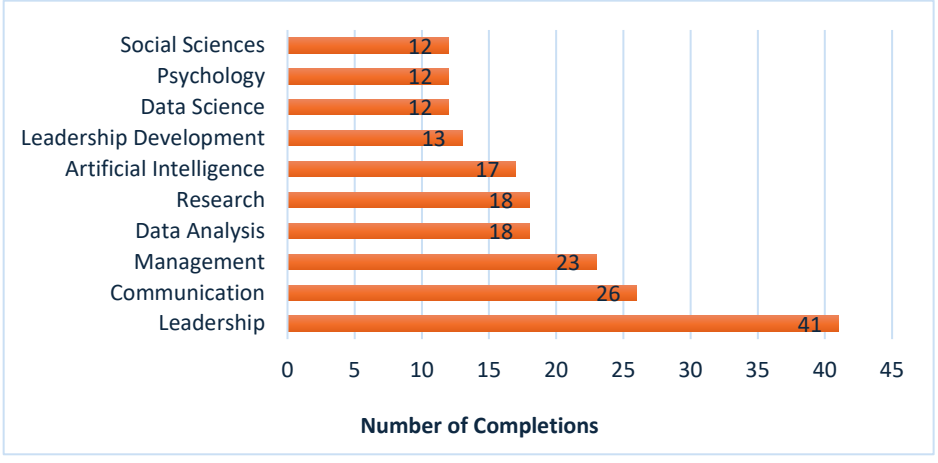


Figure 2. Top Skills by Completions

The top subjects by learning hours are Business Management, Data Analysis & Statistics, Social Sciences, Computer Science, Communication, Education & Teacher Training, Humanities, Engineering, Math, and Language (See Figure 3). This distribution of learning hours across various subjects highlights the diverse interests and developmental needs of the staff.

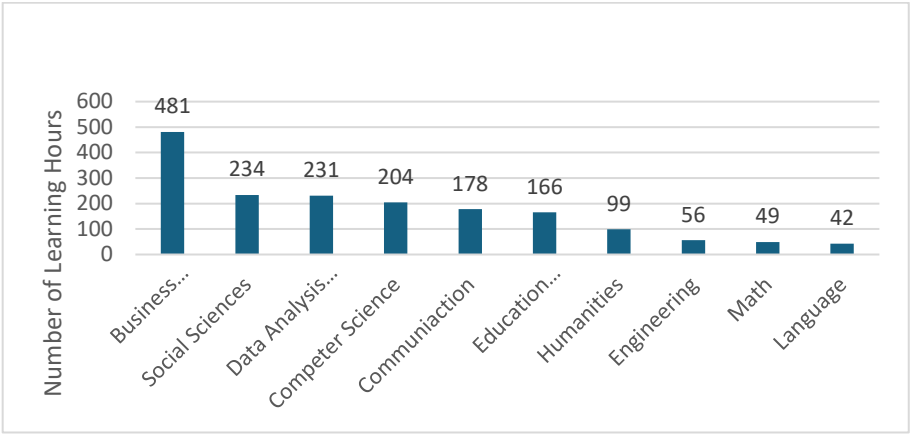


Figure 3. Top Subjects by Learning Hours

Notably, the top courses people spend most time learning is related to managing happiness, highlighting the significance of staff mental well-being, especially in the context of the challenges posed by and since the pandemic potentially representing a shift in mentality. The focus on mental health and well-being reflects a growing awareness of the importance of holistic development in higher education institutions and amongst community members.

5. Discussion

5.1. Alignment with Literature

The study's findings highlight the significance of internal talent development through e-learning initiatives among staff members, a key sustainable goal in higher education institutions. The identified skills, such as leadership, communication, management, and data analysis, align with the competencies necessary for preparing staff and students for the VUCA world (Nikolaeva & Savchenko, 2024). This highlights the relevance of the study's findings to the broader objectives of equipping staff with the skills needed to stay competitive in the labour market. The prominence of interests in leadership skills in the study's findings is particularly noteworthy. The study's results support Day's (2000) perspective by demonstrating a clear recognition among staff of the importance of these leadership skills. This finding is consistent with the challenges reported by academics transitioning into leadership roles, such as attempting to balance managerial tasks with research and teaching responsibilities (Antiado et al., 2020). The

active engagement also supports the effectiveness of e-learning initiatives as advocated by Shahzad et al. (2023).

5.2. Implications for Practice

The study's findings suggest several practical implications for higher education institutions. First, the use of e-learning platforms to gather data on staff development needs provides a valuable tool for assessing the effectiveness of training offerings. By analysing the courses completed and the time spent on various topics, institutions can better align the onsite training programmes with staff needs. This approach can help address the lack of comprehensive assessment mechanisms for traditional training methods. Second, the findings highlight the importance of mental well-being, particularly in the context of the pandemic. The popularity of courses related to managing happiness underscores the need for institutions to prioritise staff wellbeing. This aligns with the broader goal of fostering a supportive and resilient workforce capable of navigating the challenges of the VUCA world.

Furthermore, the significant gap between the number of enrollments and completions provides critical insights for improving e-learning initiatives. While many participants enroll in courses related to high-demand skills such as Data Analysis and Artificial Intelligence, the completion rates for these courses are relatively low. This indicates that despite the interests in self-development, employees may face challenges in committing to and completing the courses. Potential reasons for this gap could include time constraints, difficulty levels of the courses, or competing professional responsibilities. L&D practitioner and policymakers could investigate these factors in more detail to develop strategies that enhance course completion rates to promote the learning environment.

5.3. Limitations and Future Research

While the study provides valuable insights into the developmental needs and preferences of staff members in higher education institutions, there are several limitations to consider. Future research could benefit from such segmentation to provide a more nuanced understanding of how different types of staff engage with e-learning initiatives and what specific areas they focus on for their professional development. Specific staff roles or responsibilities should be considered as well.

Moreover, the study relied primarily on quantitative data from the e-learning platform without incorporating qualitative feedback from staff members. Future research could include surveys or focus groups to gather qualitative insights into staff experiences and perceptions of e-learning initiatives. This would provide a more comprehensive understanding of the impact of these initiatives on staff development.

6. Conclusion

In conclusion, the study's results provide a comprehensive overview of the developmental needs and preferences of staff members in higher education institutions. These findings align with the broader literature on staff development and leadership, emphasising the importance of cultivating effective leaders and addressing the unique needs of both teaching and non-teaching staff. By leveraging e-learning platforms and prioritising mental health and well-being, institutions can enhance their staff development initiatives and better prepare their workforce for the complexities of the modern academic environment.

References

Antiado, D. F. A., Castillo, F. G., Reblando, J. R. P., & Tawadrous, M. I. (2020). Managing professional development activities for non-teaching staff: For professional growth. *Universal Journal of Educational Research*, *8*(7), 3280-3285.

Baran, B. E., & Woznyj, H. M. (2020). Managing VUCA: The human dynamics of agility. *Organizational dynamics*, 100787.

Day, D. V. (2000). Leadership development: A review in context. *The leadership quarterly*, *11*(4), 581-613.

Matlakala, H. N., & Bezuidenhout, A. (2024). Administrative staffs' training needs and talent development at a Health Sciences University. *SA Journal of Human Resource Management*, *22*, 1-14.

Nikolaeva A. A., Savchenko I. A. (2024) Study of the readiness of university teachers and staff to participate in higher education development programs. *Prospects of Science and Education*, 4(70). 718–736. doi: 10.32744/pse.2024.4.44

Shahzad, K., Khan, S. A., Javed, Y., & Iqbal, A. (2023). E-learning for continuing professional development of university librarians: a systematic review. *Sustainability*, *15*(1), 849.

Singh, R., Singh, S. K., & Mishra, N. (2024). Influence of e-learning on the students' of higher education in the digital era: A systematic literature review. *Education and Information Technologies*, *29*(15), 20201-20221.

Wang, X., Liu, T., Wang, J., & Tian, J. (2022). Understanding learner continuance intention: A comparison of live video learning, pre-recorded video learning and hybrid video learning in COVID-19 pandemic. *International Journal of Human–Computer Interaction*, *38*(3), 263-281.

Zamiri, M., & Esmaeili, A. (2024). Methods and technologies for supporting knowledge sharing within learning communities: A systematic literature review. *Administrative Sciences*, *14*(1), 17.

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Integrating Economics into the Classroom through Gamification and Problem-Based Learning

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Abstract

The teaching of Political Economy faces challenges in integrating economic concepts and understanding collective decision-making, particularly for law and political science students. There is a gap between theory and practical application, as well as a disconnect between market dynamics and political decisions. To address these challenges, an educational innovation is proposed, incorporating dynamic methodologies, case studies, and technological tools. This approach aims to enhance the understanding of the economic impacts of government regulation and strengthen students' applied training from both economic and legal perspectives.

Keywords: *Gamification; problem-based learning; economics; higher education.*

1. Introduction

The course of Political Economy serves as an introduction to economics for law and political science undergraduate students. The course requires the students to learn about the mechanisms for collective decision-making as well as some basic micro and macroeconomic theory, which is critical for their development and for that reason, students need to be engaged and motivated. Both student motivation and engagement during sessions are one of the key drivers in the general achievement of students and in the satisfaction levels regarding learning experiences (Kong, 2021; Lu et al., 2014). One of the ways of fostering students' interest is through the application of teaching methods which promote teacher-student interactions (Derakhshan et al., 2021, Qureshi et al., 2023).

In that regard, this manuscript makes use of two teaching techniques which attempt to motivate students during sessions. First, the use of gamification through Wooclap. Wooclap is an online resource which allows mixing questions and problems with teaching materials. Then, the answers are used as part of the explanation. Secondly, Project Based Learning (PBL) is employed as well through a group project on market failures, which accounts for 10% of their

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final grade. By combining both these techniques, this manuscript attempts to change the functioning of sessions during Political Economy course so that students can learn effectively and be motivated at the same time.

2. Materials and methods

The main objective is to improve and enrich the teaching and learning processes by introducing new methodologies, technologies, pedagogical approaches, and resources that address the changing needs of students and the educational environment. To this end, various teaching innovation proposals are applied in the Political Economy course at the University of Valencia. These are divided into two groups:

First, teaching materials are designed based on slides and practical exercises that students can solve during sessions using any internet-connected device (promoting the use of digital technologies and educational resources in teaching and learning). The material will be accessible on the University of Valencia's virtual classroom through the Wooclap application. This tool not only brings dynamism to the classroom in real time but also offers a wide range of options and configurations related to learning sessions (encouraging the use of the various tools provided by the University of Valencia for both students and the teaching staff).

Second, considering the interdisciplinary nature of some of the content covered in the course, a Problem-Based Learning (PBL) method is developed, to be implemented during practical sessions. This method aims to enhance students' competency acquisition by engaging them in solving problems they may encounter in a professional environment. Additionally, it seeks to encourage students to take an active role in their learning process while raising awareness of the importance of applying a holistic perspective to resolving conflicts that integrate social, economic, and environmental aspects.

2.1. Gamification and New Technologies: The Value of Play in Learning

Gamification is a strategy that transforms educational processes by adhering to key premises: the activity can be learned, user actions are measurable, and feedback is timely. Consequently, it is viable to apply it in educational activities, particularly in the Political Economy course. Gamification seeks to satisfy fundamental human needs such as recognition, reward, achievement, competence, collaboration, self-expression, and altruism through game elements and aesthetics (García, 2016). It uses various components that, together with game aesthetics, create the player experience.

At the individual level, gamifying an activity requires finding the right way to motivate the right person at the right time (Parra, 2024). Therefore, it is essential to understand the different motivations that lead the learner to become more involved in the learning process.

In addition, the social component plays a relevant role, i.e., the participation of other people with whom to compete, collaborate and compare achievements. In social games, the objectives can be competitive or collaborative (Contreras, 2018). Therefore, in team games it is necessary to consider separately the mechanics that affect the team (projects, group scores, etc.) and those that apply only to the individual (motivation, positive reinforcement, etc.).

Following these guidelines, an experience of educational innovation is developed to effectively apply the concept of gamification in the teaching process of the subject of Political Economy. This subject deals with the basic functioning of the economy, as well as its implications in the allocation of resources, production and income distribution, among other objectives.

The implementation of the gamification methodology in the classroom generally follows these steps: User and context analysis, Definition of learning objectives, Experience design, Resource identification and Application of gamification elements.

This approach leverages gamification to enhance understanding of economic concepts and encourage active student participation (Palomino, 2021). Each topic begins with key concepts presented through pre-designed slides that integrate theory, practice, and in-class questions. The session concludes with a review of key points and common errors (Illustration 1).

Including multiple-choice questions in theoretical or practical explanations enhances student attention. The game assigns individual scores based on accuracy and response time, with an option for team play to encourage collaboration and tackle complex questions. Questions can be integrated during or at the end of the session, depending on class dynamics. The game lasts no more than 20 minutes and helps assess students' understanding of key concepts.

Ultimately, the overall scores obtained provide insight into the level of assimilation of the explained concepts, enabling further exploration and/or review of any point deemed necessary.

2.2. Theoretical Framework for PBL (Project-Based Learning)

In Problem-Based Learning (PBL), students take an active role by analyzing and understanding the problems, seeking the necessary information, collaborating with their peers, and critically evaluating the results. Throughout this process, instructors act as guides and facilitators, supporting students in their learning journey (Buzova & Sanz-Blas, 2023).

The effectiveness of PBL is highly dependent on the design of the problems, which should take into account three key factors: relevance, scope, and complexity. Problems should be meaningful and closely related to students' future professional fields, encouraging them to investigate and explore solutions independently. In addition, they should present a level of complexity that requires integrating knowledge from multiple disciplines, fostering a deeper understanding of the subject matter and enhancing problem-solving skills (Toledo Morales & Sánchez García, 2018).

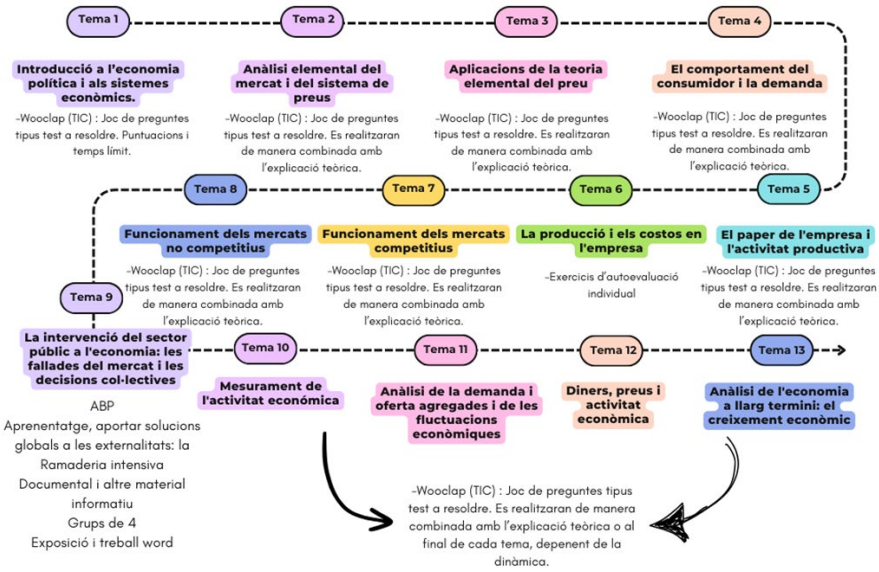


Figure 1: ICT Flowchart and Methodologies by Topics (Valencian language).

PBL fosters high-quality knowledge by promoting critical thinking, skill development, and competency training. It enhances problem identification, self-directed learning, decision-making, and collaboration, preparing students for professional challenges (Vargas & Barrera, 2021). In this case, students will work in groups of up to four to explore market failures and government intervention (Topic 9), with a focus on sustainability. They will analyze the social, environmental, and economic impacts of cases like intensive livestock farming or photovoltaic plant construction and propose solutions to mitigate these effects by internalizing external costs.

Students must recognize that decisions affect the economy, environment, and society differently, making it difficult to satisfy all stakeholders. As political science and law students, they must evaluate the best solution, considering its broader consequences. The goal is to promote a just, sustainable society and economic growth. Proposals will be peer-reviewed based on environmental, social, and economic criteria, fostering debate and deeper learning.

3. Results

The Political Economy course is taken by first year students in the following undergraduate degrees:

- Degree in Law
- Double Degree in Law + Political Sciences and Administration

- Double Degree in Law + Criminology

This results in a total of approximately 850 students, which are split into 17 groups. However, because of the novelty of the project not all teaching staff have applied the methodology yet, and therefore preliminary results are only available for two of the 17 groups so far. Additionally, because not all students answer the questionnaire, the final sample is n=39. To collect the data, at the end of last semester, students were given a questionnaire where they had to evaluate different items regarding their satisfaction with the teaching methodologies, their perceived results, as their feedback for improvement. For those items concerned with the satisfaction of the teaching methodologies as well as their perceived results, the questions are scored with values ranging from 0% if the student reported the lowest level of satisfaction and 100% if the student reported the highest. Then, the average of these responses is calculated and reported as the 'Satisfaction Level' for that question. The results of the questionnaire are shown in Table 1.

First, we find that the interactive questions through Wooclap to be effective in improving the learning experience of students, as evidenced by the levels of satisfaction of over 90% in both questions related to Wooclap. Moreover, while the Project Based Learning also seems to improve the learning experience of students, it does so slightly less than the interactive questions.

In terms of learning results, the exercises as well as the test questions seem to help the students understand the course better, however, the value of the practical exercises by themselves is slightly diminished.

Table 1. Satisfaction levels for teaching methodologies and their results. Source: Own elaboration.

Question	Satisfaction Level
Teaching Methodologies	
Q1: The classes in Political Economy have implemented Wooclap as a platform for continuous interaction. How would you value this experience?	91.03%
Q2: Do you agree with the amount of time devoted to dynamic questions (Wooclap) during the sessions?	94.87%
Q3: Do you think the Project-Based Learning (PBL) has helped you deepen your knowledge of market failures?	82.05%
Results	
Q4: Do you think the exercises as well as the test questions after each topic have helped you understand the subject?	88.03%
Q5: Value the usefulness of the practical exercises	80.77%
Q6: The subject has helped me learn about economics	82.05%

Regarding the feedback items, several non-ordered options were given in each question with the intention of learning what could be done better to improve the learning experience in future

editions of the course. The results for these questions are presented in Table 2, where the students show a higher preference for Wooclap questions as well as PBL, which falls in line with the current teaching project. Moreover, the students also report that the methodology used during the course is quite different from that in other courses. However, this result cannot be evaluated as either positive or negative just yet, at least until we are able to produce data on learning outcomes.

Table 2. Frequency of answers for feedback items. Source: Own elaboration.

Question	Frequency (n=39)			
	Wooclap questions	PBL	Inverted Classroom	Time devoted to theory
Q1: If you were to take the course again, what teaching method would you like to see emphasized? (Multiple choice)	15	16	9	7
	Very different to that of other subjects	Somewhat different to that of other subjects	Very similar to that of other subjects	Almost the same to that of other subjects
The methodology employed in the economics course has been	22	16	1	0

4. Conclusions

The learning tools based on gamification and project-based learning manage to increase students' interest in the subject of Political Economy. First, the use of Wooclap in the classroom managed to increase student attendance to the theoretical classes. The combination in the same presentation of the concepts to be addressed together with random questions that students solve in class increased students' attention significantly. Students value very positively the change in the usual dynamics, based on lectures and practical exercises. With respect to project-based learning, students show a high level of interest in combining theory related to market failures with current examples. Beyond their theoretical analysis, it allows them to provide possible solutions to mitigate the negative social, environmental and economic impacts generated. However, a greater number of surveys are required in order to analyze the results in depth and to be able to improve the dynamics used.

References

Buzova, D., Sanz-Blas, S. (2023). Trabajar la sostenibilidad en las clases de marketing a través del Aprendizaje Basado en Proyectos. In: *IX Jornada de Innovación Educativa*. Valencia, 12 July, 2023.

Contreras, R. S. (2018). Experiencias de gamificación en aulas. Bellaterra.

Dearkhshan, A., Kruk, M., Mehdizadeh, M. and Pawlak, M. (2021). Boredom in online classes in the Iranian EFL context: Sources and solutions. *System*, 101, 102556. https://doi.org/10.1016/j.system.2021.102556

García, C. M. (2016). La senda del maestro: experiencias de gamificación en el aula universitaria. In: *XII Congreso Español de Sociología. Grandes transformaciones sociales, nuevos desafíos para la sociología*. https://repositorio.21.edu.ar/handle/ues21/12835.

Kong, Y. (2021). The role of Experiential Learning on Students' Motivation and Classroom Engagement. *Frontiers in Psychology*, 12, 771272. https://doi.org/10.3389/fpsyg.2021.771272

Lu, G., Hu, W., Peng, Z., & Kang, H. (2014). The Influence of Undergraduate Students' Academic Involvement and Learning Environment on Learning Outcomes. *International Journal of Chinese Education*, 2(2), 265-288. https://doi.org/10.1163/22125868-12340024

Palomino, M. D. C. P. (2021). Implicaciones de la gamificación en Educación Superior: una revisión sistemática sobre la percepción del estudiante. *Revista de Investigación Educativa*, 39(1), 169-188. https://doi.org/10.6018/rie.419481

Parra, A. C. (2024). Uso de la gamificación en el aula: aportes para promover la calidad formativa del docente. *Investigación y postgrado*, 39(1), 85-101. https://dialnet.unirioja.es/servlet/articulo?codigo=9625510

Qureshi, M. A., Khaskheli, A., Qureshi, J. A., Raza, S. A., & Yousufi, S. Q. (2021). Factors affecting students' learning performance through collaborative learning and engagement. *Interactive Learning Environments*, 31(4), 2371–2391. https://doi.org/10.1080/10494820.2021.1884886

Toledo Morales, P., & Sánchez García, J. M. (2018). Aprendizaje basado en Proyectos: Una experiencia universitaria. *Profesorado, Revista De Currículum Y Formación Del Profesorado*, 22(2), 471–491. https://doi.org/10.30827/profesorado.v22i2.7733

Vargas, L. A. C., De la Barrera, A. E. R. (2021). Aprendizaje Basado en Proyectos (ABP): experimentación en laboratorio, una metodología de enseñanza de las Ciencias Naturales. *Plumilla Educativa*, 27(1), 105-128. https://doi.org/10.30554/pe.1.4204.2021

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A Framework for Automated Student Grading Using Large Language Models

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Abstract
This paper proposes a systematic framework for integrating large language models (LLMs) into the evaluation of student work. The framework addresses challenges inherent in automated grading, such as ensuring validity, reliability, and minimizing bias, by outlining a structured process that includes prompt design, model selection, evaluation, calibration, and iterative refinement. The approach is designed to be adaptable across diverse educational contexts, supporting both formative and summative assessment needs. This work contributes to the growing literature on AI-driven education, offering practical guidelines and highlighting the need for careful design and continuous validation for high-stakes educational applications.

Keywords: *Large Language Models; automatic asssessment; framework.*

1. Introduction

The advent of large language models (LLMs) has marked a significant milestone in artificial intelligence. These models, capable of understanding and generating human-like text, have evolved beyond mere linguistic tasks to demonstrate abilities in contextual understanding, reasoning, and problem-solving (Budnikov et al., 2024). Additionally, with their multimodal capacities, emerging LLMs are increasingly able to process and integrate inputs from diverse formats such as text, images, and structured data (Yin et al., 2024). These advancements position LLMs as transformative tools across various domains, including education, where their potential for evaluating student performance has garnered considerable interest (Domenech, 2023; Kortemeyer, 2023; Latif & Zhai, 2024).

Education systems worldwide continue to seek scalable, accurate, and efficient methods for evaluating student performance (Timotheou et al., 2023). Traditional assessment approaches, while well-established, often require substantial time and effort from educators (Brown, 2022; Dikli, 2006), a challenge that has been acknowledged in early work on automated grading

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systems (Page, 1966). LLMs offer a promising alternative to automate the analysis of student submissions and generating feedback. With their ability to contextualize responses and adapt to diverse prompts, LLMs can potentially streamline grading processes and provide individualized, text-based feedback to enhance learning outcomes.

However, the application of LLMs in student evaluation is not without challenges. One critical concern is the validity of these evaluations, particularly whether they measure constructs comparable to those assessed by human raters (Attali, 2013). Can LLMs accurately assess student work across diverse disciplines and levels of complexity? Are the scores and feedback generated by these models reliable and unbiased? Ensuring the validity, reliability and fairness of LLM-based grading is paramount to their adoption in educational settings. Addressing these concerns requires robust validation frameworks that align with established educational standards and account for the depth inherent in human judgment.

Prior research on integrating LLMs into student evaluation has adopted a variety of approaches, ranging from direct application of general-purpose models to fine-tuning them for specific educational tasks. In some cases, educators have manually entered student responses into tools like ChatGPT to solicit grading suggestions or feedback (Floden, 2024; Sreedhar et al., 2024). Others have experimented with optimization techniques, such as prompt engineering, to elicit more accurate and contextually relevant model outputs (Wan & Chen, 2024). Validation of these methodologies has been equally diverse, drawing on quantitative alignment with human graders (Pack et al., 2024; Sreedhar et al., 2024), qualitative analysis of feedback (Almasre, 2024; Wan & Chen, 2024), and psychometric evaluations to assess reliability (Pack et al., 2024; Yavuz et al., 2025). Despite these efforts, a comprehensive framework that systematically integrates LLM capabilities into educational evaluation, while addressing the challenges of validity and scalability, remains an ongoing challenge.

The objective of this paper is to bridge this gap by proposing a general framework for employing LLMs in the evaluation of student work. This framework encompasses key dimensions, including model selection, input preparation, evaluation design, and validation mechanisms. Additionally, it aims to provide guidelines for educators and researchers on optimizing LLM usage while mitigating biases and ensuring alignment with pedagogical goals. By synthesizing existing approaches and addressing current limitations, this work seeks to advance the understanding and application of LLMs in education, ultimately contributing to more equitable, efficient, and insightful assessment practices.

This paper is organized as follows. Section 2 reviews related literature and approaches to LLM-based evaluations. Section 3 outlines the proposed framework, detailing its components and discussing validation techniques. Finally, Section 4 draws some concluding remarks.

2. Background

The evolution of automated assessment systems in education has a rich history, beginning with early efforts to mechanize grading processes (Page, 1966) and progressing through various technological advances. This section reviews key developments and current approaches in automated student evaluation, with particular focus on the emergence of LLM-based methods.

2.1. Traditional Automated Assessment

Early automated grading systems primarily focused on multiple-choice questions and other structured response formats that could be evaluated through pattern matching (Forsythe & Wirth, 1965; Page, 1966). These systems gradually evolved to incorporate more sophisticated natural language processing (NLP) techniques, enabling the assessment of short-answer questions and essays. Traditional automated essay scoring (AES) systems typically relied on extracting linguistic features such as vocabulary usage, syntactic complexity, and discourse coherence to predict human-assigned scores (Attali & Burstein, 2004).

Despite their utility, these conventional approaches faced several limitations. They often struggled with semantic understanding, context sensitivity, and the ability to provide detailed, constructive feedback. Additionally, their effectiveness was largely confined to specific domains and question types, requiring substantial effort to adapt to new contexts (Balfour, 2013; Dikli, 2006).

2.2. LLM-based Assessment Approaches

Advances in deep learning have led to the development of large language models that overcome some of the challenges faced by traditional AES systems. Leveraging extensive training on varied text corpora, these models are capable of understanding and generating contextually rich responses, which makes them suitable for assessing open-ended student work (Hu et al., 2025; Mondal et al., 2024). Research such as that by Yavuz et al. (2025) and Latif and Zhai (2024) has demonstrated that LLM-based approaches can yield evaluations that correlate with human judgments.

LLM-based methods provide several benefits compared to conventional approaches. Their capacity to capture semantics and generate detailed feedback supports formative assessment practices that can inform both teaching and learning (Morris et al., 2024). In addition, the flexibility inherent to these models facilitates their application across diverse disciplines and question formats without requiring extensive modifications for each new context (Bruscia et al., 2024; Wang & Zhang, 2024).

However, these methods are not without challenges. The sensitivity of LLM outputs to prompt formulation can result in variability in assessments (Liu et al., 2023; Wan & Chen, 2024).

Moreover, ensuring that evaluations produced by LLMs are unbiased and adhere to educational standards remains an area of concern (Attali & Burstein, 2004). In response, researchers have begun to develop calibration techniques and robust validation protocols that integrate quantitative measures with qualitative insights (Pack et al., 2024; Sreedhar et al., 2024).

While LLM-based assessment approaches hold promise for enhancing the scalability of automated student evaluation, further investigation is necessary to ensure their reliability and fairness. The framework proposed in this paper builds on these developments by outlining systematic procedures for model selection, input preparation, evaluation design, and validation.

3. Framework

This section presents a comprehensive framework for implementing LLM-based student evaluation systems. The framework encompasses the essential components and processes required to implement reliable and valid automated assessment systems based on LLMs. Figure 1 illustrates the primary components and their interactions. Although described sequentially, the process is not strictly linear. Outcomes from the evaluation stage can motivate changes in prompt design and model configuration.

System Overview. The framework starts with a student's text, such as a short answer or essay, and produces a final score or grade. Optionally, it can also generate textual feedback. Four key elements structure the approach: prompt design, the application of the LLM itself, evaluation, and an optional calibration step.

Prompt design defines how the student's submission and grading instructions are presented to the LLM. The model then processes the prompt and student text to produce raw outputs. The evaluation stage verifies the reliability of the LLM's responses and assesses their alignment with human-based grading. If biases or systematic deviations are found, an optional calibration step can adjust the model's outputs. Finally, the process can iterate, incorporating insights from evaluation into refined prompt designs or updated model parameters.

Prompt Design. Prompt design specifies the task and grading criteria for the LLM. It should include a structured rubric detailing performance levels and specific criteria relevant to the assignment. The system may also incorporate examples that demonstrate correct and incorrect responses, known as few-shot prompting, to guide the model's reasoning. Additionally, the prompt may also instruct the LLM to produce intermediate reasoning steps (chain-of-thought) before arriving at a final judgment. This design can be further adjusted by assigning a particular role to the model, for instance, instructing it to act as a teacher or domain expert. Since LLMs can be sensitive to variations in how the prompt is phrased, prompt design often involves iterative experimentation and refinement to achieve reliable outputs.

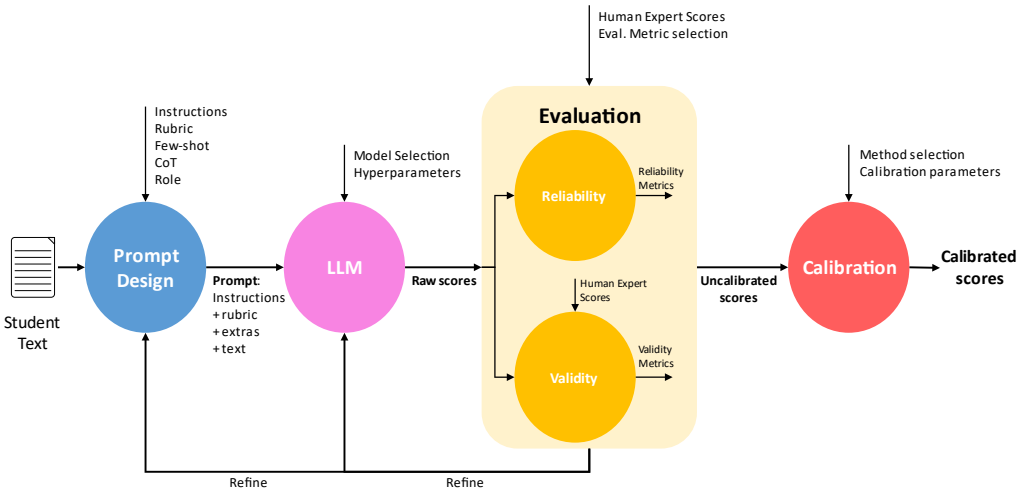


Figure 1. Overview of the proposed LLM-based grading framework. The system receives a student's text and produces raw scores using a prompt design and model selection process. The scores are then evaluated for reliability and validity, optionally undergoing calibration to correct biases or misalignments with human expert judgments. Iterative refinements can be made at each stage to improve the overall quality and reliability of the assessments.

Large Language Model. Once the prompt is formulated, it is fed into the chosen LLM together with the student text. Model selection is a key decision, as LLMs differ in their training data, size, and domain specialization. Hyperparameters such as temperature or maximum output length can further shape the model's style and reliability. The raw output from the LLM typically includes a proposed score or grade, and it can also contain explanatory feedback. However, these initial results may not fully align with human evaluations, and they can vary across repeated queries, which motivates the subsequent evaluation stage.

Evaluation. Evaluation assesses whether the model's outputs are both valid and reliable. Validity checks involve comparing the model's outputs with human-assigned scores. These comparisons may rely on statistical metrics, such as Pearson correlation coefficients (r), Spearman's rank correlation (ρ), and mean squared error (MSE) between LLM and human scores, or more qualitative analyses of the feedback provided. The goal is to identify potential biases or patterns of error and to establish how closely the model's grading aligns with established standards.

Reliability assessment complements validity by examining the consistency of the model's outputs. This involves testing whether the LLM produces similar results when presented with the same or slightly modified prompts. Metrics such as inter-rater reliability, intraclass correlation coefficient (ICC), and Cohen's or Fleiss' kappa are applied to evaluate consistency across different instances of scoring. Large fluctuations may indicate a need to adjust either the prompt design or hyperparameters. The relationship between reliability and validity is

particularly important in LLM-based assessment, as unreliable measurements inherently limit the potential validity of the system.

Calibration. When systematic deviations are observed, an optional calibration step can correct for biases in the LLM's grading. If, for example, the model consistently assigns higher scores than human raters, a calibration function can shift the raw outputs to more closely match human scores. Simple approaches might use linear transformations based on observed differences, whereas more complex methods can incorporate additional contextual variables. Calibration is especially useful in high-stakes assessments, where grading reliability is paramount.

Iterative Refinement. Although the framework is presented as a series of steps, it is often applied in a cyclic manner. Insights from the evaluation and calibration stages can inform adjustments to the prompt design or changes to model parameters. Over multiple iterations, the system can converge on a more stable, valid, and transparent grading process.

4. Conclusions

This paper has presented a systematic framework for implementing LLM-based student evaluation systems, addressing key challenges in automated assessment while leveraging the advanced capabilities of modern language models. The proposed framework integrates essential components including prompt design, model selection, evaluation protocols, and calibration mechanisms to create a robust foundation for educational assessment applications.

Several important insights emerge from this work. First, the effectiveness of LLM-based assessment systems depends heavily on careful prompt engineering and model selection. The framework emphasizes the importance of structured rubrics and clear evaluation criteria, while acknowledging that prompt design often requires iterative refinement to achieve optimal results. Second, the evaluation process must balance multiple objectives, including alignment with human judgment, consistency across assessments, and the generation of meaningful feedback. The proposed validation mechanisms provide a structured approach to measuring and improving these aspects of system performance.

Looking ahead, the integration of LLMs into educational assessment holds significant promise for scaling personalized feedback and reducing educator workload. However, successful implementation requires careful attention to validity, reliability, and fairness. The framework presented here provides some ground for developing such systems, while acknowledging the ongoing need for human oversight and validation in educational assessment.

References

Almasre, M. (2024). Development and Evaluation of a Custom GPT for the Assessment of Students' Designs in a Typography Course. Education Sciences, 14 (2), 148. https://doi.org/10.3390/educsci14020148

Attali, Y. (2013). Validity and reliability of automated essay scoring. In M. D. Shermis & J. Burstein (Eds.), Handbook of automated essay evaluation: Current applications and new directions (pp. 181-198). Taylor & Francis.

Attali, Y., & Burstein, J. (2004). Automated essay scoring with e-rater v.2.0. ETS Research Report Series, 2004 (2). https://doi.org/10.1002/j.2333-8504.2004.tb01972.x

Balfour, S. P. (2013). Assessing Writing in MOOCs: Automated Essay Scoring and Calibrated Peer ReviewTM. Research & Practice in Assessment, 8, 40-48. https://eric.ed.gov/?id=EJ1062843

Brown, G. T. L. (2022). The past, present and future of educational assessment: A transdisciplinary perspective. Frontiers in Education, 7. https://doi.org/10.3389/feduc.2022.1060633

Bruscia, M., Manduzio, G. A., Galatolo, F. A., Cimino, M. G., Greco, A., Cominelli, L., & Scilingo, E. P. (2024). An Overview On Large Language Models Across Key Domains: A Systematic Review. 2024 IEEE International Conference on Metrology for eXtended Reality, Artificial Intelligence and Neural Engineering (MetroXRAINE), 125-130. https://doi.org/10.1109/MetroXRAINE62247.2024.10797032

Budnikov, M., Bykova, A., & Yamshchikov, I. P. (2024). Generalization potential of large language models. Neural Computing and Applications, 1-25.

Dikli, S. (2006). An Overview of Automated Scoring of Essays. The Journal of Technology, Learning, and Assessment, 5 (1).

Domenech, J. (2023). ChatGPT in the Classroom: Friend or Foe? 9th International Conference on Higher Education Advances (HEAd'23), 339-347. https://doi.org/10.4995/head23.2023.16179

Floden, J. (2024). Grading exams using large language models: A comparison between human and AI grading of exams in higher education using ChatGPT. British Educational Research Journal. https://doi.org/10.1002/berj.4069

Forsythe, G. E., & Wirth, N. (1965). Automatic grading programs. Communications of the ACM, 8 (5), 275-278. https://doi.org/10.1145/364914.364937

Hu, B., Zhu, J., Pei, Y., & Gu, X. (2025). Exploring the potential of LLM to enhance teaching plans through teaching simulation. NPJ Science of Learning, 10 (1), 7. https://doi.org/10.1038/s41539-025-00300-x

Kortemeyer, G. (2023). Toward AI grading of student problem solutions in introductory physics: A feasibility study. Physical Review Physics Education Research, 19 (2). https://doi.org/10.1103/physrevphyseducres.19.020163

Latif, E., & Zhai, X. (2024). Fine-tuning ChatGPT for automatic scoring. Computers and Education: Artificial Intelligence, 6, 100210. https://doi.org/ 10.1016/j.caeai.2024.100210

Liu, P., Yuan, W., Fu, J., Jiang, Z., Hayashi, H., & Neubig, G. (2023). Pre-train, Prompt, and Predict: A Systematic Survey of Prompting Methods in Natural Language Processing. ACM Computing Surveys, 55 (9), 1-35. https://doi.org/10.1145/3560815

Mondal, H., De, R., Mondal, S., & Juhi, A. (2024). A large language model in solving primary healthcare issues: A potential implication for remote healthcare and medical education. Journal of Education and Health Promotion, 13, 362. https://doi.org/10.4103/jehp.jehp_688_23

Morris, W., Crossley, S., Holmes, L., Ou, C., Dascalu, M., & McNamara, D. (2024). Formative Feedback on Student-Authored Summaries in Intelligent Textbooks Using Large Language Models. International Journal of Artificial Intelligence in Education. https://doi.org/10.1007/s40593-024-00395-0

Pack, A., Barrett, A., & Escalante, J. (2024). Large language models and automated essay scoring of English language learner writing: Insights into validity and reliability. Computers and Education: Artificial Intelligence, 6, 100234. https://doi.org/10.1016/j.caeai.2024.100234

Page, E. B. (1966). The imminence of grading essays by computer. Phi Delta Kappan, 47 (5), 238-243.

Sreedhar, R., Chang, L., Gangopadhyaya, A., Shiels, P. W., Loza, J., Chi, E., Gabel, E., & Park, Y. S. (2024). Comparing Scoring Consistency of Large Language Models with Faculty for Formative Assessments in Medical Education. Journal of General Internal Medicine. https: //doi.org/10.1007/s11606-024-09050-9

Timotheou, S., Miliou, O., Dimitriadis, Y., Sobrino, S. V., Giannoutsou, N., Cachia, R., Mon es, A. M., & Ioannou, A. (2023). Impacts of digital technologies on education and factors influencing schools' digital capacity and transformation: A literature review. Education and information technologies, 28 (6), 6695- 6726.

Wan, T., & Chen, Z. (2024). Exploring generative AI assisted feedback writing for students' written responses to a physics conceptual question with prompt engineering and few-shot learning. Physical Review Physics Education Research, 20 (1). https://doi.org/10.1103/physrevphyseducres.20.010152

Wang, D., & Zhang, S. (2024). Large language models in medical and healthcare fields: Applications, advances, and challenges. Artificial Intelligence Review, 57 (11), 299. https://doi.org/10.1007/s10462-024-10921-0

Yavuz, F., Çelik, Ö., & Yavas Çelik, G. (2025). Utilizing large language models for EFL essay grading: An examination of reliability and validity in rubric-based assessments. British Journal of Educational Technology 56, 150–166.

Yin, S., Fu, C., Zhao, S., Li, K., Sun, X., Xu, T., & Chen, E. (2024). A survey on multimodal large language models. National Science Review, 11 (12), nwae403. https://doi.org/10.1093/nsr/nwae403

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"Computerised Medical Simulation Flipped Classroom" bridges the gap between university-based classroom teaching and hospital-based clinical training in Physiotherapy Education

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Abstract

Clinical education is an essential component of physiotherapy education. Students often report stress during hospital-based clinical training due to perceived learning gaps between university-based education and real-world practice. These gaps may stem from factors such as unfamiliarity with clinical environments, inexperience, challenges in integrating theory into practice, and underdeveloped communication skills. To address this, the concepts of medical simulation (technology) and the flipped classroom approach (pedagogy) were integrated into cardiopulmonary physiotherapy education (content), developing the Computerised Medical Simulation Flipped Classroom. This study evaluates the effectiveness of this approach and explores students' learning experiences using a mixed-methods design. A total of 166 students participated. All reported significantly improved self-perceived competency and confidence in performing assessments, delivering treatments, setting clinical priorities, and responding to dynamic patient condition changes. Focus group interviews revealed that students valued the simulation experience, particularly because it mimicked real clinical scenarios. Participants highlighted opportunities to familiarize themselves with ward environments, practice communication and hands-on skills with the simulated patients, and deepen their understanding in clinical reasoning and theoretical principles during facilitator-guided debriefing sessions. These findings suggest that the Computerised Medical Simulation Flipped Classroom effectively bridges the gap between academic training and clinical practice. Future studies should explore how this approach influences objective performance metrics, such as summative grades during clinical placements.

Keywords: *Simulation; flipped classroom; physiotherapy education*

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1. Introduction

Clinical education is an essential component of physiotherapy education. Students enrolled in physiotherapy programmes must complete a specific number of clinical training hours to meet the licensure registration criteria or qualify to sit for the licensure examination upon graduation. Although programme curricula and required clinical hours vary across countries, competency standards exist to ensure graduates meet basic entry-level professional requirements.

Traditionally, students acquire theoretical knowledge, practical skills, and clinical reasoning through "paper" case studies during university tutorials or practical sessions. They later integrate this knowledge into real-world practice during hospital-based clinical placements. At university, hard skills (e.g., clinical techniques) are typically practiced on healthy peers, while soft skills (e.g., clinical reasoning) are developed through discussions of hypothetical cases. Consequently, students often struggle to observe, feel, or differentiate between "normal" and "abnormal" signs, symptoms, and tactile feedback during subjective and objective assessments.

While the clinical reasoning process for "paper" cases and real patients is similar—involving reviewing bednotes, extracting key information, selecting assessments, devising management plans, and adjusting based on condition changes of the patients—the lack of direct patient interaction leaves students unprepared for real-world pressures. Inexperienced in observing and responding to real-time changes in vital signs or conditions, students may become anxious, hindering their ability to make quick decisions. Additionally, task-focused mindsets can lead to poor communication, causing students to overlook critical patient-reported information essential for effective care. These challenges, compounded by psychological stress, often impede learning and performance. Thus, there is an urgent need to develop modules that bridge the gap between classroom teaching and clinical training.

Previous reviews indicate that simulation in medical education improves procedural task performance (Okuda et al., 2009), scenario-based training (Okuda et al., 2009), clinical competency (Alrashidi et al., 2023) and communication between healthcare professionals and patients or relatives (Blackmore et al., 2018). These findings suggest that simulation not only improves/ refines clinical skills but also enhances interpersonal competencies. However, simulations are typically conducted in small groups to optimize hands-on learning experience. Given constraints such as limited class time, large student cohorts, inadequate simulation facilities, and insufficient staffing, integrating this approach into existing curricula has proven challenging. To address these barriers, the concepts of medical simulation (technology) and the flipped classroom approach (pedagogy) were integrated into cardiopulmonary physiotherapy education (content) (Mishra & Koehler, 2006), developing the Computerised Medical Simulation Flipped Classroom. This model shifted case-based discussions to online platforms, freeing in-class time for small-group, hands-on simulation practice and facilitator guided debriefing. The simulations dynamically replicate patient scenarios encountered during clinical

placements, allowing students to respond to evolving conditions in real time. This study aims to examine whether this integrated pedagogical approach enhances learning outcomes in physiotherapy education.

2. Methodology

A mixed-methods approach was adopted, incorporating quantitative and qualitative evaluations.

2.1. Procedures

Physiotherapy students enrolled in the subject of Cardiopulmonary Physiotherapy in undergraduate-entry physiotherapy programme (i.e., BScPT) and postgraduate entry-level physiotherapy programme (i.e., MPT) were invited to participate in the study. The information sheet and consent forms were distributed to one cohort of BScPT students and two cohorts of MPT students. Study details were thoroughly explained, and written informed consent was obtained before the commencement of the study. 166 out of 229 students (response rate of 72.5%) participated in this study. In brief, the Computerised Medical Simulation Flipped Classroom consisted of five key steps:

1) Online Problem-Based Case Discussion: Designed to promote self-directed active learning through independent research and peer collaboration.
2) Online Pre-Quiz: Prepared students to critically think and rehearse necessary assessments and/or treatments for case management with the manikin.
3) On-Site Hands-On Simulation Practice (Simulation Laboratory): Enabled students to practice case management using a computer-controlled manikin, featuring dynamic condition changes based on student performance.
4) On-Site Facilitator-Guided Debriefing: Allowed students to reflect on their performance and address gaps through in-depth peer/faculty discussions guided by facilitators.
5) Online Post-Quiz: Consolidated acquired knowledge and reinforced learning outcomes.

2.1.1. Quantitative evaluation

Participants were asked to complete a survey assessing their self-perceived competency and confidence across various stages of case management. The survey utilised a 5-item Likert scale, with responses ranging from 1 indicating “not at all”, 2 indicating “somewhat”, 3 indicating “moderately”; 4 indicating “highly” and 5 indicating “extremely”. Participants were asked to complete this survey before and after simulation to evaluate its effectiveness in enhancing students’ self-perceived levels of self-confidence and preparing them for clinical placement.

2.1.2. Qualitative evaluation

Eighteen participants were randomly selected for four focus group interviews (3–5 per group; 60–75 minutes each). A facilitator guide, with questions exploring students' learning experience, perception to this approach, preference of using simulation or traditional case-based discussion, challenges that they faced during clinical placement and the solutions that they adopted to solve the learning challenges faced in clinical placement, was set and used throughout the interviews. All focus group interviews were audio-recorded, transcribed verbatim, and anonymized for thematic analysis.

2.2. Statistical analysis

All continuous data were presented as mean ± standard deviation (SD). Categorical data were presented as median with interquartile range or percentages. Changes between pre- and post-module self-perceived confidence and competency were compared by paired t-test. Significance was set at $p < 0.05$. All data were analysed by statistical package (IBM SPSS Statistics for Windows, Version 29.0.2.0 Armonk, NY: IBM Corp).

Audio recordings of all focus group interviews (n=4) were transcribed verbatim and anonymized before analysis. The data were analysed based on the 6-step analysis framework including 1) Data familiarization and writing familiarization notes, 2) Systematic data coding, 3) Generating initial themes from coded and collated data, 4) Developing and reviewing themes 5) Refining, defining and naming themes, and 6) Writing the report (Braun & Clarke, 2021).

3. Results

166 participants with a mean age of 22.01 ± 2.58 years consented to join the study. Of these, 55% of participants were male and 60% were from undergraduate-entry programme.

3.1. Quantitative analysis

A paired t-test revealed significant increases in self-perceived confidence in case management, competency in providing assessment and treatment, and competency in clinical reasoning throughout the management process following the entire practice of Computerised Medical Simulation Flipped Classroom. Figure 1 illustrates the self-reported levels before and after the practice.



Figure 1. Changes in self-perceived responses before and after simulation.
*Note. Data were presented as mean ± standard deviation (SD). Significance was set at $p<0.05$; * indicates $p<0.05$, ** indicates $p<0.01$*

3.2. Qualitative analysis

A total of 18 participants (half male and half female) took part in four focus group interviews. The first three sessions comprised five participants each, while the final session involved three. Interviews lasted 60–75 minutes, depending on the level of engagement and interaction among participants.

3.2.1. Feelings when participating the simulation

All participants reported positive experiences with the simulation, particularly valuing its realistic, real-time exposure to ward environments, which helped them prepare for clinical placements. However, participants expressed mixed emotions. Despite initial confusion and helplessness during their first hands-on practice with a high-fidelity manikin in a simulated ward setting, they channelled these challenges into motivation to improve their skills and readiness for cardiopulmonary physiotherapy coursework and subsequent clinical training.

3.2.2. Personal experience across various components in the practice

Participants identified hands-on simulation practice and facilitator-guided debriefing as the most beneficial components. Debriefing was especially praised for its divergence from traditional tutorials, offering opportunities to articulate thoughts, reflect on performance, and identify areas for growth. During hands-on sessions, students valued experiential learning, which enabled them to integrate fragmented knowledge from lectures and practical classes, develop clinical reasoning skills, practice time management under pressure.

3.2.3. Perceived benefits of the "Computerised Medical Simulation Flipped Classroom"

Participants treasured the experience as it allowed them to synthesise disjointed theoretical knowledge from lectures, tutorials, and practical classes into holistic patient management. They

commended the approach for fostering familiarity with clinical equipment and environments, interaction with simulated patients (manikins), and enhancing verbal/non-verbal communication (e.g., using plain language, active listening, and allowing pauses for patient responses). Realistic patient interactions also improved their rapport-building skills.

4. Discussion

Clinical practice demands adaptability, as patients vary in age, cognitive status, disease severity, and presentation. Novice students often struggle to detect subtle changes in patient conditions and adjust management plans promptly. The current findings suggest that the Computerised Medical Simulation Flipped Classroom promoted active learning by requiring students to research case information and plan interventions pre-class, freeing in-person time for hands-on practice with simulated patients and debriefing.

In line with previous reports that simulation enhances procedural task performance (Okuda et al., 2009), clinical competency (Alrashidi et al., 2023), and communication skills (Blackmore et al., 2018), this study also demonstrated significant quantitative improvements in self-perceived competency in clinical skills (assessment and treatment), clinical reasoning, and confidence in case management, supporting its beneficial effects.

Beyond changes in "skills," the students' qualitative comments highlighted remarkable shifts in the "clinical reasoning" process and subsequent practices. In high-stakes clinical environments, errors are often corrected urgently through directive feedback without contextual explanation, limiting deeper understanding (single-loop learning) and failing to drive changes in cognitive and behavioural acts.

Facilitator-guided debriefing is a common approach in simulation, though various multi-staged debriefing models and feedback delivery methods exist (Şahin & Başakk, 2021). This study adopted a multi-staged debriefing model comprising 1) a reaction phase, 2) an understanding phase, and 3) a summary and take-home message phase. This model allowed facilitators to explore students' feelings (e.g., internal frustration with their performance or external frustration with peers) and identify key themes for student-centred debriefing agendas. Negative emotions, if unaddressed, could impede learning during debriefing. Thus, it is important to explore if any emotions issue to be handled before the next phase. In the understanding phase, the "Plus-Delta" and "Advocacy Inquiry-Focused Facilitation" approaches were used to guide students in reflecting on their performance, identifying discrepancies between expected and actual outcomes, and addressing gaps. This double-loop learning approach (Greenwood, 1998; Tagg, 2010) bridges clinical reasoning gaps and fosters lasting changes in cognitive and behavioural practices. Students valued this structured debriefing, emphasizing how reflection and discussion consolidated their learning.

Our quantitative and qualitative findings complemented each other, validating the efficacy of the "Computerised Medical Simulation Flipped Classroom". The approach enabled risk-free, repeated practice with simulated patients, ensuring competency development before real-world application.

5. Conclusion

The **Computerised Medical Simulation Flipped Classroom** effectively bridged gaps between university-based training and clinical training at hospital. Future studies should assess its impact on objective performance metrics, such as summative clinical placement grades.

6. Ethical approval

Study approval was obtained from the Research Ethics Committee of Lancaster University (EdRes-2024-4258-EdAp-2) and the institutional review board of The Hong Kong Polytechnic University (HSEARS20240117002).

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References

Alrashidi, N., Pasay an, E., Alrashedi, M.S., Alqarni, A.S., Gonzales, F., Bassuni, E.M., Pangket, P., Estadilla, L., Benjamin, L.S., & Ahmed, K.E. (2023). Effects of simulation in improving the self-confidence of student nurses in clinical practice: a systematic review. *BMC Medical Education* 23, 815. https://doi.org/10.1186/s12909-023-04793-1

Blackmore, A., Kasfiki, E.V., & Purva, M. (2018). Simulation-based education to improve communication skills: a systematic review and identification of current best practice. *BMJ Simulation & Technology Enhanced Learning*, 4, 159–164.

Braun, V., & Clarke, V. (2021). One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology*, 18(3), 328-352. https://doi.org/10.1080/14780887.2020.1769238

Chen, J. Y., Chin, W. Y., Tiwari, A., Wong, J. E., Wong, I. C. K., Worsley, A., Feng, Y. B., Sham, M. H., Tsang, J. P. Y., & Lau, C. S. (2021). Validation of the perceived stress scale (PSS-10) in medical and health sciences students in Hong Kong. *Asia Pacific Scholar*, 6(2), 31-37. https://doi.org/10.29060/Taps.2021-6-2/Oa2328

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behaviour*, 24(4), 385-396. https://www.ncbi.nlm.nih.gov/pubmed/6668417

Greenwood, J. (1998). The role of reflection in single and double loop learning. *Journal of Advanced Nursing,* 27(5), 1048-1053. https://doi.org/10.1046/j.1365-2648.1998.t01-1-00579.x

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017-1054. https://doi.org/DOI 10.1111/j.1467-9620.2006.00684.x

Okuda, Y., Bryson, E.O., DeMaria. S. Jr., Jacobson, S., Quinones, J., Shen, B., & Levine, A.I. (2009). The Utility of Simulation in Medical Education: What Is the Evidence? *Mount Sinai Journal of Medicine*, 76,330-343

Şahin, G., Başak, T. (2021). Debriefing Methods in Simulation-Based Education. *Journal of Education and Research in Nursing*, 18(3), 341-346

Tagg, J. (2010). The learning-paradigm campus: from single- to double- loop learning. *New directions for teaching and learning*, 123, 51-62.

Wu, Y. F., Qi, L., Liu, Y., Hao, X. Y., & Zang, S. (2021). Development and psychometric testing of a Learning Behaviour Questionnaire among Chinese undergraduate nursing students. Bmj Open, 11(6). https://doi.org/ARTN e04371110.1136/bmjopen-2020-043711

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Testing Teaching and Learning Delivery Modes for Independence – A Chi-square Analysis through Students' Perceptions of Barriers

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Abstract

This study tests the independence of four Teaching and Learning Delivery Modes (DMs) in Higher Education: Face-to-Face. Blended, Hybrid, and Online. We collected students' perceptions of barriers to these DMs through a survey with 192 respondents and tested for independence using Pearson's Chi-square. The main result is that Hybrid and Online are perceived as one DM. Considering other academic work, we can conclude that hybrid delivery modes are superior to entirely online, as they allow students to adjust the DM based on their individual needs.

Keywords: *Delivery Modes, Chi-square, Digital Teaching, Barriers.*

1. Introduction

During the COVID-19 pandemic, traditional in-person teaching was replaced by online instruction. Emergency Response Teaching (ERT) emerged as a necessity as conventional teaching methods were abruptly substituted (Hodges et al., 2020). Before the pandemic, there had been discussions about digitizing higher education institutions (HEIs), including their teaching and learning (Ananga & Biney, 2021). Still, various obstacles hindered the widespread adoption of digital teaching and learning (Tesar & Sieber, 2010). Institutions often avoided diverse Teaching and Learning Delivery Modes (DMs) or relied on temporary solutions (Hadjimanolis, 2003). The complexities and potential solutions for instructional DMs require more systematic and focused research. It is important to note that ERT and standard online teaching differ significantly in their characteristics (Tesar & Sieber, 2010). The pandemic and its aftermath can provide valuable insights into the large-scale application of various DMs, which should be leveraged to enhance their effectiveness.

Following an explorative pre-study, this paper addresses the following research question (RQ): How are the four Teaching and Learning Delivery Modes associated when measured through their perceived barriers in the post-COVID-19 era?

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First, we will summarize the challenges and solutions in the relevant literature. Next, we will outline our survey-based research method, which focuses on barriers to instructional delivery modes. To generate the results, we will employ Pearson's Chi-square test of independence and apply it to six combinations of four delivery modes. We will then present and discuss the results, concluding with a forward-looking perspective.

Our study contributes empirical insights crucial for HEI growth. Incorporating student feedback is essential with the rise of the "student-as-consumer" approach and increasing competition. We examine differences in DMs and their barriers, helping educational managers make informed decisions beyond simple DM substitutions. According to the SAMR model (Hamilton et al., 2016), redefinition may be the best approach when contexts change. Prior pandemic-related research has explored HEI strategies (Popova et al., 2020) and case studies (Marshalsey & Sclater, 2020). As survey development has taken time, post-pandemic quantitative research on barriers remains scarce since the pandemic officially ended in May 2023 (Wise, 2023).

2. Teaching and Learning Delivery Modes

A Teaching and Learning Delivery Mode (DM) is the medium or method through which instructional content is transmitted and interactions are exchanged between learner–content, learner-learner, or learner–teacher, including face-to-face (synchronous), entirely online (asynchronous), or blended/hybrid formats (Bernard et al., 2009; Jamaluddin et al., 2023).

Educators often use the TPACK framework (Technological, Pedagogical, Content Knowledge) to explore technology integration in teaching. The goal is to combine these three elements into a course design seamlessly (Harris et al., 2010). However, ERT disrupted this integration by prioritizing technology over pedagogy. Current literature reflects on pandemic experiences and anticipates future needs, predicting a surge in digital higher education post-COVID-19. However, future developments must prioritize educational quality (Daniel, 2020; Ramola, 2021). Student feedback is crucial in determining the effectiveness of digital course designs. Teachers require training in multiple DMs to deliver high-quality education (Donitsa-Schmidt & Ramot, 2020). Additionally, the pandemic highlighted the need for health-related classes and digital mental health services (Toquero, 2020). A responsive, healing, and reflective approach is recommended for future work (Bhagat & Kim, 2020). Other studies have emphasized the importance of improved internet connectivity and socioeconomic conditions for the success of digital higher education (Pokhrel & Chhetri, 2021). During the pandemic, teachers focused on providing additional instructional resources while students sought more assignments to reinforce their learning (Mishra et al., 2020).

Research has also examined the impact of technology on academic achievement (Janson et al., 2014) and the adoption of digital systems (Irons et al., 2002). Studies advocate for blended learning course designs that consider both drivers and barriers (Scherer et al., 2019). At the

organizational level, resistance to change poses significant challenges, necessitating faculty support (Al-Senaidi et al., 2009). Resource allocation issues further complicate matters, limiting educators' access to time and technology. Curriculum adjustments are seen as essential for the successful digitization of education. External factors, such as political and economic pressures, also hinder the digital transformation of higher education, as HEIs often struggle to adapt to rapidly changing environments (Burch & Mohammed, 2019).

The pandemic and the shift to ERT altered many of the existing barriers. While online teaching became the dominant DM during ERT, other DMs, such as hybrid and blended learning, had already been used (Artino, 2010). Traditional face-to-face teaching remains the standard in-classroom DM, while online teaching represents its digital counterpart. Blended learning combines face-to-face instruction with online or self-study phases, whereas hybrid DMs simultaneously integrate face-to-face and online elements (Hwang, 2018).

3. Method

In a previous qualitative analysis, we identified barriers to digital higher education (HE) instruction (Draxler-Weber et al., 2022). Building upon this study, we developed an online survey to investigate the challenges of different DMs by using the identified overall classifications and their specific barriers. Each barrier within these classes translated into at least one survey item, culminating in 34 items across eight dimensions. The dimensions ranged from barriers concerning technical resources, interaction with peers and teachers, personal skill set, didactics and pedagogy, workload, health, personal readiness, and framework conditions.

Respondents were asked to indicate whether they encountered each barrier item in one or more specified DMs, resulting in categorical data (Agresti, 2013). Additionally, the survey included demographic questions related to age, current semester, study program, the number of different DMs experienced, and the respondent’s country of study.

The online survey was completed by 192 German, Swedish, and Turkish university students during the winter term of 2023. Among the respondents, 141 were enrolled in Bachelor’s programs, 42 were pursuing Master’s degrees, and nine did not specify their degree level. Respondents were drawn from various disciplines and semesters to ensure diverse experiences and perspectives. The largest group of respondents studied Business Administration (78), followed by Media and Management (61) and Information Systems (45). Smaller groups represented Mathematics, Project Management, Law, and Economics. As we employed a convenience sampling method with students we or our colleagues taught, the respondents were primarily from one university in Germany, one in Sweden, and one in Turkey. This gives us background knowledge about their distinct learning management systems (LMS) and conferencing tools. For instance, students at the German university used Stud.IP and

BigBlueButton, while those at the Turkish university relied on Google Classroom. In contrast, the Swedish university adopted Canvas and Zoom for its digital teaching activities.

Based on the collected data, we conducted an exploratory pre-study, identifying the barriers that differentiated face-to-face and online DMs the most. The pre-study revised ten barriers in five dimensions (Packmohr & Draxler-Weber, 2025).

To investigate the relationship between DMs in this study further, we selected one barrier from each dimension of the pre-study that exhibited the smallest difference between the face-to-face and online DMs. Selecting one barrier from each dimension minimizes potential interdependencies between the barriers. Further, we hypothesize that we will obtain more reliable results using this maximum-minimum selection method. If the differences are already substantial, a Chi-square test will naturally indicate the independence of the DMs.

Table 1 summarizes the barriers selected for analysis. The Dimension column indicates the source of the barrier from the pre-study, and the Category abbreviation column specifies the short name of the item used in this study.

Table 1. Relation between dimension – item - categories

Dimension	Item in survey	Category abbreviation
Interaction	I cannot observe teachers' nonverbal reactions	nonverbal
Workload	My overall workload for the lectures is high.	workload
Health	My participation in the lectures leads to bodily discomfort.	discomfort
Personal readiness	I am not flexible enough to participate in the teaching format.	inflexibility
Framework Conditions	I perceive my spatial learning environment as distracting for the lectures (e.g. by noises).	environment

4. Results

The Chi-square test of independence analysis is used to test if there is a significant association between two categorical variables. The Null Hypothesis (H_0) is that no association between the DMs conceptualized through six barrier categories exists.

To prepare for the Chi-square test, the contingency tables for all six possible combinations of DMs were calculated. Table 2 shows an example of the face-to-face / online combination of DMs. The value 38 in Table 1 is the highest in all contingency tables. In 38 cases, respondents indicated bodily discomfort in the face-to-face DM and the impossibility of observing the teachers' nonverbal reactions in the online DM. On average, the observed values were 9.5.

Table 2. Contingency table for the observed DM combination Face-to-Face / Online[1]

F2F / Online	nonverbal	workload	discomfort	inflexibility	environment
nonverbal	1	2	1	2	1
workload	36	24	19	7	16
discomfort	38	14	17	8	16
inflexibility	25	11	8	8	8
environment	22	9	11	5	6

After calculating the observed contingencies, we performed Pearson's Chi-square test of independence for all six DM combinations. The results are shown in Table 3. For five combinations, H_0 was not rejected, indicating no significant associations exist. Only the H_0 for the hybrid / online combination was rejected, indicating a significant association.

Table 3. Results of the conducted Chi-square tests.

	F2F	Blended	Hybrid	Online
F2F	-	$\chi2$ (16) = 7.40, p > 0.05 (H0 not rejected)	$\chi2$ (16) = 21.00, p > 0.05 (H0 not rejected)	$\chi2$ (16) = 10.34, p > 0.05 (H0 not rejected)
Blended	-	-	$\chi2$ (16) = 25.48, p > 0.05 (H0 not rejected)	$\chi2$ (16) = 16.16, p > 0.05 (H0 not rejected)
Hybrid	-	-	-	$\chi2$ (16) = 37.82, p < 0.05 (H0 rejected)
Online	-	-	-	-

5. Discussion and Conclusion

Our results indicate that hybrid and online DMs are perceived as similar. Thus, in students' perceptions, there are three independent DMs: Face-to-Face, Blended, and Hybrid-Online.

In our study, we defined hybrid DM for the respondents as synchronously in time, but students can choose to participate in physical or virtual space. In an online DM, the delivery occurs synchronously in time solely in the virtual space. Comparing participation within hybrid DM, there is higher online participation if the class is announced online, even if in-class participation is possible. Also, students tend to join in-class more if only a few participants join online (Beatty, 2007). Still, hybrid models, which incorporate face-to-face interaction, may enhance motivation and engagement more than fully online DMs (Gamage et al., 2022). Thus, a purely online DM might only apply on rare occasions to prevent the spread of diseases or include a

[1] In total, there are six contingency tables for each combination. The other five contingency tables are available upon request.

geographically dispersed audience. Still, technological and personal capability efforts are much higher than those of pure DMs (Alducin-Ochoa & Vázquez-Martínez, 2016).

For our respondents, we defined blended DM as lectures synchronously in time and space, accompanied by timely asynchronous self-study phases, often through online material. Even if blended learning combines face-to-face and online elements, it shows no associations with other DMs. Thus, it is perceived as a stand-alone DM significantly different from the others. It permits self-directed learning in combination with different modes of participation and increases student engagement (Bandara & Jayaweera, 2024).

Our method involved selecting barriers to analyze the relationships between the DMs. Another approach could provide an analysis at a dimensional level, including all the barrier items from the survey. Pearson's Chi-square calculations are critical for contingency values below five (Agresti, 2013). In this case, the tables contain some values under five. Nevertheless, the average is 9.5. Therefore, we consider the data satisfactory for using Pearson's Chi-square.

In conclusion, our results show an overlap between the hybrid and online DMs. Thus, HEIs should reconsider the categorization and deployment of their DMs. Since students perceive hybrid and online modes as closely related, curriculum developers may streamline these into a single flexible category to reduce complexity. At the same time, hybrid models should be prioritized, as they offer students the ability to choose between face-to-face and virtual participation, which can enhance engagement and motivation. Blended learning also emerges as a distinct mode, as it offers flexibility to combine synchronous interaction with asynchronous self-studies. Both DMs can enhance student-centered design in curriculum planning.

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References

Agresti, A. (2013). Categorical data analysis (3rd ed). Wiley.

Alducin-Ochoa, J. M., & Vázquez-Martínez, A. I. (2016). Hybrid Learning: An Effective Resource in University Education? International Education Studies, 9(8), 1. https://doi.org/10.5539/ies.v9n8p1

Al-Senaidi, S., Lin, L., & Poirot, J. (2009). Barriers to adopting technology for teaching and learning in Oman. Computers & Education, 53(3), 575–590. https://doi.org/10.1016/j.compedu.2009.03.015

Ananga, P., & Biney, I. K. (2021). Comparing face-to-face and online teaching and learning in higher education. MIER Journal of Educational Studies Trends & Practices, 165–179. https://doi.org/10.52634/mier/2017/v7/i2/1415

Artino, A. R. (2010). Online or face-to-face learning? Exploring the personal factors that predict students' choice of instructional format. The Internet and Higher Education, 13(4), 272–276. https://doi.org/10.1016/j.iheduc.2010.07.005

Bandara, K. M. N. T., & Jayaweera, B. P. A. (2024). Commentary on the Applications of Blended Learning in the Teaching and Learning Process – A Review. Journal of Research in Education and Pedagogy, 1(2), 83–97. https://doi.org/10.70232/jrep.v1i2.10

Beatty, B. J. (2007). Hybrid classes with flexible participation options – If you build it, how will they come? Association for Educational Communications and Technology Annual Convention, Anaheim, CA.

Bernard, R. M., Abrami, P. C., Borokhovski, E., Wade, C. A., Tamim, R. M., Surkes, M. A., & Bethel, E. C. (2009). A Meta-Analysis of Three Types of Interaction Treatments in Distance Education. Review of Educational Research, 79(3), 1243–1289. https://doi.org/10.3102/0034654309333844

Bhagat, S., & Kim, D. J. (2020). Higher Education Amidst COVID-19: Challenges and Silver Lining. Information Systems Management, 37(4), 366–371.

Burch, Z. A., & Mohammed, S. (2019). Exploring Faculty Perceptions about Classroom Technology Integration and Acceptance: A Literature Review. International Journal of Research in Education and Science, 5(2), 722–729.

Daniel, S. J. (2020). Education and the COVID-19 pandemic. PROSPECTS, 49(1–2), 91–96. https://doi.org/10.1007/s11125-020-09464-3

Donitsa-Schmidt, S., & Ramot, R. (2020). Opportunities and challenges: Teacher education in Israel in the Covid-19 pandemic. Journal of Education for Teaching, 46(4), 586–595. https://doi.org/10.1080/02607476.2020.1799708

Draxler-Weber, N., Packmohr, S., & Brink, H. (2022). Barriers to Digital Higher Education Teaching and How to Overcome Them—Lessons Learned during the COVID-19 Pandemic. Education Sciences, 12(12), 870. https://doi.org/10.3390/educsci12120870

Gamage, K. A. A., Gamage, A., & Dehideniya, S. C. P. (2022). Online and Hybrid Teaching and Learning: Enhance Effective Student Engagement and Experience. Education Sciences, 12(10), 651. https://doi.org/10.3390/educsci12100651

Hadjimanolis, A. (2003). The Barriers Approach to Innovation. In L. V. Shavinina (Ed.), The International Handbook on Innovation (pp. 559–573). Pergamon.

Hamilton, E. R., Rosenberg, J. M., & Akcaoglu, M. (2016). The Substitution Augmentation Modification Redefinition (SAMR) Model: A Critical Review and Suggestions for its Use. TechTrends, 60(5), 433–441. https://doi.org/10.1007/s11528-016-0091-y

Harris, J. B., Hofer, M. J., Schmidt, D. A., Blanchard, M. R., Young, C. Y., Grandgenett, N. F., & avn Olphen, M. (2010). "Grounded" Technology Integration: Instructional Planning Using Curriculum-Based Activity Type Taxonomies. Journal of Technology and Teacher Education, 18(4), 573–605.

Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). The Difference Between Emergency Remote Teaching and Online Learning. EDUCAUSE Review.

Hwang, A. (2018). Online and Hybrid Learning. Journal of Management Education, 42(4), 557–563. https://doi.org/10.1177/1052562918777550

Irons, L. R., Keel, R., & Bielema, C. L. (2002). Blended Learning and Learner Satisfaction: Keys to User Acceptance? USDLA Journal, 16(12), 29–39.

Jamaluddin, J., Mahali, M., Mohd Din, N., Nias Ahmad, M. A., Mohamad Fadzillah, N. S., Hashim, A. @ H., & Awang, N. (2023). The Impact of Different Instruction Modes Applied as A Result of Transition of Covid-19 Phases on Students' Performance. International Journal of Academic Research in Business and Social Sciences, 13(4), Pages 792-804. https://doi.org/10.6007/IJARBSS/v13-i4/16614

Janson, A., Söllner, M., Bitzer, P., & Leimeister, J. M. (2014). Examining the effect of different measurements of learning success in technology-mediated learning research. 35th International Conference on Information Systems (ICIS), 1–10.

Marshalsey, L., & Sclater, M. (2020). Together but Apart: Creating and Supporting Online Learning Communities in an Era of Distributed Studio Education. International Journal of Art & Design Education, 39(4), 826–840.

Mishra, L., Gupta, T., & Shree, A. (2020). Online teaching-learning in higher education during lockdown period of COVID-19 pandemic. International Journal of Educational Research Open, 1, 100012. https://doi.org/10.1016/j.ijedro.2020.100012

Packmohr, S., & Draxler-Weber, N. (2025). Students' Perceptions of Barriers in Four Teaching Formats – a Quantitative Study. In M. A. Bach Tobji, R. Jallouli, H. Sadok, K. Lajfari, D. Mafamane, & H. Mahboub (Eds.), Digital Economy. Emerging Technologies and Business Innovation (Vol. 530, pp. 154–160). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-76365-6_10

Pokhrel, S., & Chhetri, R. (2021). A Literature Review on Impact of COVID-19 Pandemic on Teaching and Learning. Higher Education for the Future, 8(1), 133–141. https://doi.org/10.1177/2347631120983481

Popova, O., Gagarina, N., & Karkh, D. (2020). Digitalization of Educational Processes in Universities: Achievements and Problems. Advances in Social Science, Education and Humanities Research, 437, 738.

Ramola, R. C. (2021). Challenges and opportunities for higher education amid COVID-19 pandemic. International Journal of Computer Engineering in Research Trends, 8(2), 29–32.

Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. Computers & Education, 128, 13–35. https://doi.org/10.1016/j.compedu.2018.09.009

Tesar, M., & Sieber, S. (2010). Managing blended learning scenarios by using agile e-learning development. 125–129.

Toquero, C. M. (2020). Challenges and Opportunities for Higher Education amid the COVID-19 Pandemic: The Philippine Context. Pedagogical Research, 5(4), em0063. https://doi.org/10.29333/pr/7947

Wise, J. (2023). Covid-19: WHO declares end of global health emergency. BMJ, p1041. https://doi.org/10.1136/bmj.p1041

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What do students use AI tools for? Assessing students' use of AI tools in three typical study related scenarios

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Abstract

In recent years, generative artificial intelligence (AI) has emerged as a powerful, but also highly controversial, tool in higher education. While there are in-depth debates about the ethics and regulation of the use of generative AI, discussions about the actual use cases for which students use AI are much more limited. This paper presents an empirical case study based on a survey (realised sample n=110; response rate: ~ 80%) at a medium-sized Austrian university. The analysis shows that about 20% will definitely use AI tools for writing term papers, about 30 to 35% will use AI for preparing exams and poster presentations. Alarmingly, in regression models, knowledge of AI had no statistically significant influence on whether students considered using AI or not - the decision is mostly influenced by one's enthusiasm for AI.

Keywords: *AI use; AI Knowledge; Technology commitment; Survey Research; Student Learning*

1. Introduction - Using AI for study purposes?

In recent years, generative artificial intelligence (AI) has emerged as a powerful but also highly controversial tool in higher education (Jahic et al. 2024). Following the launch of OpenAI's trailblazer ChatGPT, specialized offerings such as *scispace* (see: https://typeset.io) or *paperguide* (see: https://paperguide.ai) found their way online, and software engineers started to develop standalone solutions such as the Austrian solution Academic AI (see: https://www.acomarket.at/de/portfolio/projekte/academic-ai).

These software packages are currently transforming the way students learn, collaborate and produce academic work. While early applications of AI in higher education were largely focused on automated grading or adaptive learning platforms (Luckin et al., 2016), recent developments have led to more diverse and individualized applications - from AI-assisted writing tools to chatbots that provide personalized study recommendations (Zawacki-Richter et al., 2019, Jahic et al. 2024). As these technologies become more accessible, questions arise about the specific

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ways in which students incorporate AI into their academic activities, and how individual and contextual factors shape their decisions to do so. In the social sciences, where critical thinking and nuanced argumentation are often seen as central elements of degree programs, the integration of generative AI warrants particular attention.

Accordingly, the paper uses a case study from the Johannes Kepler University Linz, a medium-sized public university in Austria, to investigate whether and in which situations social science students use generative AI in their studies. Before presenting the case study in sections 3 (data and methods) and 4 (analysis), a short review of the state of the art will introduce the topic. A short conclusion concludes the paper.

2. AI in Higher Education: An Evolving Landscape?

While the discussion of AI in higher education has a longer tradition – often linked to automated assessment and adaptive tutoring systems (Gonzales-Calatayud et al., 2021) – the emergence of generative AI has substantially broadened the potential use cases of related tools (Kasneci et al., 2023). This technological shift can be considered both generational and transformative: it is not only a step generational forward in technology, but generative AI is transformative, when it comes to human-computer interaction as it is capable of offering personalized feedback, language support, and structured advice on complex tasks such as coding and programming, even for users with minimal training (Prandner et al., 2025). At the same time, however, higher education institutions and individual educators remain concerned about issues of academic integrity, plagiarism, transparency, and the possible erosion of critical thinking skills (Dabis & Csaki, 2024; Sharples, 2023).

Accordingly, a key theme in current research involves understanding if and how students incorporate AI tools into their day-to-day academic routines. Recent literature suggests that assessment-related tasks strongly motivate students to experiment with AI tools. For instance, AI-based writing assistants (e.g., Grammarly, DeepL, or ChatGPT) are commonly used to refine papers, minimize spelling and grammatical errors, and enhance the coherence of arguments (Polakova & Klimova, 2023). Nevertheless, ongoing debates highlight the previously mentioned ethical considerations when using AI for writing-related assignments. In addition, various platforms (e.g., SlidesAI, Beautiful.ai) allow students to generate presentation slides, infographics, and summaries of complex data. While these applications can save significant time, educators emphasize that students must also cultivate creative and analytical competencies to effectively design content on their own (OECD, 2021).

Beyond writing and presentation tasks, an emerging line of inquiry focuses on the role of chatbots in exam-related activities. Potential uses include self-testing, summarizing course materials, and offering quick explanations of difficult concepts (Xia et al., 2024; Kasneci et al., 2023). Yet critics argue that relying on chatbots for such purposes may undermine deeper

conceptual understanding (Larson et al., 2024). Although these examples represent some of the most prominent use cases for AI, there is still limited information regarding the extent to which students engage with these technologies across different disciplines and educational contexts.

When it comes to general digital engagement and technology skills, multiple studies indicate that students with higher levels of digital competency also display stronger technology acceptance and are thus more likely to incorporate AI tools into academic tasks (Zawacki-Richter et al., 2019). Conversely, recent papers underscore those uncertainties around plagiarism, data privacy, or algorithmic biases may deter students from using generative AI (Kasneci et al., 2023). Although no conclusive data show that specific fields—such as the social sciences—are inherently more cautious about adopting AI, it is reasonable to assume a heightened awareness in such areas due to their strong emphasis on the critical evaluation of sources and arguments. Indeed, social science curricula often encourage students to examine the socio-technological implications of emerging technologies—such as biases in AI training data or ethical concerns surrounding automated decision-making—thereby fostering a more cautious stance toward AI overall (Author A, 2025).

3. Data and Methods

As the previous two sections illustrate, the use of AI in academic learning environments is a rather complex issue: while there are many potential use scenarios, studies of actual use are still rare. Even rarer are those that attempt to identify which students are using which techniques, as the fluid situation regarding ethics, policies, and expectations makes this difficult to cover. Therefore, the collaborative project "ChatGPT in university settings" (PI: Daniela Wetzelhütter - University of Applied Sciences Upper Austria; Dimitri Prandner - Johannes Kepler University Linz; Thomas Schöftner - Private Pedagogical College of the Diocese of Linz) aims to find out who among students of social sciences uses AI and what they use it for. Based on the information presented in the previous section, an empirical study was conducted at the Johannes Kepler University in December 2024, using introductory methods courses for social science students in bachelor and master programs to recruit participants. The study was conducted in the form of a quantitative online survey, hosted by a GDPR-compliant German hosting provider. Students were asked to complete a questionnaire on AI use, digital literacy, and methods. While 160 students were enrolled in the relevant courses, mid-semester attrition (people dropping out of courses or their studies altogether) resulted in a brute sample of 138 students. Of these, 101 were from undergraduate programs and 37 were from graduate programs. Of these, the overall response rate was quite high (80%), with 110 people participating.

Table 1. Independent variables used during analysis

	Dimension	**Variable / Question**	**Original scales & Range**	**Mean (Median) or Percentage**
	AI-Knowledge test	Thinking about […], which of the following uses artificial intelligence (AI)? (n=102)	4 response options for all six domains, 1 correct, random item order. 0 to 6 correct answers	2.67 (3)
Technology Commitment	Technology Competence | Negative (Extracted Variance: 40.9%; Cronbach's Alpha: 0.848)	"For me, dealing with technical innovations is usually overwhelming." (n=110)	Strongly agree (1) to strongly disagree (5) *(inversely coded)*	3.75 (4.00)
		"I find dealing with new technology difficult — most of the time I just can't do it." (n=110)	Strongly agree (1) to strongly disagree (5) *(inversely coded)*	4.16 (4.00)
	Technology acceptance (Extracted Variance: 20.9%; Cronbach's Alpha: 0.743)	"I'm very curious about new technological developments." (n=110)	Strongly disagree (1) to strongly agree (5)	3.62 (4.00)
		"I quickly take a liking to new technological developments." (n=110)	Strongly disagree (1) to strongly agree (5)	3.35 (3.00)
	Technology control conviction (Extracted Variance: 17.4%; Cronbach's Alpha: 0.487)	"It's up to me whether I succeed in using new technological developments — chance or luck have little to do with it." (n=104)	Strongly disagree (1) to strongly agree (5)	3.63 (4.00)
		"When I have difficulties with technology, ultimately it depends solely on me to resolve them." (n=104)	Strongly disagree (1) to strongly agree (5)	3.06 (3.00)
	Engagement with AI	"How much have you already engaged with AI (e.g., by reading about it or hearing about it)?" (n=103)	"Engaged with it" (1) "nevere engaged" (0)	93.2% engaged
	Enthusiasm regarding AI	"Would you generally say that the increasing use of Artificial Intelligence (AI) in everyday life makes you feel enthusiastic?" (n=102)	"Enthusiastic" (1) "Not enthusiastic" (0)	29.4% enthusiastic

The key variables of interest are the measures of whether people plan to use AI-based tools for upcoming term papers, poster presentations, or for preparation. The ordinal response scale ranged from 1 - definitely to 3 - definitely not. The descriptive results and the logistic regression on these variables can be found in the next section. To control the results, a 6-item knowledge test on the use of AI in everyday life previously used by PEW Research and developed by Kennedy et al. (2023), two self-report items on AI engagement and enthusiasm (originally 4-step ordinal items, dichotomized for analysis), and six items from Neyer et al.'s (2016) technology commitment scale. These six items were used to construct three factor variables via principal component extraction. These variables express technology competence, technology acceptance, as well as technology control belief, as suggested by Neyer et al. (2016). While the Cronbach alpha threshold of 0.7 cannot be reached for the technology control conviction dimension, it was decided to use the factor, as the solution was consistent with the theoretical model. Additionally, age (mean: 22, st.dev.: 4.5; n=94) and gender (71% female; n=91) were controlled for. Concerning tool transparency it can be stated that all calculations were conducted with SPSS V29 from IBM, while DeepL was used for spellchecking the paper.

4. Results

When it comes to using AI for academic activities, the results show that overall, students are mostly unsure if they want to use AI tools. However, when it comes to preparing for exams and creating a poster for a presentation, around a third of students said they would definitely use AI support in the future. When it comes to writing a term paper, only 22% - just over a fifth of students - said they would definitely use AI. This reflects the nature of the work involved in academic activities: While there has been controversy about the ethics of using AI for writing,

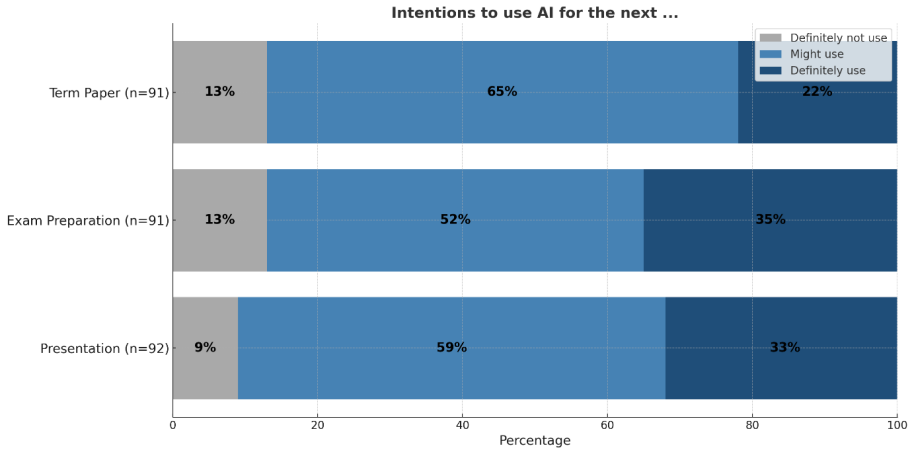


Figure 1 – AI use intention by surveyed students (own graphic)

Table 2. Logistic Regression models:
Dependent Variables: Student will definitely use AI to for the next … (Ref: Might/Definitely not);
Values stated are Exp(B), sig: * p<0.1; ** p<0.05, *** p<0.001 [Adjusted for small sample size]

Dependent variable:	**Term Paper (n=88)**	**Presentation (n=88)**	**Exam Preparation (n=87)**
	Exp(B)	**Exp(B)**	**Exp(B)**
AI-Knowledge test (score – ascending)	1.32	1.19	1.16
Technology Competence | Negative	0.68	0.85	0.87
Technology acceptance	2.24*	1.47	0.93
Technology control conviction	1.25	1.00	0.98
Engagement with AI (Ref = never)	0.28	0.53	0.81
Enthusiasm regarding AI (Ref = not enthusiastic)	4.28**	4.93***	3.65**
Sex (Ref= Female)	0.48	1.94	1.63
Age (in years	1.01	1.00	0.96
Model Quality:			
Nagelkerke's R^2	***0.31***	***0.18***	***0.11***
Model Sig.	***0.012***	***0.140***	***0.52***

with some universities deciding to reduce the role of writing in their curricula, other forms of AI use in academic contexts, such as exam preparation, have a longer tradition and are rarely mentioned in current debates.

Turning to the logistic regression models, several interesting facts emerge. First, the term paper model is the only one of the proposed models that is significant at the model level ($p<0.05$), while also explaining about 32% of the variance when it comes to identifying those who want to use AI. Statistically significant effects suggest that technology acceptance and enthusiasm for AI play a key role in the decision to use AI. As expected, the odds ratio of 4.28 shows that enthusiasm for AI is a strong predictor, as people who are enthusiastic about AI are more than four times as likely to say they want to use AI tools for their next term paper than those who are not. Technology acceptance has an odds ratio of 2.24. The other two models are not statistically significant, but enthusiasm for AI is still a significant influence for both models, which opens the space for further discussion about what potential measures and models need to be considered in future research to satisfactorily explain students' use of AI. It seems to be mostly related to the fact that attitudes towards technology shape the openness to try AI-based tools.

5. Conclusion

The empirical case study presented in this paper provides valuable insights into students' use of AI for academic purposes. First, only a minority of students indicate that they would not consider using AI in future work. Second, the data suggests that the use of AI is perceived as

more problematic when it comes to applications related to text production. This is consistent with the prevailing public debate about the role of AI in academic integrity and authorship. In contrast, the other two tasks examined (creating a presentation and preparing for an exam) in the context of AI use seem to be more widely accepted by students. Overall, this means that AI is here to stay in learning and teaching and will be used by students, and that adaptation is needed on both sides - educators and learners.

This is consistent with recent arguments by Larson et al. (2024) and even before the advent of generative AI by Luckin et al. (2016). From an interpretive perspective, the results presented from the multivariate logistic regression models are particularly relevant given the existing knowledge of past technological breakthroughs and their impact on learning and teaching. Traditional models of technology adoption, such as the Technology Commitment Scale, do not appear to influence students' use of AI at the expected intensity. Instead, the model suggests that AI adoption is mostly driven by enthusiasm rather than informed knowledge of the technology. This poses a potential risk, as students may integrate AI into their academic work regardless of their level of understanding of its implications. As a result, there is a need to further discuss the role of education and training in digital competencies (Grünangerl & Prandner, 2024). However, this study has some limitations that should be addressed in future research. First, the findings are based on a single case study at one university with a limited number of participants, which limits generalizability. Second, the survey questions focused on future intentions rather than actual behavior, which may not accurately reflect real-world AI usage patterns. Future research should use more direct data collection methods, such as soliciting data donations from students, to capture actual AI usage behaviors rather than relying solely on self-reported intentions. Nevertheless, the central conclusion remains that student AI use is currently characterized by uncertainty, making it difficult to identify clear predictors and associated usage patterns.

References:

Dabis, A., & Csáki, C. (2024). AI and ethics: Investigating the first policy responses of higher education institutions to the challenge of generative AI. *Humanities and Social Sciences Communications, 11*(1), 1–13. https://doi.org/10.1057/s41599-024-03526-z

González-Calatayud, V., Prendes-Espinosa, P., & Roig-Vila, R. (2021). Artificial Intelligence for Student Assessment: A Systematic Review. *Applied Sciences*, *11*(12), 5467. https://doi.org/10.3390/app11125467

Gruenangerl, M.; Prandner, D. 2024. The contribution of digital technology training to the digital competency gap. A case study from Austria. In*: 10th International Conference on Higher Education Advances (HEAd'24) (pp. 597-604)*. https://doi.org/10.4995/HEAd24.2024.17322

Jahić, I., Ebner, M., Schön, S., & Edelsbrunner, S. (2024). Exploring the use of generative AI in education: Broadening the scope. In: *International Conference on Human-Computer Interaction* (pp. 283–304). Springer Nature Switzerland.

Kasneci, E., Seßler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., & Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, 103, 102274.

Kennedy, B., Tyson, A., & Saks, E. (2023). *Public Awareness of Artificial Intelligence in Everyday Activities (Wave 119)*. Pew Research Center. https://www.pewresearch.org/ science/wp- content/uploads/sites/16/2023/02/PS_2023.02.15_AI-awareness_REPORT.pdf

Larson, B. Z., Moser, C., Caza, A., Muehlfeld, K., & Colombo, L. A. (2024). Critical thinking in the age of generative AI. *Academy of Management Learning & Education*, *23*(3), 373-378.

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence unleashed: An argument for AI in education.* Pearson. https://static.googleusercontent.com/media/edu.google.com/en//pdfs/Intelligence-Unleashed-Publication.pdf

Neyer, F. J., Felber, J., & Gebhardt, C. (2016). Kurzskala Technikbereitschaft (TB, technology commitment). *Zusammenstellung sozialwissenschaftlicher Items und Skalen (ZIS)*. https://doi.org/10.6102/ZIS244

OECD (2021), *OECD Digital Education Outlook 2021: Pushing the Frontiers with Artificial Intelligence, Blockchain and Robots*, OECD Publishing. https://doi.org/10.1787/589b283f-en.

Polakova, P., & Klimova, B. (2023). Using DeepL translator in learning English as an applied foreign language–An empirical pilot study. *Heliyon*, *9*(8). https://doi.org/10.1016/j.heliyon.2023.e18595

Sharples, M. (2023). Towards social generative AI for education: theory, practices and ethics. *Learning: Research and Practice*, *9*(2), 159-167.

Prandner D, Wetzelhütter D and Hese S (2025) ChatGPT as a data analyst: an exploratory study on AI-supported quantitative data analysis in empirical research. Front. Educ. 9:1417900. doi: 10.3389/feduc.2024.1417900

Xia, L. A., Sun, O. Y., & Reis, C. (2024). Hearing Students' Voices: Access, Use Patterns and Attitudes toward Generative AI Technologies among Chinese Students. *ChatGPT and Global Higher Education: Using Artificial Intelligence in Teaching and Learning* (pp. 122 – 134). StarScholars.

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – Where are the educators? *International Journal of Educational Technology in Higher Education, 16*, 39. https://doi.org/10.1186/s41239-019-0171-0

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Envisioning and Co-designing the Future of STE(A)M Education and Research in Europe

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Abstract

While STEM graduates are on high demand, the interest of students to uptake STEM education is not matching industry need, creating a growing gap of experts. Enriching STEM with the Arts, creativity and interdisciplinary approaches (STEAM) seems a promising avenue. This research, part of an EU-funded project to develop policies and recommendations for STE(A)M research in the Horizon Europe funding program, is based on a foresight methodology conducted through twelve workshops with a broad range of stakeholders. Results provide evidence of current and future trends and needs in the context of higher education, including career design support and exploration along the learning continuum, more collaborations with industry and civic organization for a systemic change toward challenge-based education, potentially facilitated by AI, hybrid and blended learning, and the need to offer and test a variety of interdisciplinary learning opportunities to accommodate learners' diversity.

Keywords: *STEM; policies; participatory approach; foresight; inclusivity; research.*

1. Introduction

The demand for graduates in Science, Technology, Engineering, and Mathematics (STEM) disciplines within Europe has become a focal point of policy discussions, given its implications for economic growth, innovation, and competitiveness (Widya, Rifandi & Rahmi, 2019).

A 2024 report from the European Commission's Joint Research Centre (Mazzeo Ortolani, Pokropek, Karpinksi & Biagi, 2024; EC, 22 Jan 2025) emphasized that many students across the EU fail to achieve minimum proficiency levels in key Science, Technology, Engineering, and Mathematics (STEM) areas, particularly mathematics and science. The report also highlighted a shortage of qualified mathematics and science teachers at all educational stages, underscoring the need for enhanced policy efforts and research to address these challenges (Mazzeo Ortolani, Pokropek, Karpinksi & Biagi, 2024), as well as regional differences within the EU. The same report highlights that "Integrated STEM and STEAM (adding arts)

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approaches are becoming more common, focusing on developing skills such as creativity and problem-solving. Although integrated STEAM approaches are appealing and theoretically sound, they are defined and applied inconsistently. This complicates curriculum design, evaluation, and scientific studies." (EC, 22 Jan 2025). The report concludes with a call for more research on the topic.

With this research, we aim to start answering this call to action for more research on STE(A)M, specifically focusing on understanding the future needs of STEM and STEAM for the next 10 years, with a 2035-time horizon. This work is part of the EU-funded project Road-STEAMer (No. 101058405) aiming at developing recommendations for policies and in Horizon Europe fundings for increasing the relevance and uptake of STEAM in secondary and tertiary education. The methodology adopted to investigate the needs for STE(A)M education in Europe, is foresight, conducting workshops with a variety of relevant stakeholders including students, lecturers, industry players, policymakers, subjects with disabilities and from vulnerable groups. Specifically, the technology roadmapping (Phaal, R., & Muller, G., 2009) technique, already deployed for policy making (Yasunaga, Watanabe & Korenaga, 2009; Ahlqvist, Valovirta & Loikkanen, 2012) is adapted for the context of STEM policy making and enriched with the methodology of massive codesign (Meroni, Rossi & Selloni, 2018), with visually pre-filled canvases (Comi & Whyte, 2018). Twelve workshops have been conducted, and the results aggregated to derive emerging themes. Such results have implications for theory and practice. In terms of policies, insights from the workshops can provide valuable input for shaping EU, national and international policy recommendations. Implications for research include directions for future studies to systematically test a variety of STE(A)M and interdisciplinary and transdisciplinary STE(A)M learning options to support diverse learning preferences, for example with randomized experiments (Banerjee & Duflo, 2009). For teaching and learning practice, the insights derived from the foresight workshops provide tertiary education and program managers with suggestions for enhancing STEM programs and subjects to become more interdisciplinary, challenge-based and skills-focused, arts-enriched, as well as future-proofing programs by embedding AI tools, topics and technologies, in particular for tailoring learning programs to a variety of learners' needs.

2. The context of STEM and STEAM education research

The STEM acronym refers to Science, Technology, Engineering, and Mathematics education and has, in the last decades, developed to indicate an interdisciplinary approach that integrates the four disciplines to foster critical thinking, problem-solving, and innovation among students (Martín-Páez, Aguilera, Perales-Palacios & Vílchez-González, 2019; Tytler, 2020). In more recent years, the inclusion of the Arts and creativity has led to the evolution of STEM into STEAM, emphasizing arts, creativity and design alongside technical subjects to enable learners to address complex interdisciplinary real-world challenges. Even within the field of STEM,

multiple interpretations exist of what constitutes STEM education, not always involve the integrated presence of all four disciplines (Martín-Páez et al., 2019) underscoring the need for a clearer and more consistent definition of STEM education in academic literature. Core to the STEM academic discourse is the attention to the gender gap and female participation in STEM education and careers (Tandrayen-Ragoobur & Gokulsing, 2022). Aguilera and Ortiz-Revilla (2021) conducted a systematic literature review to compare STEM and STEAM education in relation to student creativity. Their analysis revealed that both STEM and STEAM approaches, tend to foster higher levels of creativity among students. Tytler (2020) outlines the issue of the STEM acronym in diverse languages and contexts (including STEAM). He argued that traditional siloed disciplinary teaching is insufficient for preparing students to tackle contemporary challenges, proposing instead, educational strategies that emphasize not only knowledge but also skills (aligned for example with the OECD Learning Framework 2030; OECD, 2018), attitudes and values. The progression from STEM to STEAM education is conceptualized by Razi and Zhou (2022), by discussing the potential for further integrating disciplines such as humanities and social sciences, and thus proposing a more holistic educational framework. This expanded approach aims to address complex societal issues by fostering interdisciplinary collaboration. The authors argued that such an inclusive model could better prepare students for the multifaceted challenges of the future equipping them with a relevant skill set. Empirical evidence seems still lacking. In recent years, the application and investigation of Artificial Intelligence (AI) is brining an unprecedented change in the field of education, in particular STEM education (Xu, & Ouyang, 2022), that is not yet fully understood.

From a more theoretical perspective, Yeomans et al. (2025) conducted a literature review on STEAM research to derive a classification of theories deployed in the field, identifying 26 frameworks and clustering them into four approaches: ‘experiential real-world interactions’, ‘human psychological and cognitive’, ‘social, spatial, and material interconnectivity’, and ‘cultural and equity’. For the emergent STEAM education field to move forward, a critical evaluation of STE(A)M research assumptions is necessary. The present study, building on extant research, aims to contribute to the advancement of the discipline by empirically investigating stakeholders’ current and future needs and challenges of STEM secondary and tertiary education, with a 10-year time frame. Specifically, this study aims to answer to the following research question: “What are the priorities, needs and challenges of stakeholders for STEAM education research policies in the next 10 years?”

3. STE(A)M Education Foresight

3.1. Methodology and Sample

With the aim to contribute to STE(A)M literature and educational practices, the technology roadmapping (Phaal & Muller, 2009) methodology is adapted to STEAM research policies. This

widely utilized technique has already been successfully applied to policy making (Yasunaga, Watanabe & Korenaga, 2009; Ahlqvist, Valovirta & Loikkanen, 2012). The original technology roadmapping canvas, with a 10-year time horizon, is adapted to the research questions by including dedicated areas for: policies in Education (sub-classification: National, Eu and Extra-EU), research, EU funding programs, education (sub-classification: primary, secondary, tertiary and informal), and subtopics of the geopolitical context (grand challenges as defined by the European Commission, and STEM, arts, humanities, social sciences).

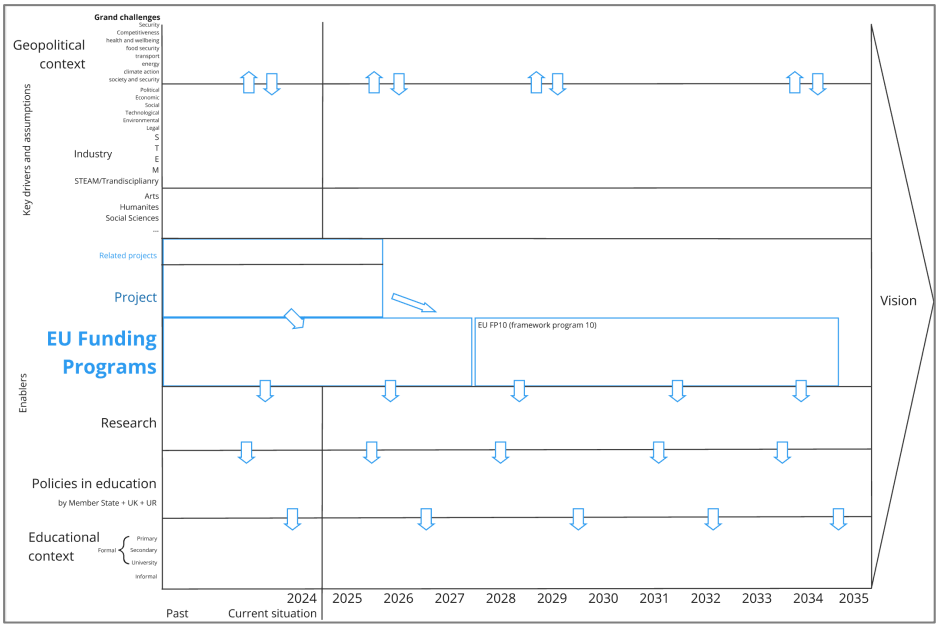


Figure 1. The canvas utilized for foresight workshops

For this research, the classic roadmapping synchronous methodology is extended to deploy an asynchronous massive codesign approach (Meroni, Rossi & Selloni, 2018): a series of twelve workshop have been conducted with a diverse range of stakeholders: university students, university lecturers, program managers, entrepreneurs, students with disabilities and from vulnerable groups, non-formal education, a governmental organization, researchers and policymakers. The total sample is composed of 59 subjects from over 15 countries conducted from May 2024 to January 2025. The workshops have been conducted sequentially, progressively pre-filling the canvas to provide support for visual thinking (Comi & Whyte, 2018). The detailed methodology is described in (Bresciani, Jiang and Rizzo, 2025). All contributions are captured by the participants or by the facilitator as sticky notes on the canvas and tagged according to the type of the stakeholder. Input from all workshops are overlayed on a single board and semantically aggregated. Emerging themes are identified and outlined in the next section. For more details see https://www.road-steamer.eu/ (D5.1 and D5.2).

3.2. Results

3.2.1. Meta level: naming STE(A)M

The issue of the naming and definition has emerged strongly, with subjects of different nationalities not being familiar with "STEAM" and sometimes not even with "STEM". When familiar with the acronyms, the understanding was mostly narrowly perceived to an aggregation of four technical/scientific discipline, not understanding what the "arts" could provide and being reluctant to such topics.

3.2.2. Coherent STEAM education policies and strategies at EU and national level

Stakeholders identify as a major challenge the variety of definitions of STEM/STEAM and advice having a transnational definition of STE(A)M education at EU level. It is recommended that the EU suggest Member States to adopt the unified policy and strategy at national level.

3.2.3. Making an economic case for STEAM education

To support the EU and nations in defining and adopting a unified STE(A)M education strategy, it is suggested to develop studies to make an economic case for STEAM and interdisciplinary education to replace or heavily revise traditional national education paradigms: interdisciplinary competence- or skills-based (rather than knowledge-based) education, focused on real word challenges, could provide several economic benefits to nations and to individuals, off-setting the cost of the necessary systemic changes of the educational system required for implementation. Research should test (i.e., with experimental trials) a variety of STE(A)M and transdisciplinary (existing or new) learning paradigms to achieve systemic change (not just teaching practices) and evaluate which paradigm is most effective for which type of learner, including students with disabilities or belonging to vulnerable groups (and intersectionality).

3.2.4. Systemic change of the educational system and assessment: AI and inclusivity

The next decade (2025-2035) is expected to exacerbate the current disconnect between the knowledge-focused siloed school system and the skills needed to address societal challenges (i.e., sustainability, competitiveness and security), industry needs (i.e., of technologically literate but also socially competent workforce) and personal development (i.e., the mental health emergency and continuous learning). A systemic reform of the educational field seems needed, allowing flexibility in the national curricula and for tertiary education lecturers to work together across disciplinary domains and degrees, on cross-disciplinary projects. According to respondents, in the era of AI – after having ensured a strong basis of basic reading, writing and mathematics - education should focus on developing skills (such as critical thinking, computational thinking, communication, collaboration, etc.) rather than knowledge. Assessment must change accordingly. Artificial Intelligence does not only affect the type of knowledge and abilities needed by the future workforce, but provides the opportunity for a fundamental

innovation in the educational sector, providing the opportunity for personalized learning that humans have never experienced in history. As traditional class teaching and even tutoring and corrections of assignment can be delegated to AI, lecturers have to be re-trained to harness the possibilities of AI in education, providing value to learners by focusing on tasks that AI cannot perform. Future research should experiment and test the effectiveness of novel teaching approaches that include skills and support career exploration. More research is needed to optimize the use of AI for the different educational level, and understand how technology can provide more flexible and inclusive education opportunities for vulnerable groups and learners with diverse abilities, such as through online, blended and hybrid learning.

3.2.5. Multi-stakeholder collaborations through open-schooling

Participants highlighted the need for the educational system at all levels to better ground teaching to societal and industry needs thought collaborations with profit, civic and governmental organizations, such as with the open school approach and participation in living labs, sharing or sponsoring spaces and equipment, or by offering joint diplomas and degrees (i.e., companies with credited secondary education institutes and universities).

3.2.6. Develop and test STEAM and transdisciplinary learning material

Teachers, lecturers and program managers highlighted the need to develop and test the pedagogical efficacy of STE(A)M and interdisciplinary learning material that is based on real-life challenges and skills development, and related to a range of careers exploration (in collaboration with external stakeholders including companies and governmental organizations). Such material should be available in national languages and systematized in a one-stop-shop digital space where lecturers can easily find materials, share and have peer-to-peer support.

3.2.7. Life and career design along the learning continuum

The choice of pursuing secondary or tertiary education in a STEAM discipline -or not- seems not to be based on students' solid and realistic understanding of the actual lived experience and career implications. A promising research avenue can be established in life design, investigating how to support learners along the learning continuum, from primary school to retirement, to understand concretely what it entails to take a STEAM-related course of studies and career. Longitudinal studies could to develop and test life and career design support (i.e., structured activities between secondary and tertiary education, or teachers/university lecturers training on career design support to students).

4. Implications for theory, practice and policies

The empirical research conducted with a variety of stakeholders supported by a roadmapping canvas, provides some preliminary results to the research question, aimed at investigating the

priorities, needs and challenges of stakeholder for STEAM education research policies in the next 10 years, in the European context. At policy level, topics emerged from the codesign activities provide directions to EU funding schemes and policies, as well as to national policy makers. In terms of higher education research, and specifically for STE(A)M, results outline some discrepancy between the literature and stakeholders' priorities, that provide valuable input for a range of future research topics. Such potentially uncovered research areas include the development and systemic testing of a variety of interdisciplinary learning paradigms and their effectiveness for diverse types of learners, with a particular focus to intersectionality, disability and the role of AI in providing customized learning experience, specifically testing online, hybrid and blended learning for a radical systemic change of Europe's education. Stakeholders unanimously agree on the need to focus on competence and skills rather than knowledge, demanding a reform of current educational and assessment. Another promising avenue for research is life and career design, exploring effective modalities to support career choice.

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References

Aguilera, D., & Ortiz-Revilla, J. (2021). STEM vs. STEAM education and student creativity: A systematic literature review. *Education Sciences*, *11*(7), 331.

Ahlqvist, T., Valovirta, V., & Loikkanen, T. (2012). Innovation policy roadmapping as a systemic instrument for forward-looking policy design. Science and Public Policy, 39(2), 178–190. https://doi.org/10.1093/scipol/scs016

Banerjee, A. V., & Duflo, E. (2009). The experimental approach to development economics. Annu. Rev. Econ., 1(1), 151-178.

Bresciani, S., Jiang Y. & Rizzo, F. (2025). Co-Designing STEAM Education Future Research and Policies: A Progressively Pre-Filled Technology Roadmapping Technique. Futures Conference 2025: Futures of Technologies – Mutual Shaping of Socio-Technical Transformations, 10-12 June 2025, Turku, Finland.

Comi, A., & Whyte, J. (2018). Future making and visual artefacts: An ethnographic study of a design project. Organization studies, 39(8), 1055-1083.

EC, 22 Jan 2025 STEM education: report highlights need for more policy efforts and research. https://education.ec.europa.eu/news/stem-education-report-highlights-need-for-more-policy-efforts-and-research?utm Last accessed Feb 7th 2025.

Martín-Páez, T., Aguilera, D., Perales-Palacios, F. J., & Vílchez-González, J. M. (2019). What are we talking about when we talk about STEM education? A review of literature. Science Education, 103(4), 799-822.

Mazzeo Ortolani, G., Pokropek, A., Karpinksi, Z., & Biagi, F. (2024). STEM competencies, challenges, and measurements: A literature review. Joint Research Center, ISBN 978-92-68-20938-7, 10.2760/9390011

Meroni, A., Rossi, M., & Selloni, D. (2018). Massive Codesign: A Proposal for a Collaborative Design Framework. Franco Angeli.

OECD (2018). The future of education and skills: Education 2030. Paris: OECD.

Phaal, R., & Muller, G. (2009). An architectural framework for roadmapping: Towards visual strategy. Technological Forecasting and Social Change, 76(1), 39–49. https://doi.org/10.1016/j.techfore.2008.03.018

Razi, A., & Zhou, G. (2022). STEM, iSTEM, and STEAM: What is next?. International Journal of Technology in Education, 5(1), 1.

Tandrayen-Ragoobur, V., & Gokulsing, D. (2022). Gender gap in STEM education and career choices: what matters?. *Journal of Applied Research in Higher Education*, *14*(3), 1021-1040.

Tytler, R. (2020). STEM education for the twenty-first century. Integrated approaches to STEM education: An international perspective, 21-43.

Widya, Rifandi, R., & Rahmi, Y. L. (2019, October). STEM education to fulfil the 21st century demand: a literature review. In Journal of Physics: Conference Series (Vol. 1317, No. 1, p. 012208). IOP Publishing.

Xu, W., & Ouyang, F. (2022). The application of AI technologies in STEM education: a systematic review from 2011 to 2021. *International Journal of STEM Education*, *9*(1), 59.

Yasunaga, Y., Watanabe, M., & Korenaga, M. (2009). Application of technology roadmaps to governmental innovation policy for promoting technology convergence. Technological Forecasting and Social Change, 76(1), 61–79.

Yeomans, L., Chappell, K., Hetherington, L., Bresciani, S., Unterfrauner, E., Fabian, C. M., & Koulouris, P. (2025). Practice or Praxis? A Theoretical Classification System for STEAM Education. Education Sciences, 15(2), 164. https://doi.org/10.3390/educsci15020164.

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The role of cinema in legal education: an exploratory study on pedagogical impact and empirical findings in labour law teaching

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Abstract

This study examines the use of cinema as a pedagogical tool in legal education, specifically in the teaching of labour law. This study reflects on cinema as a pedagogical practice in higher education and, in particular, its application to the teaching of labour law. It seeks to include empirical results and assess the value of film narratives in grasping content and developing critical thinking. A survey was carried out among law students, seeking to identify the strengths and limitations of this pedagogical practice. The results show that cinema has a strong potential to foster student commitment and knowledge retention. The study concludes with some recommendations to speed up the integration of cinema as a pedagogical practice in legal curricula.

Keywords: *Cinema; legal education; labour law; pedagogical methodology; empirical study.*

1. Introduction

Traditionally, legal teaching uses methodologies based on theoretical presentations, analysing court decisions and doctrinal studies (Cownie, 2010). However, current pedagogical approaches encourage more participatory and interdisciplinary teaching and learning methodologies in order to improve students' understanding and critical capacity. Film, as a visual product with a narrative, can be seen as a pedagogical tool that enables a teaching methodology that is contextualised and, at the same time, focused on understanding legal principles (Denvir, 1996).

This study aims to expand on the conclusions already presented in the article 'Cinema as a Pedagogical Practice in Higher Education: A Case Study Applied to Labour Law' (Pinto & Machado, 2024), in which a preliminary presentation of the discussion on the role of cinema in legal education was made.

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This article, rather than reviewing the literature, seeks to incorporate empirical evidence as a result of a survey among students who took part in the activity proposed in the labour law subject. The aim of the study is to evaluate the use of cinema as a pedagogical practice and the consequent impact on the understanding of the content and the development of the students' critical spirit. This paper examines the use of cinema as a pedagogical tool in legal education, specifically in the teaching of labour law. It builds on the description of a pedagogical practice in higher education by incorporating the final empirical results of an audience of law students at the University of Santiago, Cape Verde.

2. Literature Review

Cinema has been recognised as a possible teaching tool in various areas, including law. Several studies have argued that some films can be used as a tool to explain legal concepts and expose ethical dilemmas that are very close to reality (Eddy & Bracken, 2008). In fact, legal education has already used cinema to encourage debate around legal ethics and access to justice (Greenfield, Osborn & Robson, 2001), as well as to present issues related to the social impact of court decisions (Russell, 2009). With specific regard to labour law, we can find a wide selection of films that portray labour struggles and the imbalance of power between workers and employers (Grubba, 2020). Some of the more classic films, such as Modern Times (1936) and I, Daniel Blake (2017), allow students to reflect on and discuss the evolution of work organisation, workers' struggles and their social impact (Lacerda, 2007). However, there are still some challenges in using cinema as a pedagogical practice, especially in terms of interpreting the narrative, which is always subjective, and also some prejudices that can bias discussions (Pinho & Demartini, 2013). Discussions should always be moderated by the teacher and further reading can be suggested to ensure that the film complements the legal content of the labour law subject.

3. Pedagogical Practice Background

3.1. Objectives

The use of this pedagogical practice has two general objectives: (1) To provide a reflection on the evolution of labour law; (2) To raise awareness of the reality of labour relations.

And there are two specific objectives: (1) To use cinema as a teaching tool; (2) To discuss film narrative and its different components.

3.2. Pedagogical contribution

It is essential to provide students with a critical view of the world of work, both for their training as citizens and for their legal training. Watching and analysing films is essential for training

more complete professionals who can contribute to the consolidation of the Cape Verdean legal system. It is a unique opportunity to develop their critical awareness.

Before screening the film, instructors provide students with relevant background information on labour law principles and historical context. This contextualization primes students to analyze the legal issues depicted in the film critically.

Following the screening, facilitated discussions are conducted to explore the legal implications of the narrative. Students are encouraged to identify legal concepts, analyze their application within the film, and engage in reflective dialogue.

The cinema can promote the exercise of freedom of thought, opinion and awareness of the role that everyone has to play in their social environment (Pinho & Demartini, 2013).

3.3. Target Audience

The pedagogical practice was applied to an audience with the following characteristics: (1) Law degree students; (2) University of Santiago, Cape Verde; (3) Distance learning system.

3.4. Themes

The themes related to labour law that we intend to address are as follows: Labour and the Industrial Revolution; Labour and Modernity; Labour and the labour movement; Labour and subjectivity; Labour and unemployment; Labour and globalization; Domestic labour; Oppression and gender; Harassment and psychological violence.

3.5. Movies

As law and and justice are important themes in film (Denvir,1996). In that context, the movies suggested to students are: Germinal (Germinal), Claude Berri, 1993; I compagni (The organizer), Mario Monicelli, 1963; Daens (Daens), Stijn Coninx, 1992; Tempos Modernos (Modern Times), Charles Chaplin, 1935; La Classe Operaia va in Paradiso (The Working Class Goes to Heaven), Elio Petri, 1972; Eles não usam Black Tie (They Don't Wear Black Tie), Leon Hirszman, 1981; El método (The Method), Marcelo Piñeyro, 2005; Le Couperet (The Ax), Costa-Gavras, 2004; I, Daniel Blake, Ken Loach, 2017; Los Lunes al sol (Mondays in the sun), Fernando Aranoa, 2002; Domésticas - (Maids), Fernando Meirelles, Nando Olival, 2001; Dogville, Lars von Trier, 2003; O Diabo Veste Prada (The Devil Wears Prada), David Frankel, 2006; Direktøren for det hele (The Boss of It All), Lars von Trier, 2006.

3.6. Dynamics and assessment

Each student must watch one of the films listed below and then submit a text containing between 500 and 600 words.

The text to be written by the students should discuss the historical moment portrayed by the film and reflect on the connection between the film and labour law issues. In addition, students may submit an oral presentation of their reflection in class. This work is optional and only serves to enhance the grade.

In terms of assessment, students had to complete written essays in which critical analysis and the link between the film's narrative and the corresponding labour law themes were valued. There was also an oral presentation and discussion to gauge understanding of the themes described.

4. Methodology

In order to assess the impact of cinema on the teaching of labour law, a survey was carried out among 28 students of the labour law subject of the law degree. All the participants had attended the course in which the films were analysed. The survey sought to discuss the role of cinema in legal education, with a particular focus on its perception and use in the teaching of labour law.

The analysis of the data corresponding to the identified sample makes it possible to assess the different perspectives of the participants regarding cinema as a pedagogical tool and to discuss its effectiveness in the teaching and learning process.

The results obtained were categorised into the following areas: characterisation of the sample, perception of cinema, application to learning labour law. After answering the survey, the data was analysed using a mixed method combining statistical analysis and qualitative analysis.

5. Findings and Discussion

The results obtained confirm the consensus around cinema as a pedagogical tool, and the main conclusions are those set out below.

5.1. Characterisation of the sample

The sample comprises a diverse group of participants, the majority of whom (84.4%) express a liking for cinema (figure 1). The age distribution highlights that most respondents are aged 31 to 40 (40.6%), with other age groups also well-represented, as seen in figure 2. This diversity ensures a comprehensive understanding of the perceptions across different demographics.

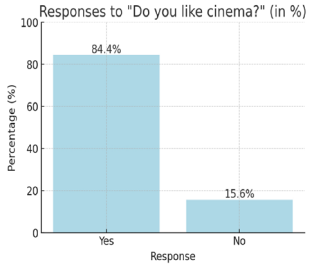


Figure 1. Response to "Do you like cinema?"

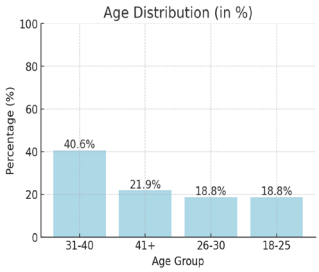


Figure 2. Age distribution

5.2. Perception of Cinema

Cinema is widely regarded as a valuable pedagogical tool. The majority of participants rated its use in teaching as "excellent" (62.5%) or "good" (28.1%), as demonstrated in figure 3. Additionally, all respondents believe that teaching becomes more contextualised with cinema (figure 4), and 93.8% agree it enhances decision-making and idea-sharing in the classroom (figure 5). While 87.5% reported that cinema stimulates critical thinking (figure 6), only 6.2% of teachers frequently use films for teaching, suggesting a disconnect between perception and practice.

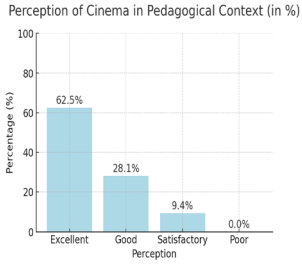


Figure 3. Perception of cinema in pedagogical context

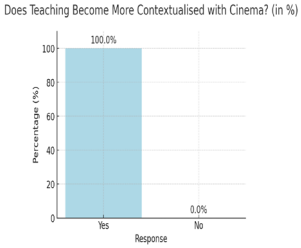


Figure 4. Response to "Does teaching become more contextualized with cinema?"

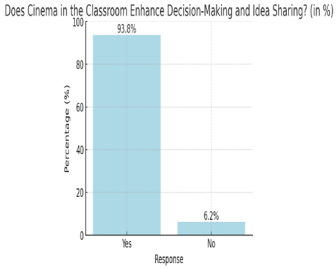


Figure 5. Response to "Does cinema in the classroom enhance decision-making and idea sharing?"

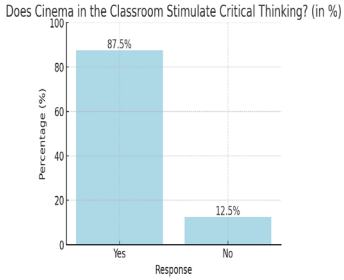


Figure 6. Response to "Does cinema in the classroom stimulate critical thinking?"

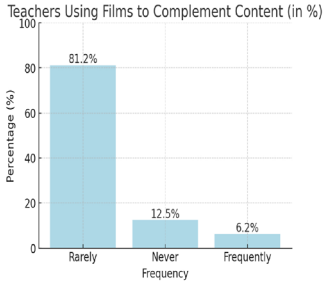


Figure 7. Teachers using films to complement content

5.3. Application to the learning of Labour Law

The integration of cinema into labour law education is perceived as highly beneficial (figure 8). Participants highlighted its ability to enhance critical thinking (28.6%), increase interest in the course (24.3%), improve knowledge acquisition (20.0%), and foster communication skills (15.7%). Films like *Modern Times* and *Germinal* were most frequently chosen for discussion (25% each), underlining their relevance to the subject (figure 9). These findings suggest that cinema can be an effective tool for contextualising complex concepts and making learning more engaging.

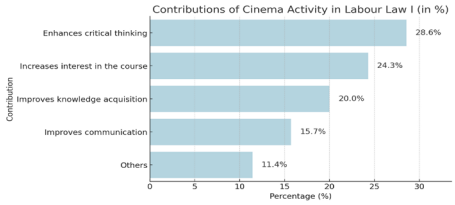


Figure 8. Contributions of cinema activity in labour law subject

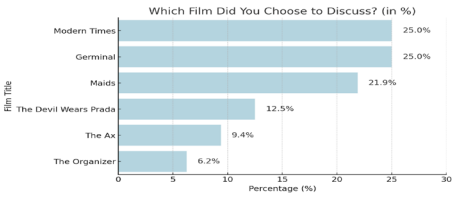


Figure 9. Response to "Which film did you choose to discuss?"

These findings support previous research advocating for structured discussions and supplementary readings to optimise the effectiveness of cinema-based learning (Berk & Rocha, 2019).

6. Recommendations

Considering the results of the survey, we recommend some strategies to enhance the involvement of cinema in the teaching of labour law:

Recommendation 1 - Selection of films: select films that allow for an approach and discussion on a wide range of labour law topics.

Recommendation 2 - Assessment: integrate the assessment carried out through the analysis and presentation of critical essays on the films in order to reinforce the learning outcomes.

Recommendation 3 - Guided discussions: orientate the debates in such a way as to keep the focus on legal issues and not divert attention to discussions of a socio-political nature.

Recommendation 4 - Complementary reading: suggest bibliography that helps to complement the narratives described in the films in order to provide more robust theoretical support.

7. Conclusions

This study confirms that cinema is a relevant pedagogical tool for legal teaching, and more specifically for teaching labour law. The results show that students see the use of cinema in the classroom as an effective tool for improving their understanding of legal issues, for promoting debate and critical reflection, and for learning concepts. However, there are still challenges surrounding the selection of films and how to guide debates.

In terms of future research, we propose a long-term exploratory analysis of the impact of using films in legal courses and the corresponding concrete application to different fields of law. The integrated use of other digital media as a pedagogical tool could also be explored in future researches.

References

Berk, A., & Rocha, M. (2019). O uso de recursos audiovisuais no ensino de ciências. *Revista Contexto & Educação, 34*(107), 72–87.

Costa Pinto, J., & Sousa Machado, S. (2024). *Cinema as a pedagogical practice in higher education: A case study applied to labour law*. *International Journal of Teaching, Learning and Education, 3*(2), 1–3. https://doi.org/10.22161/ijtle.3.2.1

Cownie, F. (2010). Legal education and the legal academy. In Peter Cane & Herbert M. Kritzer (eds.), *The Oxford handbook of empirical legal research*. New York: Oxford University Press.

Denvir, J. (1996). *Legal reelism: Movies as legal texts*. University of Illinois Press.

Eddy, P., & Bracken, D. (2008). Lights, camera, action! The role of movies and video in classroom learning. *Journal of Faculty Development, 22*(2), 125–134.

Greenfield, S., Osborn, G., & Robson, P. (2001). *Film and the law.* Bloomsbury.

Grubba, L. S. (2020). Cinema, human rights and development: The cinema as a pedagogical practice. *CINEJ Cinema Journal, 8*(1), 87–123.

Lacerda, G. (2007). *O direito do cinema: Relato de uma experiência didática no campo do direito.* FGV.

Pinho, A.; Demartini, Z. (2013). Cinema como Prática Didático-pedagógica no Ensino Jurídico. *Revista Pedagógica- UNOCHAPECÓ, Chapecó*, v. 01, n. 30, p. 561-594.

Russell, W. B. (2009). *Teaching social issues with film.* University of Central Florida.

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The Inspire Initiative: Addressing Gender Imbalances in Economics

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Abstract

The Inspire Initiative, one of the four initiatives of the Royal Economic Society's (RES) UK Women in Economics Network (UK WEN), aims to address gender imbalances in economics by providing career insights and role models for young women. Through events featuring accomplished women economists, the initiative inspires students and early-career professionals to pursue and advance in economics. This paper evaluates the initiative's impact, focusing on events held during 2024–2025. Using quantitative survey data and qualitative feedback, it highlights how the initiative has positively influenced participants' career motivation, confidence, and understanding of diverse career paths within academia, government, and the private sector. Results show significant empowerment and increased clarity in career goals. This is a UK national initiative aimed at promoting greater inclusivity and diversity in the economics profession.

Keywords: *Women in economics; gender diversity; career development; empowerment and inspiration; economics education; role models.*

1. Introduction

Gender imbalances in economics remain a longstanding issue, with women significantly underrepresented in both the academic and professional world. While progress has been made in many disciplines, economics continues to lag behind in terms of gender diversity, with women representing a smaller proportion of economics undergraduates, and their numbers decreasing further as they advance to postgraduate levels and into the workforce (Ginther & Kahn, 2004; Paredes Fuentes et al., 2023). This phenomenon is often described as the "leaky pipeline," where women exit the profession at various stages due to systemic barriers such as implicit biases, limited exposure to female role models, and a general lack of inclusivity within the field (Buckles, 2019; Lundberg & Stearns, 2019).

Research suggests that these disparities are not just limited to academic settings but are also reflected in the lack of women in leadership roles within economics (Bayer & Rouse, 2016).

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Despite the growing recognition of the importance of diversity in economics, particularly in terms of representation in senior roles, women remain underrepresented in these areas (Auriol et al., 2022). The absence of adequate mentorship and professional guidance for women in the field further compounds this gender gap in leadership positions.

The Inspire Initiative, launched by the Royal Economic Society's (RES) UK Women in Economics Network (UK WEN) in 2023, seeks to address these challenges by providing a platform for young women and early-career professionals to engage with accomplished women in economics. The initiative is part of UK WEN's broader strategy to improve gender equality in economics and create a more diverse and inclusive profession. As one of the four initiatives of UK WEN, the Inspire Initiative aims to provide career insights, access to role models, and a showcase of the diverse career paths within the economics profession for women at various stages of their careers.

Since leading the Inspire Initiative in July 2023, I have organised 11 events, including 4 in the 2023–2024 academic year and 7 in the 2024–2025 academic year. These events have attracted over 500 participants, engaging with accomplished women economists from diverse fields within academia, government, and the private sector. Through these events, participants gain valuable insights into the varied career pathways within economics, learn from personal experiences shared by female role models, and receive practical advice on overcoming challenges and achieving success in their careers.

The primary aim of the Inspire Initiative is to reduce the gender imbalance in economics by providing female students with tangible role models who can inspire and motivate them to pursue careers in the field. Through its two main strands—Inspirational Talks for Future Economists, aimed at students, and Inspirational Talks for Future Leaders, directed at early-career professionals—the initiative seeks to empower women, boost their confidence, and help them navigate the often male-dominated spaces of economics. By offering a platform for women in leadership roles to share their stories, the Inspire Initiative also seeks to develop a cultural shift within the profession, encouraging more women to take on leadership positions and therefore promoting gender equality.

Despite the growing recognition of the need for such initiatives, research into their effectiveness is still developing. Bateman et al. (2021) highlight the importance of addressing gender imbalances in economics, with a particular focus on structural barriers, mentorship, and career progression for women in the field. This paper aims to assess the impact of the Inspire Initiative based on the events held during the 2024–2025 academic year. By drawing on quantitative survey data and qualitative feedback from participants, this paper explores how the initiative has influenced career motivation, confidence, and understanding of the diverse career paths available within economics.

2. The Inspire Initiative

2.1. Overview and Structure

The Inspire Initiative, launched by the Royal Economic Society's (RES) UK Women in Economics Network (UK WEN) in 2023, aims to address gender imbalances in the field of economics. This initiative seeks to provide aspiring and early-career women economists with the resources, mentorship, and role models necessary to thrive in the profession. It targets two distinct groups: young women currently studying economics and early-career professionals looking to advance in their careers. The initiative operates through two primary strands:

Inspirational Talks for Future Economists: This strand focuses on university students, both undergraduate and postgraduate, offering them an opportunity to engage with accomplished women economists. The aim is to raise awareness of the diverse career opportunities in economics, inspire confidence, and encourage women to pursue and persist in economics-related careers.

Inspirational Talks for Future Leaders: This strand is aimed at early-career women economists who are navigating their way through academia, the public sector, and the private sector. These events focus on leadership development, overcoming gender-specific barriers, and providing professional guidance for women looking to progress into senior roles.

Through these talks, the initiative strives to promote a more inclusive and diverse profession by elevating the visibility of female role models and providing actionable career insights.

2.2. Objectives of the Inspire Initiative

The core objectives of the Inspire Initiative are:

Empowerment and Retention: To empower young women and early-career professionals by providing them with the inspiration, confidence, and career guidance they need to pursue and sustain careers in economics.

Role Model Visibility: To increase the visibility of successful women in economics, by offering participants tangible examples of individuals who have navigated the challenges of the profession and succeeded.

Promotion of Career Diversity: To expose participants to a broad range of career paths within the economics profession, from academia to government and the private sector, helping them make informed decisions about their career trajectories.

Leadership Development: To support women in developing the skills necessary to take on leadership roles in economics, tackling barriers to progression, and fostering a pipeline of future women leaders.

2.3. Description of the Events

Since taking leadership of the Inspire Initiative in July 2023, I have organized and led 11 events, including four in the 2023–2024 academic year and seven in the 2024–2025 academic year. These events have attracted over 500 participants and have featured prominent women economists from academia, government, and the private sector. The events are designed to be interactive and participatory, incorporating a range of activities to engage attendees and providing them with practical insights. Key event components include:

Panel Discussions: Experts from various fields within economics are invited to share their career journeys, discussing the challenges they have faced and the strategies they used to overcome them.

Q&A Sessions: Participants are encouraged to engage directly with the speakers during structured Q&A sessions, providing an opportunity for participants to ask questions and receive personalised advice.

Career Advice from Speakers: During the events, speakers share valuable information about career opportunities within their organisations, including internships, early-career roles, and strategies for career advancement. This enables participants to better understand the diverse career pathways available in the field of economics and learn how to navigate them successfully.

Networking and Mentorship: The initiative creates networking opportunities, enabling participants to connect with speakers and peers. These interactions may lead to mentoring relationships that support continuous professional development.

The events are delivered in collaboration with leading universities, economic societies, industry bodies, and professional networks, ensuring broad participation and ensuring the initiative's messages reach a wide and diverse audience.

3. Methodology and Results

3.1. Methodology

This paper employs a mixed-methods approach to evaluate the impact of the Inspire Initiative, combining both qualitative and quantitative data collected from participants at the events conducted as part of the initiative during the 2024–2025 academic year. The analysis primarily focuses on understanding how the initiative influences university students' career motivation, confidence, and awareness of career paths within economics. Additionally, it explores how the initiative encourages students to remain in the profession and pursue a career in economics, highlighting the impact of female role models and career insights shared during the events.

3.1.1. Data Collection

Feedback was gathered from participants at the end of each event via anonymous surveys. The surveys were designed to capture both quantitative and qualitative data. Quantitative Data: Participants rated various aspects of the event (e.g., overall satisfaction, usefulness of career advice, and engagement with role models) on a Likert scale, using options such as 'excellent', 'good', 'fair', and 'poor'. These closed-ended questions provided a structured way to measure the impact of the event in terms of key outcomes. However, quantitative data analysis was focused on the two most recent events: the University of Manchester (March 2025) and Birmingham City University (February 2025). These events were selected because they had a higher response rate compared to others, resulting in a more robust sample size for analysis. The quantitative data from these events helped to assess the initiative's effectiveness in terms of career motivation, confidence-building, and the understanding of diverse career paths within economics. Qualitative Data: To capture more in-depth insights, open-ended questions were used across all five university events conducted during the 2024–2025 academic year. These questions allowed participants to provide deeper insights into various aspects, such as the most inspiring parts of the event, how it influenced their career decisions, and their understanding of career options in economics. The qualitative data was thematically analysed to identify recurring patterns, with a focus on key themes such as the impact of female role models, career barriers in economics, and the perceived value of networking opportunities.

3.1.2. Data Analysis

For the quantitative data, responses from the University of Manchester and Birmingham City University events were aggregated and analysed to measure the overall impact of the event on participants. Summary statistics (e.g., the percentage of participants rating aspects of the event as 'excellent' or 'good') were calculated and presented in tables to highlight the key areas of impact. For the qualitative data, open-ended responses were coded into themes aligned with the core objectives of the Inspire Initiative. These themes included increased career motivation, greater confidence, career diversity awareness, and enhanced understanding of leadership roles in economics. Thematic analysis was performed to identify common insights across the five university events.

3.1.3. Limitations

While the survey data provides valuable insights, the study is subject to a few limitations. Not all events collected participant feedback, resulting in incomplete data for some events. Additionally, some events had smaller sample sizes, which may limit how widely the findings can be applied. However, focusing on the most recent events with higher response rates ensures that the quantitative analysis is based on a more reliable and representative sample. Another

limitation is the reliance on self-reported data, which can be subject to biases, such as participant memory recall.

3.2. Results and Findings

The analysis of the Inspire Initiative's impact draws on both quantitative and qualitative data collected from participants in five university events held during the 2024–2025 academic year. The quantitative data is derived from responses to structured survey questions, while the qualitative data captures participants' open-ended feedback.

3.2.1. Quantitative Results

The quantitative analysis focuses on the two most recent events, those held at the University of Manchester (March 2025) and Birmingham City University (February 2025), with a total sample of 46 responses. Table 1 presents the combined results from these two events, reflecting participants' responses to key aspects of the event, with the results shown in percentages.

Table 1. Results

Rating	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
Excellent	82.61	60.87	63.05	69.57	100
Good	15.22	39.13	34.78	26.09	
Fair	2.17		2.17	4.34	
Poor					

Explanation of the results in Table 1:

1: Overall event rating: The overall satisfaction with the event was overwhelmingly positive, with 82.61% of participants rating it as "Excellent," and 15.22% rating it as "Good." Only 2.17% rated the event as "Fair," with no responses marked as "Poor."

2: Diverse career path examples: The initiative provided valuable insights into career opportunities, with 60.87% of participants rating this aspect as "Excellent" and 39.13% as "Good." This indicates the event's success in showcasing diverse career paths in economics.

3: Role model access: Participants appreciated the access to senior female role models in economics, with 63.05% rating this aspect as "Excellent" and 34.78% as "Good." This suggests the event was successful in elevating the visibility of successful women in the field.

4: Inspiring economics students to remain in the profession: The event effectively inspired students to pursue and persist in economics-related careers, with 69.57% rating this objective as

"Excellent" and 26.09% as "Good." This result demonstrates the initiative's success in motivating participants to stay in the profession.

5: Recommend to others: 100% of participants stated they would recommend the event to other students, highlighting the high level of satisfaction and perceived value of the event.

3.2.2. Qualitative Results

The qualitative analysis focuses on feedback collected from open-ended questions across all five university events. This data provides a deeper insight into participants' experiences and highlights recurring themes related to the impact of the initiative. Thematic analysis of the responses revealed the following key themes:

Career Motivation and Confidence: Participants reported a significant increase in career motivation and confidence after engaging with the events. Many students expressed that hearing from female role models inspired them to continue pursuing careers in economics. As one participant noted, "Hearing from someone who has faced similar challenges was incredibly inspiring." Another participant mentioned, "These talks have shown me that there is space for women at all levels in economics."

Role Models and Career Insights: The visibility of successful women in economics was cited as one of the most impactful aspects of the event. Participants appreciated learning about the varied career paths of women economists, including those in academia, government, and the private sector. "The different paths the panellists took to get to where they are today were very inspiring," said one participant.

Networking Opportunities: Many participants highlighted the importance of networking and the potential for mentorship. Attendees valued the opportunity to connect with established economists, with several reporting that they formed meaningful professional connections during the event. "The networking opportunity was invaluable, and I now have a few mentors I can turn to for advice," one respondent stated.

Diverse Career Paths in Economics: Participants noted that the events expanded their understanding of the diverse career paths available within economics. "It made me realise that there are many different fields within economics I can explore, beyond what I initially thought," said one attendee. This feedback indicates that the initiative is broadening students' career horizons and helping them see economics as a multifaceted field.

Challenges and Overcoming Barriers: Many participants acknowledged the challenges faced by women in the economics profession and appreciated hearing how the panellists overcame these barriers. The theme of "imposter syndrome" was mentioned frequently, with several participants remarking that hearing about how successful women had navigated these challenges gave them confidence to continue pursuing their goals. As one respondent shared, "It was

reassuring to hear that even the most successful women in economics have faced the same challenges."

Overall, the quantitative and qualitative data indicate that the Inspire Initiative has had a positive impact on participants' career motivation, confidence, and understanding of diverse career paths in economics. The initiative has successfully engaged participants across multiple universities, providing them with access to female role models, career insights, and valuable networking opportunities. The themes emerging from qualitative data highlight the importance of visibility, mentorship, and career advice in supporting women's careers in economics.

4. Conclusion

The Inspire Initiative has demonstrated significant potential in addressing gender imbalances in economics, particularly in terms of career motivation, confidence, and access to role models. The initiative has successfully engaged a broad range of participants, empowering them to pursue careers in economics and take on leadership roles. The combination of quantitative and qualitative data highlights the positive influence of female role models, career insights, and mentorship opportunities provided during the events. Feedback from participants indicates a clear demand for such initiatives, with many reporting increased motivation to pursue and sustain careers in economics, as well as greater clarity about the diverse career paths available in the field. The networking opportunities, personal stories, and advice shared by established women economists have proven invaluable in shaping participants' career aspirations. While the data collected thus far is promising, further research is needed to assess the initiative's long-term effects and its potential for broader implementation across the profession. Expanding the initiative's reach to more universities and sectors could further enhance its potential to address gender disparities in economics. In conclusion, the Inspire Initiative has made meaningful strides in empowering women in economics, fostering an inclusive and diverse environment.

References

Auriol, E., Friebel, G., Weinberger, A., & Wilhelm, S. (2022). Underrepresentation of women in the economics profession more pronounced in the United States compared to heterogeneous Europe. *Proceedings of the National Academy of Sciences*, *119*(16), e2118853119.

Bateman, V., Gamage, D. K., Hengel, E., & Liu, X. (2021). The gender imbalance in UK economics. *Royal Economics Society (RES) Silver Anniversary of Women's Committee Report*.

Bayer, A., & Rouse, C. E. (2016). Diversity in the economics profession: A new attack on an old problem. *Journal of Economic Perspectives*, *30*(4), 221-242.

Buckles, K. (2019). Fixing the leaky pipeline: Strategies for making economics work for women at every stage. *Journal of economic perspectives*, *33*(1), 43-60.

Ginther, D. K., & Kahn, S. (2004). Women in economics: moving up or falling off the academic career ladder?. *Journal of Economic perspectives*, *18*(3), 193-214.

Lundberg, S., & Stearns, J. (2019). Women in economics: Stalled progress. *Journal of Economic Perspectives*, *33*(1), 3-22.

Paredes Fuentes, S., Burnett, T., Cagliesi, G., Chaudhury, P., & Hawkes, D. (2023). Who studies economics? An analysis of diversity in the UK economics pipeline.

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Study habits of university students in an AI-driven math bridging course

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Abstract

Traditionally, students having difficulty in coping with the academic demands of university student life undergo coaching or mentoring by a teacher. This study, which is part of a larger ongoing research about the integration of an adaptive learning system (Assessment and Learning in Knowledge Spaces or ALEKS) in mathematics bridging courses, sought to examine the study habits of probationary first year university students required to enroll and pass these courses. The researchers administered oral interviews to four participants in the said courses. Findings from the data revealed that the students found ALEKS to be beneficial to their study habits as they found it convenient and accessible when it comes to preparing for tests and giving immediate and helpful feedback. Moreover, the built-in features of ALEKS not only assisted them in understanding the topics in the course but also helped them in accomplishing assigned tasks efficiently.

Keywords: *Adaptive learning system, ALEKS, math bridging course, study habits, university students.*

1. Introduction

It is a reality in the Philippines that some students who are admitted into higher education are less prepared to handle the demands of academic work in the university. Hence, some universities opt to offer accommodations for students in such cases (e.g., probationary status). For example, in the locale of the study, students who aim to major in management courses face the challenge of taking two calculus courses in their first year. An even greater challenge for those on probation would be to reach the academic standard of the university as this would cost them their formal admission.

University students with low admission scores in mathematics are required to enroll and obtain a satisfactory mark in two 3-unit bridging courses during their first year that cover topics

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typically discussed in high school level mathematics. These bridging courses are designed to ensure that the students are better prepared in taking university-level mathematics courses.

Underperformance in academic achievement is often linked with differences in the ways that students respond to instruction and pedagogy. In traditional classrooms, teachers are expected to cater to students with varying aptitudes and learning styles. However, due to different limiting factors such as the pressure of complying with directives and timetable imposed in the university academic calendar, teachers tend to prioritize coverage of the curriculum over giving timely and personalized feedback during assessments and attending to individual needs of their students in general.

Thus, in this study, the authors are interested in investigating the study habits of the current cohort of 1st year university students taking the mathematics bridging courses in School Year 2024-2025. Hence, they seek to answer the following research questions: (1) How do students integrate ALEKS when studying mathematics? (2) How do the study habits of students differ pre-exposure and post-exposure to ALEKS? With this study, it is hoped that the results will inform departmental-level policies regarding the continued use and implementation of ALEKS and/or similar artificial intelligence or AI-powered learning platforms. On a larger scale, results will help provide insights to departments in the same or other universities in their pursuit of integrating AI in university instruction.

2. Review of Related Literature

Park and Lee (2004) define adaptive instruction as “educational interventions aimed at effectively accommodating individual differences in students while helping each student develop the knowledge and skills required to learn a task" (p. 651). With the diversified needs of students in a digital age, there is a growing demand for technological software and applications that aim to provide personalized instruction. More teachers are becoming aware of the application of such tools in education and their affordances. This phenomenon has been described in Mishra and Koehler’s (2006, as cited in Graham et al., 2012) technological pedagogical and content knowledge (TPACK) framework. Theoretical frameworks about the use of technology or AI with the teacher as the center of pedagogy are abound. The use of AI in classroom settings can be classified as AI-directed, AI-supported, and AI-empowered (Ouyang & Jiao, 2021, as cited in Mohammed et al., 2022), which show the levels in which learners engage with AI, ranging from receiving AI-driven instruction to collaborating with AI, and ultimately leading their own learning. Data from Mohammed et al. (2022)’s systematic literature review also show a growing number of research investigating the use of AI in mathematics education. The incorporation of AI in education is a testament to a paradigm shift in education, away from the traditional “one size fits all” style of instruction for groups of students and

addresses the students' varying learning needs, pace, and unique thinking capabilities as mentioned in Srinivasa et al. (2022).

One of the increasingly used adaptive learning systems or platforms is ALEKS, which stands for Assessment and Learning in Knowledge Spaces. Cosyn et al. (2021) describe ALEKS as a web-based intelligent tutoring system based on the Knowledge Space Theory, which is founded on the idea that a learner transitions from one knowledge state to another across a knowledge space. Additionally, each knowledge state is defined by a particular set of items that a learner is capable of answering correctly. McGraw Hill (2025) claims that it is the most effective adaptive learning program to date, offering Mathematics, Chemistry, and Statistics courses. ALEKS employs adaptive learning and assessment, adjusting item difficulty based on students' responses and guiding them through cycles of learning and evaluation until they reach a satisfactory level of mastery (Cosyn et al., 2021). While ALEKS personalizes the learning experience, instructors can fine-tune the system by selecting specific items, ensuring alignment with instructional goals and student needs (ibid.).

The use of ALEKS in instruction and/or assessments is not entirely new as it has been introduced as a supplement to traditional assessments and/or intervention to student learning in the past few years. A testament to this is the meta-analysis conducted by Fang et al. (2018) on studies related to the effectiveness of ALEKS on learning. Their findings seem to reveal neutral results such as: (1) that the use of ALEKS in instruction does not differ much from traditional instruction as it only has a very small positive effect on student learning; (2) that the learning efficacy is relatively comparable across different levels of education of the learners; (3) that the effectiveness of ALEKS on learning does not differ whether it was used for principal or supportive instruction; and (4) that there is no significant difference between the learning outcomes of those who were tested using instructor-designed tests and of those using standardized tests. However, in the same study, it is interesting to note that ALEKS was more effective when it was used for a semester as compared to when used for a year.

As for the use of ALEKS in specific subject matters, there are existing studies documenting recent applications in mathematics and chemistry. A meta-analysis by Sun et al. (2021) noted positive effects of ALEKS on students' learning, specifically in studies whose research design involved the use of ALEKS ranging from 4 weeks to 1 school year. Two other moderating variables that they identified were pedagogical use and student characteristics (e.g., gender, race/ethnicity, level of education). On the other hand, Harati et al. (2021) revealed a rather contrasting set of results among students in chemistry courses using ALEKS for four months. They detected a significant decline in the self-regulated learning skills of students, which they claimed to be linked with lack of motivation and social presence. Finally, Craig et al. (2013) discussed the implementation and impact of ALEKS as an intervention in a 25-week after-school program for Grade 6 students struggling in mathematics. They found that students who interacted with ALEKS obtained equal or higher scores in terms of math performance, conduct

and involvement than those who were in the teacher-led classrooms. While the difference among mean scores is not found to be statistically significant, the authors have reason to believe that there is value in the use of ALEKS in after-school intervention programs due to the decreased amount of assistance needed by students. In terms of study habits, some literature sought to establish links between study habits and mathematics achievement (see Odiri, 2015; Verma et al., 2022).

3. Methodology and Findings

There were 73 students who took the mathematics bridging course in the university for SY 2024-2025, and all of them were invited to participate in this study. The population consists of students with varying ability levels based on their final math grade in the previous semester. Of these 73 students, 23 had grades less than 50% (below passing), 49 had grades between 50% to 86% (moderate), while only one student obtained a grade above 86% (high). There were 32 students who agreed to participate in our study, but only nine agreed to be interviewed about their experience in using ALEKS. However, due to scheduling constraints, the data gathered for this manuscript consisted of interview transcripts from only four students. All four of them have a moderate ability level.

The interview questions were about the changes in their study habits prior to and during their use of ALEKS in their mathematics bridging course. The interviews were conducted by pairs, and on-site. Analyzing the interview transcripts gave rise to four emergent themes, which are as follows: (1) ALEKS makes it convenient and accessible for students when it comes to preparing for tests; (2) ALEKS has unique built-in features which assisted them in understanding the topics in the course; (3) ALEKS provides immediate, accurate, and meaningful assessment feedback; (4) ALEKS provides a form of structure as to when they need to study math and accomplish the tasks. These themes shall be expounded in the succeeding paragraphs.

The mathematics bridging course is situated in a computer laboratory with university-provided laptops. This set-up allows students to access ALEKS at any point during classroom instruction. During the interviews, students also said that they access ALEKS using their personal laptops and smartphones. When accessing ALEKS via their smartphones, they either go to the ALEKS website, open the ALEKS application, or through the university's official learning management system. These varied options present students the opportunity to study math and continue doing the modules in ALEKS, especially before scheduled ALEKS quizzes, and even outside of their usual study spaces (i.e., home).

The students found the following features of the ALEKS interface beneficial as they studied mathematics: the built-in "dictionary", and the review button. Whenever the students answer items generated by ALEKS, they are sometimes provided with a short discussion that would help them answer the item. In the discussion page in ALEKS, students are provided with

definitions of mathematical terms (by clicking or hovering the word or phrase) that they can access at their convenience. On the other hand, the review button allows students to go back to the past questions (including the explanation to the correct answer) given to them by ALEKS. This even includes the items where they committed mistakes, thereby allowing students to rationalize their mistakes. Because of this feature, the students were able to go over what they have learned over the course of the module to help them recall what is necessary for the test.

The students felt that ALEKS works best with them because of its ability to provide immediate feedback, especially right after answering ALEKS-generated items. Such functionality is shared by AI-powered educational tools. In particular, ALEKS keeps track of student performance and is able to produce real-time reports and helpful student metrics, such as the ALEKS pie progress which comprise the topics chosen by the instructor for the course. Mastering all topics in the modules would mean getting a score of 100% in the ALEKS pie. As the student progresses through the course, ALEKS quantifies each student's progress by displaying the percentage of topics learned and mastered. During the interviews, the students felt that this numerical representation accurately depicts their performance. In fact, their personal assessment of their performance concurs with what ALEKS has shown. The students have mentioned in their accounts that such metrics motivate them to study, as the amount of time that they have spent is proportional to the amount of topics in the module they have yet to learn.

The students shared that they plan their study schedule based on the metrics available on the ALEKS interface. Whenever an ALEKS quiz is scheduled, the students ensure that they accomplish the necessary module a few days before the quiz. Additionally, they dedicate a few hours (usually on the day prior to the quiz) reviewing using the review button in ALEKS. The students also note that because of how ALEKS grades their performance (e.g., right minus wrong system), they needed to adapt strategies to progress faster. For instance, this system encouraged them to answer consecutive items correctly, as much as they could, avoid being penalized even for committing mistakes intermittently. This is because accumulating errors signals ALEKS to augment more items or subject them to repeating the requisite topics, to improve their proficiency. As an adaptive learning system, ALEKS adjusts the length and difficulty of items based on how the student answers questions on ALEKS. Additionally, since ALEKS quizzes are taken from the same pool of questions, students are compelled to finish the modules beforehand. All of these described behaviors related to the students' study habits may have been influenced by the design of ALEKS.

4. Conclusion

Exploring an AI-driven mathematics bridging course is significant because it exposes how the dynamics between teacher and students are reshaped, with students' study habits proving to be a good starting point. Credé and Kuncel (2008) argue that study habits act as a third pillar of

academic success among college students, in addition to skills and attitudes. In the context of this study, students' study habits warrant attention most especially that the mathematics bridging courses have been intentionally designed to gauge students' preparedness and train them for university-level mathematics.

From the narratives shared by the participants during the interviews, it can be gleaned that students relied on ALEKS as their single, primary online source of content and sample exercises in preparation for their quizzes. Because of immediate feedback and quantitative metrics generated by ALEKS, students become more motivated to study and finish their tasks on time. In addition, the researchers found three notable changes in students' study habits before and after the use of ALEKS. First, because of the accessibility of using ALEKS with any gadget, students felt the flexibility in scheduling their study time with mathematics and their choice of physical study spaces. Second, because of immediate and relevant feedback on their answered exercises, their use of ALEKS appeared to provide closure to the feedback loop in their learning process. Lastly, their learning of mathematics, especially their out-of-classroom activities, became partially guided by AI-based diagnostics and recommendations.

These changes in study habits correspond to some of the categories of self-regulated learning (SRL; Zimmerman & Schunk, 1989) strategies that university students develop when using technologies. In the work of Yot-Domínguez and Marcelo (2017), which proposed an instrument that identifies and categorizes students' use of technology in relation to cognitive, metacognitive, and resource management strategies for self-regulated learning, these changes correspond to Factor 7 (Personal Management) and Factor 8 (Self-Evaluation). These findings suggest that the integration of AI-based learning tools like ALEKS may play a significant role in fostering and supporting students' development of self-regulated learning behaviors in digital environments.

In this regard, the authors recommend the integration of AI-powered educational tools such as ALEKS in mathematics bridging courses. The findings in this study are crucial because skills-based courses, like mathematics, require repetitive practice, which is reinforced by external prompts from ALEKS.

References

Credé, M., & Kuncel, N. R. (2008). Study habits, skills, and attitudes: The third pillar supporting collegiate academic performance. *Perspectives on Psychological Science*, *3*(6), 425-453. https://doi.org/10.1111/j.1745-6924.2008.00089.x

Cosyn, E., Uzun, H., Doble, C., & Matayoshi, J. (2021). A practical perspective on knowledge space theory: ALEKS and its data. *Journal of Mathematical Psychology*, *101*, 102512. https://doi.org/10.1016/j.jmp.2021.102512

Craig, S. D., Hu, X., Graesser, A. C., Bargagliotti, A. E., Sterbinsky, A., Cheney, K. R., & Okwumabua, T. (2013). The impact of a technology-based mathematics after-school program using ALEKS on student's knowledge and behaviors. *Computers & Education*, *68*, 495–504. https://doi.org/10.1016/j.compedu.2013.06.010

Fang, Y., Ren, Z., Hu, X., & Graesser, A. C. (2018). A meta-analysis of the effectiveness of ALEKS on learning. *Educational Psychology*, *39*(10), 1278–1292. https://doi.org/10.1080/01443410.2018.1495829

Graham, C. R., Borup, J., & Smith, N. B. (2012). Using TPACK as a framework to understand teacher candidates' technology integration decisions. *Journal of Computer Assisted Learning*, *28*(6), 530–546. https://doi.org/10.1111/j.1365-2729.2011.00472.x

Harati, H., Sujo-Montes, L., Tu, C.-H., Armfield, S., & Yen, C.-J. (2021). Assessment and Learning in Knowledge Spaces (ALEKS) Adaptive System Impact on Students' Perception and Self-Regulated Learning Skills. *Education Sciences*, *11*(10), 603. https://doi.org/10.3390/educsci11100603

McGraw Hill (2025). *About ALEKS*. https://www.aleks.com/about_aleks

Odiri, O. E. (2015). Relationship of study habits with mathematics achievement. *Journal of Education and Practice*, *6*(10), 168-170. https://files.eric.ed.gov/fulltext/EJ1081665.pdf

Park, O., & Lee, J. (2004). Adaptive instructional systems. In D. H. Jonassen (Ed.), *Handbook of Research on Educational Communications and Technology* (2nd ed., pp. 651-684). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Srinivasa, K. G., Kurni, M., & Saritha, K. (2022). Harnessing the power of AI to education. In K. G. Srinivasa, M. Kurni, & K. Saritha, *Learning, Teaching, and Assessment Methods for Contemporary Learners: Pedagogy for the Digital Generation*. Springer Nature. https://doi.org/10.1007/978-981-19-6734-4_13

Sun, S., Else-Quest, N. M., Hodges, L. C., French, A. M., & Dowling, R. (2021). The Effects of ALEKS on Mathematics Learning in K-12 and Higher Education: A Meta-Analysis. *Investigations in Mathematics Learning*, *13*(3), 182–196. https://doi.org/10.1080/19477503.2021.1926194

Verma, N., Chitkara, M., & Malhotra, R. (2022). Statistical analysis of study habits in mathematics achievement. In *AIP Conference Proceedings*, *2357*(1), 080011. https://doi.org/10.1063/5.0080558

Yot-Domínguez, C., & Marcelo, C. (2017). University students' self-regulated learning using digital technologies. *International Journal of Educational Technology in Higher Education*, *14*(1), 38. https://doi.org/10.1186/s41239-017-0076-8

Zimmerman, B. J., & Schunk, D. (Eds.). (1989). *Self-regulated learning and academic achievement: Theory, research, and practice*. New York: Springer-Verlag. https://doi.org/10.1007/978-1-4612-3618-4

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From shop floors to breakthroughs: Is vocational education good for innovation?

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Abstract

The fundamental impact of human capital on innovative performance is a consensual finding in the innovation literature. Universities play a pivotal role in fuelling innovation across various industries, providing students with essential knowledge and skills to generate new products, processes, and business models. However, while the crucial role of the university is undeniable, it should be remembered that human capital formation is a complex and multifaceted phenomenon, influenced not only by factors such as institutional context and culture but also by the prevailing secondary education system. Since 1999, the Bologna Process has resulted in numerous reforms aimed at ensuring comparability among standard and quality of higher education qualifications in Europe. However, secondary school education systems vary significantly among countries. One of the most striking differences is the relevance attributed to vocational training programmes. Vocational training is essential for preparing students for specific careers and industries and focuses on the development of practical skills and knowledge that are directly applicable in the workplace. This paper analyses the impact of secondary school education on innovation performance in European regions. The rationale is that, despite a widely held belief that innovation requires workers with an academic education, vocational education and training is a major driver of innovation performance. We employ Eurostat data for the last two programming periods to and determine the extent to which secondary school systems and European Commission policy, specifically the European Social Fund Educational and Vocational Training theme, can contribute to innovation performance in European regions.

Keywords: *Innovation; European regions; schooling; human capital; vocational training*

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1. Introduction and background literature

Vocational Education and Training (VET) in regional development has garnered increasing attention, particularly regarding its potential to address spatial inequalities and support place-based innovation. VET is widely recognized as a key mechanism for fostering a skilled workforce capable of sustaining economic growth. Yet, its relationship with innovation is context-dependent, shaped by local economic structures, institutional settings, and alignment between education systems and labor market demands (Boschma et al., 2013; Sevinc et al., 2020; Corradini et al., 2023; Büyükyazıcı et al., 2023). Research has highlighted VET's contributions to employment and regional resilience, especially in structurally weaker areas or metropolitan settings with diverse human capital needs (Filippetti et al., 2019; Poelhekke, 2013). However, persistent mismatches between skill supply and occupational demand underscore the need for integrated, regionally coordinated VET systems. Although VET is generally seen as vital for equipping individuals with practical, job-ready skills, its innovation impact is nuanced. Some studies argue that VET supports incremental innovation by providing firms with skilled workers able to implement and maintain new technologies (Rupietta et al., 2021; Toner et al., 2004). For instance, apprentices can act as hybrid change agents, facilitating internal and external knowledge flows (Rupietta et al., 2021). Toner et al. (2004) similarly demonstrate that innovation and training intensity are strongly correlated in innovation-intensive sectors. Other evidence reinforces this perspective. Poelhekke (2013) finds that vocationally trained workers, particularly in technical occupations, significantly contribute to employment growth in German metropolitan regions. Büyükyazıcı et al. (2023) emphasize the importance of VET-driven skill relatedness and complexity in supporting regional diversification and innovation. Yet, the literature also reveals limitations. Rodríguez-Soler and Brunet Icart (2017), examining VET–SME interactions in Spain, find that while workplace training is common, it remains underutilized as a lever for broader innovation. Similarly, Lavía et al. (2012) note that continuous training from VET centers benefits industrial SMEs, though engagement levels vary. These findings point to the need for stronger strategic coordination between education and innovation systems—echoing calls for regional skills governance that embeds VET into local innovation strategies (Raagmaa & Keerberg, 2017; Corradini et al., 2023).

Emerging studies also stress the importance of aligning VET systems with regional development priorities. The impact of VET on innovation is influenced by the spatial distribution of skills, the structure of local economies, and the presence of complementary institutions (Boschma et al., 2013; Corradini et al., 2023). In manufacturing-oriented regions, VET often provides a better match with firms' technical demands (Poelhekke, 2013; Allais & Schöer, 2024), whereas service or knowledge-based economies may rely more heavily on tertiary education to drive innovation. Evidence from regional studies confirms these contextual variations. Filippetti et al. (2019) show that training policies in Italy have stronger effects in the South, where structural gaps are greater. Manca (2012) and Canal Domínguez (2021) further highlight the complementarity of

vocational and tertiary education in fostering regional convergence and cohesion. These insights reinforce the idea that VET's effectiveness depends not just on content, but on its interaction with the broader human capital composition of a region. A particularly promising area of research focuses on the role of regional education providers as agents of change within innovation systems. When well-integrated into territorial strategies, VET centers and higher education institutions (HEIs) can function as institutional entrepreneurs—coordinating with firms, anticipating skills needs, and supporting diversification (Raagmaa & Keerberg, 2017; Büyükyazıcı et al., 2023).

This paper contributes to the debate by examining the VET–innovation relationship across European regions using a comprehensive dataset. Our findings show that, at an aggregate level, VET is negatively associated with innovation, whereas tertiary education shows a positive correlation—likely due to its stronger ties to R&D and knowledge generation. However, this pattern is not uniform. In manufacturing-intensive regions, VET exhibits a positive and significant association with innovation, echoing the findings of Bennett et al. (2004) and Allais & Schöer (2024), who emphasize the value of practical, technical skills in driving innovation in these settings. These findings suggest that the impact of VET varies significantly by regional economic structure. In regions with strong manufacturing bases, VET provides essential hands-on skills and technical expertise needed to implement and manage innovation. Conversely, in high-tech or service-based economies, innovation is more tightly linked to the theoretical and research-oriented training provided by HEIs. Overall, while VET may appear to have a weaker link to innovation compared to tertiary education, its positive role in manufacturing regions highlights its underappreciated potential as a driver of place-based innovation. A more strategic integration of VET into regional innovation systems—accounting for local economic conditions—could enhance its contribution to inclusive growth and regional development across Europe.provided by tertiary institutions may be more directly linked to innovation outcomes.

2. Empirical analysis

Our analysis is based on European Commission (EC) open data available on the Eurostat portal. The database includes information on secondary and tertiary education, population, R&D activity, economic activity and patenting. We obtained data at NUTS2 regional level that refers to the period 2016-2021. Therefore, the database is organised in a panel data structure. Data on education takes into account both general student career paths and VET ones. It also includes information on regions' falling into the "talent development trap", which was obtained from the EC report on economic, social and territorial cohesion (European Commission, 2024). The test of the research hypotheses is based on a set of OLS regressions run on a panel data structure with region and year fixed effects. Table 1 and Table 2 present the results of our analysis. In Table 1, patents are the dependent variable; in Table 2 GDP (stock) is the dependent variable. We are aware that patents are an imperfect measure of innovation, especially for sectors such

as services, software, or design, where intellectual property is often protected through secrecy or informal means. Indeed, patents are biased towards certain industries—such as pharmaceuticals, chemicals, and electronics —while underrepresenting sectors where innovation is more tacit, process-oriented, or non-technical. Nonetheless, patents remain one of the few systematic, publicly available, and internationally standardised indicators of technological innovation, particularly useful for capturing knowledge outputs and innovations at the regional or sectoral level. In both tables VET is measured alternatively as percentage of students enrolled in VET over total population (columns 1-3) and percentage of students enrolled in VET over the total students in secondary education (models 4-6).

Our results suggest a complex and context-dependent picture, in which VET's contribution to innovation varies significantly depending on regional economic structures and institutional conditions. Across European regions, VET enrolment at the secondary level shows a negative and significant correlation with patent activity, suggesting that, under certain conditions, vocational training may hinder regional innovation. In Model 1, the estimated elasticity is −0.84, meaning that a 1% increase in the share of the population enrolled in VET correlates with a 0.84% decrease in patent applications, all else being equal. This aligns with broader concerns that VET, while effective for employability, may not foster the high-level cognitive skills—such as critical thinking, creativity, and problem-solving—required for innovation in knowledge-intensive sectors (Boschma et al., 2013; Corradini et al., 2023).

Unlike tertiary education, which emphasizes abstract and research-based knowledge, VET focuses on applied, sector-specific competencies. While this practical orientation supports entry into the labor market, particularly in traditional industries, it may not cultivate the interdisciplinary and adaptable skillsets increasingly demanded in dynamic and high-tech environments (Manca, 2012; Büyükyazıcı et al., 2023). The negative correlation may also reflect structural limitations, including the prestige gap between vocational and general education in countries like Italy. This status divide can lead to self-selection effects, where more academically inclined students avoid vocational tracks, reducing VET's innovation potential (Poelhekke, 2013; Canal Domínguez, 2021). Further, the short-term employability advantage of VET may disincentivize students from pursuing tertiary education, reducing the regional supply of highly qualified graduates in STEM and R&D-intensive fields. In sectors like ICT and pharmaceuticals, where disruptive innovation is key, the absence of deeper theoretical training can be a limiting factor. Cultural perceptions of VET as a "second-best" option may further restrict its contribution to innovation (Cabus, 2015; Filippetti et al., 2019).

However, the negative relationship is not universal. When we account for regional economic structure, the picture changes. Introducing an interaction term between VET enrolment and manufacturing employment reveals a positive and significant effect. In regions with strong manufacturing bases, a one-unit increase in the VET share is associated with a 3.36% increase

Table 1. VET and Innovation

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Pat	Pat	Pat	Pat	Pat	Pat
Region FE	yes	yes	no	yes	yes	no
Year FE	yes	yes	yes	yes	yes	yes
population_age	-0.103	-0.080	0.087	-0.133	-0.155	0.088
	[0.152]	[0.150]	[0.057]	[0.151]	[0.149]	[0.058]
emp_manuf	0.024	-0.688**	-0.094	0.010	-0.929**	-0.094
	[0.168]	[0.229]	[0.057]	[0.168]	[0.273]	[0.059]
TDT			0.001			0.000
			[0.009]			[0.011]
tertiary educ	0.304**	0.294**	-0.008	0.302**	0.271**	-0.005
	[0.077]	[0.076]	[0.035]	[0.077]	[0.077]	[0.036]
VET_educ_pop	-0.866+	-5.713**	0.756*			
	[0.455]	[1.166]	[0.306]			
VET_educ_pupils				-0.050	-0.370**	0.034
				[0.031]	[0.080]	[0.021]
VET_educ_pop * emp_manuf		35.565**				
		[7.897]				
VET_educ_pop * TDT			-0.595+			
			[0.329]			
VET_educ_pupils * emp_manuf					2.007**	
					[0.464]	
VET_educ_pupils * TDT						-0.023
						[0.017]
Constant	0.274	0.289	-0.265	0.392	0.634	-0.271
	[0.573]	[0.565]	[0.214]	[0.568]	[0.564]	[0.218]
Observations	875	875	812	875	875	812
Number of id	157	157	143	157	157	143
Standard errors in brackets						
**** p<0.01, * p<0.05, + p<0.1**						

in patent applications. This interaction suggests that VET's contribution to innovation depends on the sectoral context. Where manufacturing employment is high, VET plays a more complementary role in supporting innovation. This result reflects the reality of manufacturing-oriented regions—such as Baden-Württemberg, Lombardy, Emilia-Romagna, Catalonia, Flanders, and Upper Silesia—where VET systems are often well-integrated into local economies and closely aligned with the skill needs of firms (Brunello & Rocco, 2017). In these settings, VET facilitates incremental innovation, particularly in production processes and product improvements. The practice-based orientation of vocational programmes aligns with the evolutionary nature of innovation in manufacturing sectors. Moreover, the embeddedness of VET in regional production systems fosters collaboration between firms, schools, and public institutions. This supports knowledge spillovers and builds coherent regional innovation systems (Rupietta & Backes-Gellner, 2019; Rodríguez-Soler & Brunet Icart, 2017; Albizu et al., 2017). Regions with dense manufacturing networks benefit from more frequent and productive exchanges of knowledge and talent, reinforcing a culture of continuous improvement and mutual learning (Rodríguez-Pose & Wilkie, 2020; Boschma et al., 2013; Sevinc et al., 2020).

We further explore the role of regional structural conditions by introducing the talent development trap (TDT) into our analysis. The results indicate that VET's positive effects on innovation are conditioned by the absence of a high TDT score. In regions with high TDT scores—indicating structural weaknesses such as low educational attainment, demographic decline, and youth outmigration—VET is significantly less effective in contributing to patent activity. In such regions (e.g., parts of Southern Italy or the Western Balkans), even a well-structured VET system struggles to offset broader labor market constraints and institutional deficiencies. This finding highlights the limitations of VET in isolation. Without strong institutional support, robust labor demand, and policies to retain talent, VET cannot fulfill its potential to drive innovation. In areas suffering from brain drain or limited opportunities for skilled employment, vocational graduates may either leave or fail to find roles that allow them to apply their competencies in innovation-oriented settings. This reinforces existing inequalities and risks turning VET into a mechanism for reproducing, rather than mitigating, territorial disadvantage (Filippetti et al., 2019; Sevinc et al., 2020). Ultimately, our findings support the case for place-sensitive, systemic skills policies. In regions with favorable conditions—especially strong manufacturing sectors and institutional coordination—VET can be a driver of incremental innovation. But in regions facing structural traps, it must be complemented by industrial policy, investment in skills retention, and stronger coordination between education providers, firms, and regional authorities (Raagmaa & Keerberg, 2017; Corradini et al., 2023). Only under these conditions can VET contribute meaningfully to innovation and inclusive regional development.

Table 2. VET and GDP

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	GDP	GDP	GDP	GDP	GDP	GDP
Region FE	yes	yes	no	yes	yes	no
Year FE	yes	yes	yes	yes	yes	yes
population_age	0.812**	0.860**	0.991**	0.882**	0.866**	1.032**
	[0.246]	[0.245]	[0.230]	[0.242]	[0.241]	[0.231]
emp_manuf	-0.236	-1.295**	-0.807**	-0.211	-1.759**	-0.688**
	[0.263]	[0.403]	[0.246]	[0.263]	[0.476]	[0.246]
TDT			-0.482**			-0.522**
			[0.046]			[0.051]
tertiary educ	-0.065	-0.089	0.247+	-0.068	-0.110	0.198
	[0.119]	[0.119]	[0.128]	[0.119]	[0.119]	[0.127]
VET_educ_pop	2.282**	-5.664*	0.387			
	[0.872]	[2.456]	[1.122]			
VET_educ_pupils				0.142*	-0.398**	-0.131+
				[0.056]	[0.150]	[0.077]
VET_educ_pop * emp_manuf		54.037**				
		[15.628]				
VET_educ_pop * TDT			6.513**			
			[1.164]			
VET_educ_pupils * emp_manuf					3.301**	
					[0.851]	
VET_educ_pupils * TDT						0.337**
						[0.059]
Constant	6.351**	6.336**	6.453**	6.050**	6.376**	6.372**
	[0.889]	[0.884]	[0.863]	[0.878]	[0.875]	[0.867]
Observations	1,071	1,071	978	1,071	1,071	978
Number of id	193	193	177	193	193	177
Standard errors in brackets						
**** p<0.01, * p<0.05, + p<0.1**						

While the relationship between Vocational Education and Training (VET) and innovation remains mixed, our findings reveal a positive and statistically significant association between VET and regional GDP. As shown in Table 5, the baseline model estimates an elasticity of 0.84, indicating that a 1% increase in the share of population in VET education is associated with a 0.84% increase in per capita GDP, all else equal. This effect reflects VET's contribution to improving workforce employability and productivity across key sectors such as manufacturing, logistics, healthcare, and construction (Cedefop, 2020; Rodríguez-Pose & Wilkie, 2020). VET equips individuals with practical, occupation-specific skills that align closely with local labor market needs. These capabilities are crucial in sectors that rely on day-to-day operational effectiveness and process-based improvements. Unlike innovation-led growth, which often depends on advanced research and highly specialized human capital, GDP growth in many European regions is more sensitive to labor force participation and skills matching—areas where VET has proven strengths. Columns 2 and 5 of our regression models introduce an interaction term between VET and manufacturing employment, yielding a positive and significant result. This finding suggests that the GDP-enhancing effect of vocational education is amplified in regions with a strong manufacturing base. Eichhorst et al. (2013) and Sevinc et al. (2020) similarly argue that VET's alignment with regional economic structures boosts productivity, even in less technologically advanced regions. Corradini et al. (2023) further note that VET systems embedded in place-based strategies can drive structural transformation in lagging territories.

While VET may not directly fuel breakthrough innovations, it strengthens regional economies by reducing unemployment, improving job matching, and increasing workforce participation (Brunello & Wruuck, 2019). These effects are particularly relevant for regions where innovation is incremental and sectoral stability is more important than technological disruption. Cedefop (2018) underscores that VET responds to the needs of foundational industries, ensuring their competitiveness through a reliable supply of skilled labor. VET also plays a crucial role in fostering inclusive growth. By providing career pathways for individuals who do not pursue university education, VET contributes to social mobility and economic resilience. This inclusiveness expands labor force participation and supports income generation in communities that may otherwise be excluded from the benefits of growth (Eichhorst et al., 2013; Cedefop, 2020). The impact is particularly relevant for non-core or peripheral regions, where tertiary education rates are lower, and vocational training can fill significant human capital gaps (Canal Domínguez, 2021).

Columns 3 and 6 introduce the talent development trap (TDT) variable and its interaction with VET. The TDT captures vulnerabilities such as youth outmigration, demographic decline, and low educational attainment. Our results show that while TDT is negatively associated with GDP, VET has a positive moderating effect. In regions affected by development traps, increases in vocational education can help mitigate economic stagnation. These interaction terms are

consistently positive and significant, indicating that VET strengthens regional economic performance, even under adverse structural conditions. This supports the view that VET is particularly effective in structurally weaker regions, acting as a buffer against development traps when embedded in coordinated skills strategies. Filippetti et al. (2019) and Corradini et al. (2023) highlight that training policies have a greater impact on employment and economic performance where baseline conditions are weaker. Our findings confirm that VET's contribution to GDP is not only robust but also especially critical in vulnerable regions. In summary, while VET's role in supporting innovation may depend on specific regional and sectoral conditions, its impact on GDP is consistently positive and reinforced in contexts with strong manufacturing or structural challenges. These results underscore the importance of integrating VET into regional development strategies aimed at boosting inclusive, place-based economic growth.

3. Conclusions

This paper explored the role of Vocational Education and Training (VET) in shaping regional innovation and economic performance across Europe. We found that while VET is negatively associated with innovation overall, it is positively linked to GDP and promotes innovation in manufacturing-oriented regions. These findings underscore the importance of regional economic structures in mediating the effects of VET. VET enhances productivity by equipping workers with practical, job-relevant skills—particularly in sectors like manufacturing, logistics, and healthcare. Its economic benefits are amplified when embedded in supportive regional frameworks that align training with local industrial needs. Public-private partnerships between VET institutions and firms ensure that programmes remain responsive to evolving technologies and market demands. When integrated into coordinated regional governance structures, such partnerships can foster dynamic innovation ecosystems (Boschma et al., 2013; Corradini et al., 2023). Several European regions illustrate this approach. In Germany's Baden-Württemberg, the dual apprenticeship system aligns vocational training with firm-level innovation needs. Emilia-Romagna in Italy connects VET programmes with firms like Ferrari and Ducati, while Upper Silesia in Poland has developed similar models for Industry 4.0 upskilling. These cases show that VET can contribute meaningfully to innovation when institutionally embedded in regional development strategies (Raagmaa & Keerberg, 2017; Rodríguez-Soler & Brunet Icart, 2017). Innovation hubs also demonstrate how VET can support applied R&D. In the Netherlands' Brainport Region, Summa College involves students in real-world projects with firms like Philips and ASML. Similarly, the Pôle Formation UIMM in Nantes integrates VET students into collaborative manufacturing and maritime innovation efforts. These examples highlight the value of aligning VET with research and industry to stimulate regional innovation.

For VET to fulfill its potential, it must be part of a broader, place-sensitive policy mix. Effective strategies require coordination across education, industrial, and innovation policy domains and should include mechanisms for lifelong learning and upskilling (Cedefop, 2019; Filippetti et al.,

2019). In structurally weaker regions, VET can support resilience, but only if backed by sustained investment and institutional capacity. The observed negative correlation between VET and innovation in some areas highlights the risk of overly rigid, narrowly defined training. Future-oriented VET systems must integrate entrepreneurial and R&D components and engage with broader innovation networks. When spatially embedded and strategically governed, VET can support both incremental and transformative innovation in an evolving regional economy.

References

Albizu, E., Olazaran, M., Lavía, C., & Otero, B. (2017). Making visible the role of vocational education and training in firm innovation: evidence from Spanish SMEs. European Planning Studies, 25(11), 2057–2075.

Allais, S., & Schöer, V. (2024). Vocational skill development strategies of manufacturing companies in six low- and middle-income countries: an exploratory study. Journal of Vocational Education and Training, 1–31. https://doi.org/10.1080/13636820.2024.2428764

Backes-Gellner, U., & Lehnert, M. (2021). The Contribution of Vocational Education and Training to Innovation and Growth. Oxford Research Encyclopedias: Economics and Finance. https://doi.org/10.1093/acrefore/9780190625979.013.653

Boschma, R., Iammarino, S., & Steinmueller, W. E. (2013). Editorial: Geography, skills and technological change. Regional Studies, 47(10), 1615–1617.

Brunello, G., & Wruuck, P. (2019). Skill shortages and skill mismatch in Europe: A review of literature. IZA Discussion Paper No. 12346.

Büyükyazıcı, M., Gümüş, S., & Demirkaya, Y. (2023). Geography, skills, and technological change. Regional Studies, 57(1), 19–34.

Cedefop (2020). Empowering individuals to contribute to innovation and skills development. Luxembourg: Publications Office of the European Union.

Corradini, C., Morris, D., & Vanino, E. (2023). Towards a regional approach for skills policy. Regional Studies, 57(6), 1043–1054.

Eichhorst, W., Hinte, H., & Rinne, U. (2013). Youth Unemployment in Europe: What to Do about It? IZA Policy Paper No. 65.

Filippetti, A., Guy, F., & Iammarino, S. (2019). Regional disparities in the effect of training on employment. Regional Studies, 53(5), 711–722.

Piva, M., & Vivarelli, M. (2018). Technological change and employment: Is Europe ready for the challenge? Eurasian Business Review, 8(1), 13–32.

Raagmaa, G., & Keerberg, A. (2017). Regional higher education institutions in regional leadership and development. Regional Studies, 51(2), 260–272.

Rodríguez-Pose, A., & Wilkie, C. (2020). Innovation and regional growth in Europe: The role of labour market institutions. Research Policy, 49(7), 104042.

Rupietta, C., & Backes-Gellner, U. (2019). How firms' participation in apprenticeship training fosters knowledge diffusion and innovation. Journal of Business Economics, 89(6), 569–597.

Sevinc, D., Fitjar, R. D., & Rodríguez-Pose, A. (2020). Ensuring skills are available in the right locations: Are we there yet? A regional analysis of qualification gaps. Regional Studies, 54(11), 1548–1560.

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Case study design for facilitating the green transition of the maritime industry

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Abstract

The future green transition of the maritime industry is largely driven by electrification and a shift towards using more sustainable fuels such as green methanol or ammonia. Higher education must facilitate this transition and is under pressure to bridge the growing green skills gap across the industry. For this purpose, a new case study designed to convey key project management competencies of a green transition in the maritime industry is presented. The study contributes to case-based learning research and practice by demonstrating and discussing how the green transition can be facilitated in teaching and learning based on a real-world example.

Keywords: *Case-based learning (CBL); Project management; Sustainability and SDG in higher education.*

1. Introduction

The green transition, i.e., the decarbonization of global industry sectors, is paramount to mitigating the ongoing climate crises and meeting the so-called "1.5°C target" outlined in the Paris Agreement (UNFCCC, 2018). The International Maritime Organization (IMO) identified that the share of shipping emissions in global anthropogenic emissions has increased by 13% over 6 years from 2.76% in 2012 to 2.89% in 2018 (IMO, 2020). Hence, as a relevant contributor to climate change, the member states of the IMO adopted in 2023 the IMO Greenhouse Gas Strategy to reduce greenhouse gas (GHG) emissions from international shipping, including a commitment to reach net-zero GHG emissions close to 2050 (IMO, 2023). This future green transition of the maritime industry is largely driven by electrification and a shift towards using more sustainable fuels such as hydrogen or methanol.

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The green transition has brought with it the introduction of new skills and knowledge to address sustainable design, environmental management, and green technologies (Thake, 2025). Both, industry and higher education, must facilitate the green transition in the maritime industry and are under pressure to bridge the growing green skills gap. Currently, the growth in demand for green skills is outpacing its supply with seven in eight workers lacking even a single green skill (LinkedIn, 2023).

With this approach to case-based learning, we intend to contribute towards closing the skills gap in teaching and learning in higher education within the context of engineering management. We are proposing a new case study design to convey key project management competencies of a green transition in the maritime industry to undergraduate and postgraduate students. This includes the investigation of the following main research question (RQ):

RQ: How can a case study be designed to convey relevant project management competencies of a green transition in the maritime industry?

2. State-of-the-art

2.1. Case-based learning

Cased-based learning (CBL) as an active teaching method (Cen et al., 2021) introduces the complexity of the real world in teaching and learning by using scenarios, challenges, and problems (Pinto, 2022). While being quite similar to problem-based learning (PBL), its main difference is that CBL can include all details of the underlying problem, including the solution, and often requires learners to develop solutions with the guidance of the teacher, which often makes CBL less complex and easier to implement for achieving the learning outcomes (Pinto, 2022). CBL can provide an open-ended exploration of solutions, encourage discussion and explore ambiguity while offering more structure and targeted assistance to the learner during the solution-finding process (Srinivasan et al., 2007). Some recent studies confirm the general effectiveness and efficacy of CBL for different educational areas such as the medical and pharmaceutical (Tsekhmister, 2023; Cen et al., 2021), psychology (Wu et al., 2023), anatomy (Sangam et al., 2021), or leadership education (Asyifa et al., 2024). Maslen and Hayes applied CBL in engineering practice and demonstrated that it is useful to implement Kolb's four-stage model of experimental learning (Kolb, 2014) in teaching activities (Maslen and Hayes, 2020). To facilitate deeper learning, some studies discuss combining additional teaching approaches with CBL. For example, Tayce et al. discuss the combination of CBL with peer-assisted and just-in-time teaching and learning (Tayce et al., 2021), while van Erp highlights an approach for combining CBL with project, and research-based learning (van Erp, 2022).

2.2. Green transition in the maritime industry

The maritime industry is composed of maritime shipping, ports, management, and ancillary services as its main elements (Notteboom et al., 2022). Wang et al. (2023) elaborate that green shipping management can reduce carbon emissions by using new green fuels, and green port construction can increase profits implementing electrification and automation solutions. Other authors highlight clean technology adoption and environmental policies such as emissions trading schemes as important drivers (Buchmann, 2022) and emphasise the relevance of a digital transformation to support a green transition (Oloruntobi et al. 2023). The adoption of this so-called twin (green and digital) transition can assist the maritime industry improve efficiency while reducing its environmental impact (Laybourne, 2023).

2.3. Project management

Project management is oriented on the integrated project management practices or life cycle phases of a project, spanning from pre-project activities, initiating a project, overseeing, directing, and controlling a project, to managing delivery, closing a project, and post-project activities (ISO, 2020). It covers management practices related to planning, benefits, scope, resources, cost, quality, and risks among many others (ISO, 2020). In addition, modern project management addresses agile, hybrid, data-driven or lean approaches.

3. Case-based learning design

3.1. Method

The research method for designing the case study as a central element of case-based learning follows a qualitative, action-research approach comprised of critical reflection. The design process hereby is understood as a dialogue between a problem and a solution through an iterative process of analysis, synthesis, and evaluation (Nijhuis and Vries, 2019). The morphology presented in Table 1 highlights the fundamental criteria and constraints for performing this iterative design process.

Table 1. Morphology of design criteria and constraints.

Learning activities	Should reflect the relevant activities of the project life cycle (ISO, 2020).
Case Study Subject	Should reflect key aspects of the twin (green and digital) transition of the maritime industry.
Case Study Structure	Should reflect the key elements of a business model according to Osterwalder and Pigneur (2010).
Constraints	Should support 3 assessment types: Creation of project management artifacts, results presentation, and quiz; should be suitable for 4 days (4 x 8h) learning activities, where 4-6h per day are used for student work on the case study.

3.2. Results

3.2.1. Student tasks, rationale, and constraints, results

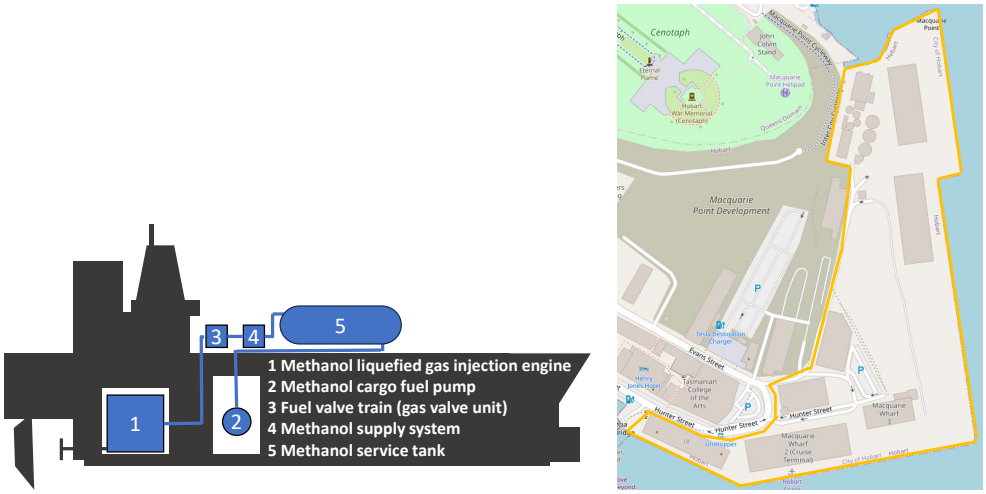
The results of the design process are introduced in the following sections. Table 2 presents the task, rationale, deliverables, and constraints for the case study.

Table 2. Task, rationale, deliverables, and constraints.

Task (for student groups of 4 to 6 team members)	• You as a student group are acting as a project planning team from a civil shipbuilding and construction company located in Australia. • The company aims to establish a new business unit for building, maintaining, and retrofitting climate-neutral vessels, and just bought the port in Hobart, Australia, for this purpose. • The sustainable vessels will be using methanol as a fuel for the engine. As a project team you are responsible for re-imagining the current port in Hobart, so that it can be used for building, maintaining, and retrofitting, climate-neutral vessels. • Retrofitting means installing a new methanol drive system by replacing the conventional drive system of a vessel.
Rationale (to motivate the case study for the students)	• "Green ambitions are high, with shipowners and operators dedicating manpower to green initiatives and developing roadmaps"; 73% view net zero as a high priority and 77% have set net-zero targets (Loo et al., 2023). • For example, the shipping giant Maersk plans to achieve net zero emissions across its business and offer 100% green solutions to customers by 2040 with green methanol as a cornerstone of this transition towards more sustainable e-fuels (Maersk, 2022).
Deliverables (to be presented to the fictive board of directors)	• Business case of the new facility and project plan. • Re-imagined conceptual layout for the port including an overview of shipbuilding and retrofitting processes, an indication of the material flow and a selection of key manufacturing, and material handling equipment. • Technology radar for prescriptive and predictive maintenance of the vessel.
Constraints (to be considered while developing project solution for the case study)	• Cutting-edge technology: Industry 4.0-ready. • High Changeability: Layout should be easy to change for new products. • Sustainable: Re-use as much as possible from the already existing infrastructure and utilise local contractors and suppliers if possible. • Cost-efficient: Budget should be in the range of $50Mio. to $80Mio. • Time-efficient: The facilities should be ready to use by 01.06.2026

3.3.2. Product and site

The case study product which will be manufactured by the shipyard is a 65m coastal roll-on, roll-off (RORO) vessel operated on green methanol, while the shipyard site is the port area in Hobart, Tasmania (Figure 1).



(a) (b)

Figure 1. (a) Product. Source: Methanol Institute (2020). (b) Site. Source: OpenStreetMap (2024).

3.3.3. Customers and stakeholders

Table 3 lists the customers and other relevant stakeholders of the project.

Table 3. Customers and stakeholders.

Tasmanian Government	• Will buy 3 vessels per year for the next 5 years including a 20-year maintenance contract for the vessels. • Aims to promote tourism from and to the islands around Tasmania as well as the local industry by upgrading the shipping capacities.
Government of Indonesia	• Will buy 7 vessels per year for the next 20 years including a 20-year maintenance contract for the vessels. • Aims to promote tourism from and to the islands around Indonesia as well as the local industry by upgrading the shipping capacities.
Australian coastguard	• Will have 5 vessels per year retrofitted.
City of Hobart	• Requires the creation of at least 50 new jobs and subsidises the shipyard with $20 Mio.
Local port community	• Aims for safe and quiet operation of the new ports, lobbies for a stop of operations between 8.00 p.m. and 7.00 a.m. and no weekend shifts.

3.3.4. Additional context

To support the case study, additional context is made available to the students. This context includes: (1) Additional stakeholders and their expectations and values; (2) an organizational chart of the company and affiliation of the project planning team; (3) the project scope, including a proposal for a work package structure; (4) the shipbuilding process chain, including relevant

layout zones, key fabrication and assembly technologies, and material handling equipment; (5) the maintenance process chain for vessel maintenance, i.e., prescriptive, predictive, preventive, reactive/ corrective maintenance, including layout zones, and key technologies; (6) the retrofitting process chain, including layout zones, technologies, and material handling equipment; (7) an example of a port layout including a depiction of a generic material flow and relevant manufacturing, assembly, and material handling zones; and (8) the relevant phases of facility planning from target specification to ramp-up support.

3.3. Proof-of-concept

The first implementation of the case study design was tested at Flinders University in 2024. The sample size for validation was comprised of more than 20 diploma students but did not include the gathering of primary data for an in-depth validation and evaluation of the case. Thus, a future replication aims at implementing the case in a controlled teaching environment in combination with an accompanying ethics approval to evaluate the efficacy and effectiveness of the case design by gathering student feedback about the learning process and outcomes by using Kolb's four-stage model of experimental learning (Kolb, 2014) as a theoretical foundation for the evaluation. We aim to gather student feedback on how the case study impacts the competency and skill building for the green transition as well as for project management. This data will allow us to derive further improvements for the next iteration of the case study design.

4. Discussion

The case study demonstrates one possible design pathway for applying case-based learning for teaching the green transition of the maritime industry while simultaneously emphasizing the development of relevant project management competencies. The case study design contributes to CBL research and practice by providing a specific example that enables the creation of novel approaches for efficaciously applying case-study design learning in project management. The case study is expected to enable the competency development of future maritime professionals, allowing them to make a meaningful contribution to the IMO GHS reduction strategy (IMO, 2023) and the Paris Agreement (UNFCCC, 2018). Furthermore, it is expected to provide teachers in higher education with a relevant teaching concept for supporting the United Nations (UN) Sustainable Development Goals (SDGs), specifically SDG 7 and SDG 9 (UN, 2015). However, an in-depth evaluation of the case study design to efficaciously and effectively teach aspects of the green transition and project management competencies still needs to be performed. Thus, future study activities aim at confirming the importance of implementing a case-based learning design in higher education which ultimately can equip the next generation of workforce employees to understand the costs and benefits of the green transition (Thake, 2025) in workplaces and particularly the maritime industry. These costs and benefits can be shared between employees, organizations, and communities (Thake, 2025).

5. Conclusion

The study creates new insights into how case-study-designed learning can be utilized during the different life cycle phases of project management to improve the problem-solving and solution-finding process. To support the success of the green transition, higher education in conjunction with training policies plays a significant role in ensuring that today's workforce has the relevant knowledge and skills to adapt to the changing requirements of the green economy. This study contributes to the growing body of literature on educational impact by exploring how case-study learning can be designed with the broader goals of higher education, including fostering critical thinking, creativity, and career readiness. The study findings offer valuable insights for educators and institutions seeking to leverage case-study learning to enhance the effectiveness of group work and prepare students for the green transition workplaces of the future. This study is timely given the rapid advancement of the green transition and the increasing emphasis on collaborative skills in the modern workforce.

References

Asyifa, M., Tarjiah, I., & Utomo, E. (2024). Evaluating the effectiveness of case-based learning in designing basic leadership training: a systematic literature review. Jurnal EDUCATIO: Jurnal Pendidikan Indonesia, 10(2), 266-273.

Buchmann, F. M. (2022). Driving the Green Transition of the Maritime Industry through Clean Technology Adoption and Environmental Policies. Copenhagen Business School [Phd]. PhD Series No. 10.2022.

Cen, X. Y., Hua, Y., Niu, S., & Yu, T. (2021). Application of case-based learning in medical student education: a meta-analysis. European Review for Medical & Pharmacological Sciences, 25(8).

IMO (2020). Fourth Greenhouse Gas Study 2020. International Maritime Organisation.

IMO (2023). Revised GHG reduction strategy for global shipping adopted. International Maritime Organisation. News. 7th July 2023.

ISO (2020). ISO 21502:2020 - Project, programme and portfolio management — Guidance on project management. International Organization for Standardization.

Kolb, D. A. (2014). Experiential learning: Experience as the source of learning and development. FT Press.

LinkedIn (2023). Global Green Skills Report 2023.

Loo, L., Kuttan, S. C., Tan, M. Mohottala, S., Goh, S. C. (2023). Voyaging Toward a Greener Maritime Future. Boston Consulting Group. Available online at: https://www.bcg.com/publications/2023/voyaging-toward-a-greener-maritime-future

Maersk (2022). A.P. Moller-Maersk accelerates Net Zero emission targets to 2040 and sets milestone 2030 targets. Press release. 12th January 2022.

Maslen, S., & Hayes, J. (2020). Case based learning among practicing engineers: design, facilitation and lessons learned. Cognition, Technology & Work, 22(2), 307-319.

Methanol Institute (2020). Methanol as a Marine Fuel. Presentation. Available online at: https://www.methanol.org/wp-content/uploads/2020/01/Methanol-as-a-marine-fuel-january-2020.pdf

Nijhuis, S., & de Vries, J. (2019). Design as research in landscape architecture. Landscape Journal, 38(1-2), 87-103.

Notteboom, T., Pallis, A.& Rodrigue J.-P. (2022). Port Economics, Management and Policy, New York: Routledge.

OpenStreetMap (2024). https://www.openstreetmap.org/#map=17/-42.879616/147.342796. OpenStreetMap data is licensed under ODbL.

Oloruntobi, O., Mokhtar, K., Gohari, A., Asif, S., & Chuah, L. F. (2023). Sustainable transition towards greener and cleaner seaborne shipping industry: Challenges and opportunities. Cleaner Engineering and Technology, 13, 100628.

Osterwalder, A., & Pigneur, Y. (2010). Business model generation: a handbook for visionaries, game changers, and challengers (Vol. 1). John Wiley & Sons.

Pinto, B. L. (2022). Distinguishing between Case Based and Problem Based Learning. International Journal of Kinesiology in Higher Education, 7(3), 246–256.

Sangam, M. R., Praveen, K., Vinay, G., Bokan, R. R., Deka, R., & Kaur, A. (2021). Efficacy of case-based learning in anatomy. Cureus, 13(12).

Srinivasan, M., Wilkes, M., Stevenson, F., Nguyen, T., & Slavin, S. (2007). Comparing problem-based learning with case-based learning: effects of a major curricular shift at two institutions. Academic Medicine, 82(1), 74-82.

Tayce, J. D., Saunders, A. B., Keefe, L., & Korich, J. (2021). The creation of a collaborative, case-based learning experience in a large-enrollment classroom. Journal of Veterinary Medical Education, 48(1), 14-20.

Thake, A. M. (2025). Transitioning to a green economy-the impact on the labor market and workforce skills. In: Greening Our Economy for a Sustainable Future (pp. 163-175). Elsevier.

Tsekhmister, Y. (2023). Effectiveness of case-based learning in medical and pharmacy education: A meta-analysis. Electronic Journal of General Medicine, 20(5).

UN (2015). The 2030 Agenda for Sustainable Development. United Nations.

UNFCCC (2018). The Paris Agreement. United Nations Framework Convention on Climate Change. Paris Climate Change Conference - November 2015.

van Erp, T. (2022). Combining Research-, Project-, and Case-Based Learning in Higher Manufacturing Engineering Education. In Global Conference on Sustainable Manufacturing (pp. 1016-1024). Cham: Springer International Publishing.

Wang, T., Cheng, P., & Zhen, L. (2023). Green development of the maritime industry: Overview, perspectives, and future research opportunities. Transportation Research Part E: Logistics and Transportation Review, 179, 103322.

Laybourne, G. (2023). Sailing towards the twin transition: How shipping can use digital to decarbonize. World Economic Forum Annual Meeting. 16th January 2023

Wu, F., Wang, T., Yin, D., Xu, X., Jin, C., Mu, N., & Tan, Q. (2023). Application of case-based learning in psychology teaching: a meta-analysis. BMC Medical Education, 23(1), 609.

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Bringing Science Fiction into teaching of Bioethics

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Abstract

This article questions science fiction might be considered as a pedagogical tool for teaching bioethics in higher education. One can stress that science fiction narratives can stimulate critical thinking and provide a lens for understanding complex ethical dilemmas. It can be highlighted that science fiction has the ability to illustrate abstract bioethical concepts, provoke in-depth debates about scientific and ethical implications, and support students to develop judgment and practical reasoning skills. Potential methodological pitfalls are addressed, such as oversimplification, scientific inaccuracies, and cultural biases. A structured approach is proposed for selecting and integrating science fiction works into teaching, emphasizing the importance of scientific accuracy, thematic relevance, and educational value. A practical pedagogical framework for using science fiction in bioethics courses, including a proposed course design for bachelor-level students that encourages active learning and critical analysis, is presented and discussed.

Keywords: *bioethics; science fiction; Critical thinking; decision-making skills, evaluation grid*

1. Introduction

Students are exposed to an increasing amount of information, which necessitates the use of a set of tools and knowledge to navigate and orient themselves in order to distinguish facts from interpretations, as well as truth from error. Managing this critical mass of information disrupts the relationship to knowledge and has become a particularly pressing issue in the context of socially sensitive questions. Among these, the ethical challenges associated with advances in medicine and biology are regularly debated and result in legislative frameworks or the creation of practical guides by research ethics committees. Ethical issues related to the environment translate into a climate of eco-anxiety among young adolescents and young adults (Costello et al., 2009). Addressing bioethical questions has become a major challenge in higher education.

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This challenge can be linked to other questions: How do we learn and how do we teach in a context where there is immediate access to a multitude of contents, mixing knowledge, pseudo-knowledge, beliefs, and opinions? What resources and cases should be analyzed with students? How can we evaluate their understanding of ethical questions?

Training in critical thinking and practicing critical thinking appear as viable options to explore tools and methods for addressing bioethical questions. Students can adopt these tools and apply them in other domains. Critical thinking transcends disciplines: it engages students in an active, inter-relational stance, teaching them to position themselves as citizens through skills that will develop both professionally and personally. The development of critical thinking aligns with societal demands for upholding democratic values (Lecointre, 2018).

By nature interdisciplinary, bioethics requires significant investment from teachers. While bioethics is sometimes perceived as being limited to medical questions, where teachers may feel a lack of legitimacy, a broader conception can be mobilized. The term "bioethics" emerged in the U.S. in the 1970s, originating in Wisconsin and Georgetown (Potter, 1970). Van Rensselaer Potter in Wisconsin envisioned bioethics as a “science of survival” integrating biology and human values, while André Hellegers in Georgetown focused on medical ethics for clinical problem-solving. Potter’s broader vision addressed humanity's existence over time and space, contrasting Georgetown's traditional medical ethics. Milestones include the 1979 Belmont Report's principles of autonomy, beneficence, non-maleficence, and justice, foundational for research ethics following the revelations of the scandal of the Tuskegee study’s on syphilis.

Based upon feedback from teaching bioethics in higher education (Bodart and Poteaux, 2022; Canu et al., 2022), the article addresses the use of science fiction as a pedagogical tool for teaching bioethics and proposes a scheme and criteria of an evaluation grid.

2. How Science Fiction may contribute to Bioethics teaching?

2.1. Science Fiction as a Multifaceted Tool for Bioethics Education through defamiliarization, and critical thinking

Science fiction offers multiple dimensions that enrich understanding and stimulate critical thinking. Its narratives provide (1) a mirror to comprehend the present, (2) a warning through extrapolation of current trends, and (3) a way to challenge immutable assumptions, proposing alternative “realities”. One notable concept is the *mooreeffoc effect*, created by G.K. Chesterton and popularized by C.S. Lewis. This "defamiliarization" effect reframes familiar ideas or objects through an unusual lens, reigniting a sense of wonder. Such reframing challenges student’s habits of perception, prompting them to reassess ingrained mental frameworks. This re-evaluation mirrors the cognitive shifts achieved through ethical thought experiments, like the *trolley problem* created by P. Foot. These methods can promote ethical reasoning.

Science fiction novels and movies can be effectively integrated into pedagogical alignment and contribute to teach bioethics in different manners (Gordijn and Have, 2017). Learning activities can be built according to the aims of the pedagogical alignment. First, *science fiction novels and movies may act as intuition pumps to illustrate concepts and dilemmas*; they can illustrate complex concepts and therefore they may increase the accessibility of potential abstract bioethical concepts (1) through engaging narratives and plausible situations, and (2) through contextualization and familiarization with ethical dilemmas by exploring future scenarios. Indeed, science fiction scenarios constitute spaces to explore our fears, hopes, and ideals related to biomedical advances or socio-economic choices. Second, *science fiction novels and movies can stimulate critical thinking.* They can provoke in-depth debates and reflections on the ethical implications of scientific advances. Students can exercise practical reasoning by analyzing the situations presented and study the ethical decisions of characters in various situations and analyze moral choices made by the characters. Yazici and colleagues (2010) noted in their study that debates on bioethical issues with the benefit of science fiction presentation were observed to be most effective method for student to develop their judgment towards bioethical issues, grasping both theoretically and experimentally aspects with positive attitudes.

To be efficiently used, one might be cautious by carefully selecting works based on their relevance (nature of the bioethical issues involved) and scientific quality. Moreover, the selected works shall be integrated into a structured pedagogical framework, complementing other academic resources, such as historical cases. Proposed teaching shall enhance student engagement through narrative immersion, transcending traditional theoretical frameworks such as thought experiments (e.g., the trolley dilemma), and employing the Mooreeffoc effect to potentially create socio-cognitive conflict. Nevertheless, one shall not forget to encourage students to develop a critical perspective on the representations proposed.

2.2. Pitfalls of using science-fiction novels and movies

Several methodological pitfalls and challenges have to be considered, therefore leading the choice of science-fiction presenting a scientific accuracy or at least, an accuracy that can be easily discussed. As discussed above, academic articles shall be provided to complete the analysis of the ethical issues. Context and background information will be of use to enable the students to distinguish between speculative elements and current scientific realities. First, science fiction works may provide oversimplification of complex issues, by presenting bioethical dilemmas in a simplified manner, or they may offer a limited scope, not covering all the relevant bioethical issues, or focusing in a disproportional manner on certain topics, neglecting the others. Second, students must be aware that not all science fiction works are based upon accurate scientific facts, which could lead to misconceptions about technologies. It may raise difficulties to distinguish fiction from reality: students may struggle to distinguish between speculative elements and real scientific possibilities, potentially leading to misunderstandings

about current biotechnological abilities, for therapeutic purposes for example. Third, several works of science fiction may exhibit bias. In one hand, they are often products of their time and cultural context, which may limit their relevance or suitability for use in bioethical debates. On the other hand, other works may rely on emotional manipulation rather than logical reasoning. Such cases shall not be included in a pedagogical scenario, unless being used as an example to exert critical thinking and expose with clarity the bias. For example, works like *Westworld* or *Black Mirror* shape cultural perceptions of technology and ethics, yet their suspension of disbelief can lead audiences to accept fictional premises uncritically. Fourth, dystopias rely on worst-case scenarios, which may instill undue fear or pessimism about scientific advancements, and therein, hinder a balanced discussions about the potential benefits and risks within an ethical dilemma. One shall find the references associated with these analysis within table 1.

3. How to choose an appropriate science-fiction work?

Science fiction bridges fiction, theory and reality, and may provide contents preparing students to navigate through complex ethical landscapes with imagination, empathy, and critical insight. The selection of science fiction works depends on various criteria :

- Thematic Relevance shall resonate with the purpose of illustrating or analyzing bioethics principles, like ethical dilemmas (e.g., AI, genetic engineering), societal issues (e.g., dystopian futures, climate change), or philosophical questions about humanity and existence.

- Scientific Accuracy and Plausibility : scientific elements should be logical and align with known facts or theories commonly shared in the scientific community. Beyond the consistency or science, hard science fiction works focus on accurate scientific details and plausible technological advancements (e.g., physics, astrophysics) while soft science fiction works may focus more on societal or philosophical themes, with less emphasis on scientific rigor.

- Educational value. Selected works can provoke critical thinking and debates about ethical or scientific issues. It is necessary to ensure the work aligns with educational goals, such as introducing values (figure 1) and/or scientific concepts.

Narrative quality, consistency and character development are also of interest by providing in depth understanding of moral choices made by the characters. Cultural and contextual relevance ought not to be neglected since they are factors of immersion. Science fiction masterpieces create a cognitive reservoir of imagined experiences that examine potential applications and consequences of scientific and social developments. Emerging genres like climates fiction highlighted environmental ethics, blending imaginative storytelling with urgent real-world concerns. Table 1 groups together, in a non-exhaustive manner, novels, films or television series that can be employed, as well as references where these resources have been analysed. These works of fiction might be used alone, in the multiple dimensions that they expose. Alternatively,

the understanding of a single principle, such as that of human dignity, can be illustrated through the mobilization of several works like Brave New World, Gattaca, The Parable of the Sower, The Handmaid's Tale or Flowers for Algernon.

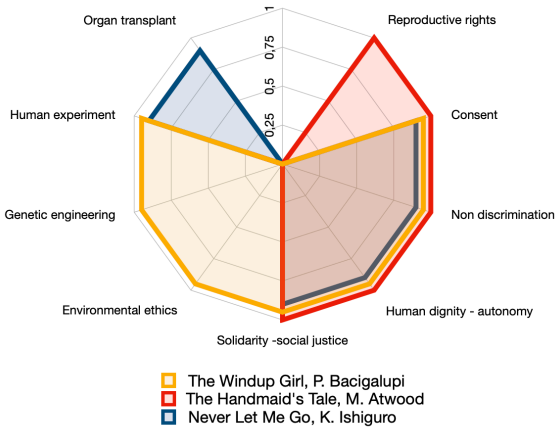


Figure 1. Comparison of the use of three different science fiction works to study values raised in bioethics (arbitrary unit).

Table 1. Works of fiction and anticipation that can be used to discuss and analyze ethical issues.

Fiction's name	Fiction's format	Principles and values	References
Brave new world, A. Huxley	Novel (1932)	Genetic manipulation, social control, non-discrimination and eugenics	Chan, 2009; Rumpala, 2015,
Dune, F. Herbert	Roman (1965), Movie (2021)	Ecological crisis, environmental ethics	Rumpala, 2015
The Handmaid's tale, M. Atwood	Novel (1985), Television (2017)	Reproductive rights, non-discrimination and eugenics, consent, human dignity and social justice.	Magee, 2018
Gattaca, A. Niccol	Novel (1997)	Genetic manipulation, non-discrimination and eugenics.	Ogbunugafor et Edge, 2022 ; So et al., 2022
Never let me go, K. Ishiguro	Novel (2005), Movie (2010)	Human cloning, exploitation of bodies, human dignity	Chan, 2009
The windup girl, P. Bacigalupi	Novel (2009)	Genetic modification, slavery of modified creatures, ecological crisis.	Rumpala, 2015
Black Mirror	Television (2011-14 ; 2016- 24).	Artificial intelligence, privacy, autonomy, human dignity, mental manipulation	Chan, 2009

4. Building up a pedagogical script integrating science-fiction works in a bachelor course for introduction to bioethics

A course fostering critical thinking and reflection has been part of our bioethics teaching since 2020. Two formats were developed to fit Bachelor architecture constraints, referred to as L2 and L3 courses. Since some students attend both years, we adapted the teaching to maintain L3 engagement while considering constructive alignment. For 2024–2025, we added science fiction analysis. The course includes a 2-hours session and two student presentation sessions (Canu et al., 2022). The first session focuses on: (1) reviewing the course's reflective framework and critical thinking goals, (2) selecting science fiction works tied to specific bioethical principles, and (3) choosing real cases linked to those themes.

Students who created evaluation grids the previous year will be able to reuse these grids to evaluate their presentation work as well as the presentations of their peers' work. However, these grids must be modified to include new criteria: relevance of the film or novel to illustrate a bioethical issue, contextualization and analysis of the scientific accuracy and plausibility, critical analysis of values and ethical dilemmas within science fiction and relation to real cases.

Between the two presentation sessions, students receive informative feedback from the teacher on their performance. At the end of the first session, students fill out a self-assessment sheet of their work. They are asked to respond on several dimensions: quality of their group work organization, work atmosphere, distribution of the workload in the group. They must also comment on the contribution of fiction to the work on bioethical issues, the strong points of their presentation performance, and areas for improvement.

An evaluation of the courses will performed, including (i) an analysis of students' evaluation grid productions by the teachers (clarity of criteria, clarity and relevance of descriptor, use of the grid by the students, (ii) an analysis of the student' self-assessment sheets, (iii) an anonymous questionnaire carried out using socrative platform (made up of 23 closed questions organized as follows : (1) general appreciation, (2) lessons, (3) animation of the lesson and interactions, (4) activities and (5) evaluation; and open-ended questions focused on the relevance of teaching in their training, on the three strengths of teaching and the last question invited students to provide suggestions for improving teaching) and (iv) group interviews.

In the context of a case analysis, several expectations must be met. Students must demonstrate an understanding of the narrative framework of the novel or movie, and the ability to identify the values related to bioethics present in the work, as well as the evidence that shows the tension between these values; students must also demonstrate the ability to scientifically contextualize the resource (plausibility, factual errors, confrontation with current techniques, theories not taken into account). As an example of case analysis, Gattaca, a 1997 science fiction film by Andrew Niccol, serves as a powerful tool for exploring bioethical issues (Ogbunugafor et al, 2022; Greenbaum and Gerstein, 2022). Set in a dystopian future, it depicts a society divided

between genetically engineered "valids" and naturally conceived "in-valids." It encourages critical thinking about the long-term consequences of genetic technologies and the balance between scientific progress and ethical considerations. Together with Aldous Huxley's Brave New World, Gattaca offers a context to remind students of milestones in molecular biology concepts. Molecular biology emerged in the 1930s when genetics and biochemistry converged. Major advancements occurred in the 1940s-50s, including the discovery of DNA's structure through X-ray diffraction. In 1953, the identification of DNA's double helix was a key milestone, and by the 1960s, decoding the genetic code revealed how DNA sequences code for proteins. The 1990s Human Genome Project revolutionized DNA sequencing, while recent breakthroughs like genetic engineering using CRISPR-Cas9 and synthetic biology continue to open new perspetives, from fundamental research to therapeutic purposes. Many of the core concepts mentioned in the movie are anchored in scientific reality, with limits to be considered: (1) the film's portrayal of genetic prediction is somewhat exaggerated but not entirely implausible. Current research has made significant advances in predicting traits and disease risks based on genetic information. Students shall note that if epigenesis was neglected in the movie, its importance is crucial and can be discussed with students, in a debate on genetic determinism; (2) practice of selecting embryos based on genetic traits, as shown in the film, is already a reality (pre-implantation diagnosis), though not to the extent depicted in Gattaca. (3) while not as overt as in the film, concerns about genetic discrimination in employment and insurance are very real in today's society. It offers the opportunity to expose that, being enforced in the European Union in 2016, the GDPR (General Data Protection Regulation) classifies genetic data as personal data, imposing strict requirements regarding its collection, processing, and storage. Individuals must provide explicit and informed consent for the use of their genetic data, which must be handled transparently. Finally, several key bioethical principles have to be identified by the students in their analysis of Gattaca: (1) eugenics and human enhancement (2) equality and non-discrimination (3) genetic determinism (4) privacy and genetic information (5) consent and autonomy.

5. Conclusion

In exploring the integration of science fiction as a pedagogical tool for bioethics, the aim was to highlight its unique potential to inspire critical thinking and ethical reflection. Science fiction bridges the gap between theoretical bioethical concepts and their real-world implications. Works such as Gattaca serve as both a cautionary tale and engages students emotionally, facilitating deeper exploration of bioethical dilemmas. To maximize its educational impact, careful selection of science fiction works is essential, prioritizing thematic relevance, scientific plausibility, and cultural resonance. These narratives provide a cognitive framework that complements traditional teaching methods, fostering empathy and enabling students to navigate complex ethical dilemmas with greater nuance.

Ultimately, the use of science fiction in bioethics education not only enriches the learning experience but also provides students with the tools to critically assess the balance between scientific innovation and ethical responsibility in shaping our collective future.

References

Bodart, J. F., & Poteaux, Y. (2022). Développement de la pensée critique chez des étudiants de Licence en enseignements d'introduction à la bioéthique. In *Proceedings of the 32nd Congress of the International Association for University Pedagogy*, Rennes, France, 30 mai-3 juin.

Canu, M.-H., Dehennaut, V., Dupont, E., Pauwels, M., & Bodart, J. F. (2022). Introduction to bioethics through mobilization of critical thinking skills. In *Proceedings of the 8th International Conference on Higher Education Advances (HEAd'22)*, Valence, France, 15-17 juin. https://doi.org/10.4995/HEAd22.2022.14463

Chan, S. (2009). More than cautionary tales: The role of fiction in bioethics. *Journal of Medical Ethics*, 35, 398-399.

Costello, A., Abbas, M., Allen, A., Ball, S., Bell, S., Bellamy, R., Friel, S., Groce, N., Johnson, A., Kett, M., Lee, M., Levy, C., Maslin, M., McCoy, D., McGuire, B., Montgomery, H., Napier, D., Pagel, C., Patel, J., & Patterson, C. (2009). Managing the health effects of climate change. *The Lancet*, 373(9676), 1693-1733.

Gordijn, B., & Ten Have, H. (2018). Science fiction and bioethics. *Medicine, Health Care and Philosophy*, 21(3), 277-278.

Greenbaum, D., Gerstein, M. GATTACA is still pertinent 25 years later. Nat Genet 54, 1758–1760 (2022).

Lecointre G. (2018) Savoirs, opinions, croyances, une réponse laïque et didactique aux contestations de la science en classe, Belin Eds.

Magee, S. (2018). The Handmaid's Tale (Season 1, 2017). *Reproductive Biomedicine & Society Online, 7*, 44-46.

Ogbunugafor, C. B., & Edge, M. D. (2022). Gattaca as a lens on contemporary genetics: Marking 25 years into the film's "not-too-distant" future. Genetics, 222(4).

Potter, V. R. (1970). Bioethics, the science of survival. *Perspectives in Biology and Medicine*, 14(1), 127-153.

Rumpala, Y. (2015). Littérature à potentiel heuristique pour temps incertains. *Methodos*, 15.

So, D., Crocker, K., Sladek, R., & Joly, Y. (2022). Science fiction authors' perspectives on human genetic engineering. *Medical Humanities*, 48(3), 285-297.

Yazıcı, N. N., & Altıparmak, M. (2010). Science fiction aided bio- technology instruction: Effects of bioethics group discussions on achievement and attitudes. *Procedia-Social and Behavioral Sciences, 2(2),* 4125-4129.

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Do you know the Frankenbite? Media Literacy on the power of story and editing

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Abstract

Over the last decade, the hybridization of information and entertainment into infotainment in legacy and social media, plus technical innovations from deep fakes to AI, have escalated the challenge of upholding ethical principles in media creation. Our media literacy curriculum for high school students addresses the prevalence of fictional storytelling in fact-based media. Our goal is to guide students as media consumers to understand and explore the ways in which picture editors alter facts to favour story, and to decipher fact from fiction in audiovisual media. However, the responses and feedback we received after two trial years revealed a disturbing general mistrust of students in all media, questioning of any empirical facts and established science. This article explores this fundamental epistemic dilemma in teaching media literacy, leading to a crisis in society. We are experiencing a shift in the media landscape as dramatic as the transition from oral to written storytelling.

Keywords: *fake news; media literacy; storytelling; editing.*

1. The view from the Cutting Room

The general objective and specific objectives of this paper is to report what television makers do when very little happens in the real. The answer is picture editors go to work. With the frankenbite (Fig. 1)– a portmanteau of "Frankenstein" and "soundbite" – one flip creates conflict where there was none before.

When I first learned about the frankenbite, I assumed its use was limited to Reality TV; I was engaged in documentary – what scholar Bill Nichols calls "a discourse of sobriety" (Nichols, 1991). But when I began to critically analyze my own practices, I realized that I too sacrificed the real and "lied the truth" for a better story. The longing for narrative structure, regardless of genre, demands a multitude of choices, both in the recording and in the editing of fact-based reporting. A documentary film shows what "happens in front of the camera," but only after the

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Figure 1. The Frankenbite. Source: termwiki, no date

deliberate selection and ordering of captured reality. The editing of pictures and sounds is the most significant indicator of a media creator's point of view: what is included, left out, juxtaposed, compared, and the order in which the information is placed. All reveal what the creator considers crucial and propels even nonfiction toward the conclusion the maker has pre-determined. The audience, therefore, is presented not with *the real,* but an interpretation of reality as determined by media makers. Even so, picture editing remains on the margins of media scholarship and largely invisible to media consumers. If the audience *does* notice the editing, their attention is drawn away from the narrative and emotion of the program, hampering their engagement with the intended meaning of the story. This paper will offer two conflicting appearances of narratives, suggest a method to protect media consumers from fake news, report on the outcomes of our research, and discuss key take aways.

2. On Story and Anti-Story

Humans are perpetual storytellers in and of our own lives – we see our lives as a journey, with a beginning, middle, and an end. Roland Barthes positioned narrative as one of the great cognitive categories through which humans understand the world. Without story, humanity would experience life as a blooming, buzzing confusion. Storytelling even pervades academic fields traditionally held to be governed by logic, syllogism, or formula, such as history – the writing of which Hayden White's *Metahistory* (White, 1973) equates with literature– or law and the social sciences. Yet, analysis of narrative practice has not kept pace with its proliferation and celebration in culture.

In recent times, society has delegated an ever-larger portion of its essential storytelling function to legacy media, and now increasingly, social media, where facts are regularly manipulated to create more compelling stories. *Who* tells stories and *how* they are told have fundamentally turned in a direction opposite to enlightenment, and toward profitability and ideology. Our research is grounded in the belief that stories are increasingly destructive, and have permeated the non-fiction media landscape where narratives are now valued more than facts.

The recent phenomenon of "fake news" is the result of a collective attachment to narrative coherence over factual reality. The rise of upon a public that behaves according to emotion rather than rational thought. Neil Postman (Postman and Postman, 2005) famously pointed to a tyranny of story in which we have come to "adore the technologies that undo [our] capacities to think." The new media landscape has led to the emergence of "anti-stories," defined as formulaic and fundamentalist narratives in fact-based mass media, serving the interests of corporate and political elites to sell products or agendas.

But the ability of media consumers to decipher fact from fiction on legacy and social media has not kept pace. The prevalence of media that purports to be fact-based but really just tells stories, coupled with a lack of tools to empower the new generation of media consumers to read and media, expose an urgent need for media literacy education. Our research team hypothesized that most youth do not currently have the critical skills necessary to discern fact from fiction in fact-based programs in legacy and social media. We further postulated a dramatic disconnect between the media studies content students currently engage with in school, the media platforms they engage with their peers, and the media landscape that informs their view of the world outside their own lived experience. We suggested two causes (and thus remedies) for this disconnect. First, student awareness of media does not consider its production and post-production processes. Second, students lack the access to "insider" knowledge regarding media content production, and while being media creators themselves, have not been given the agency of applying editing tools to create their own narratives. To address these gaps, we developed a resource called A Vaccine Against fake news.

3. A Vaccine Against Fake News

Audiences need the necessary tools to distinguish fact from fiction, data from story, and evidence from narrative tropes, in fact-based media. Recent research has shown that most American youth lack the capacity to discern truth from fiction in online news-based media. In Canada, 90 per cent of all citizens say they have fallen for fake news online, with 45 per cent listing television as the most common source of misleading reports. Therefore, we hypothesized that media users lack sufficient media literacy to give them agency as consumers. However, the responses we received from participants during the pilot phase of our research study challenge this assumption.

Hill (2007) defines media literacy as the viewer's ability to analyze and respond to media with a critical distance and a degree of reflectivity about what is perceived. Thus, the study of fact-based programs needs to go beyond indexical concerns about objectivity, factuality, and truth claims. It needs to analyze spectatorship – audiences' cognitive and affective perceptions of nonfiction's mediated reality, in which the degree of mediation is as variable as a spectator's

awareness of it. Civil society's challenge is to ensure that youth learn critical media literacy skills and build their capacities and knowledge to participate in democratic structures.

The theoretical framework underpinning the curriculum's design could clarify how our approach differs from or builds upon existing media literacy models. The resource we are testing, and the means through which we will collaborate with research participants, is a process of experiential learning. Experiential learning involves a cyclical process of knowledge building, knowledge application, and reflective observation (Kolb, 1983). In terms of Media Literacy-specific learning, we are influenced by the media literacy triangle, developed by Eddie Dick (Abreu, 2019). This approach is intended to guide conversations around media by looking at media from three vantage points: text, production, and audience. The central idea is that the text, its production, and its audience all combine to create meaning.

We are interested in the complex, contingent, and context-specific ways that youth negotiate their relationship to mass media. The debate on fake news has heightened, to a lesser degree, public awareness of the composed and mediated nature of television, specifically television programs that claim to give true accounts of everyday reality. As viewers become increasingly media literate, ever more aware of the tricks of the trade and constructed nature of objectivity and balance, we asked whether they will be able to build up a healthy skepticism to protect themselves from fact-based media that manipulates instead of informs, narrates instead of explains. Or will they develop a cynicism that questions or dismisses all fact-based media, whatever its source?

The instrumentalist view that media owners control media content, and that the media performs ideological functions, highlights the potential effects media has on individuals. But these effects also include complex combinations of long-term and short-term processes that audiences may actively negotiate themselves. Society is paying for its media illiteracy in the steady erosion of fact by narrative. This is where our research comes in. To respond to this challenge, we first needed to learn how students use media to construct a factual understanding of the world outside their own lived experience.

We partnered with the Toronto District School Board (TDSB), one of the largest and most diverse school boards in North America, to ensure that the tool we developed would be relevant and accessible to a variety of cultural backgrounds. Exploring both the essential and dangerous qualities of narrative amidst hyperbolic technological change, A Vaccine against fake news came to draw on the insights of those who work with and think about story – picture editors. In user-determined focus groups, we asked students to create their own stories, applying specific video editing techniques. The process of creation had them describe, develop, and test the story, and thus provided educators with new strategies for teaching media literacy. Our aim for the pilot phase of our initiative was to conduct post-workshop surveys with the focus groups, review the resulting data, and then finalize an interactive, open access tool for media literacy education

in high school classrooms anywhere, using browser-based dynamic media creation that allows users to create nonlinear narratives in fact-based media. The survey responses we received, however, would raise fundamental questions about the purpose of media literacy in general and our approach in particular.

4. Outcome

As a mixed-methods action research project, we are ultimately "focused on the improvement of practice" (Merriam & Tisdell) in classrooms across Ontario. Our emphasis on action research means that we have a study design that will develop over time, based on our learning from previous phases. We conceive of it as "a spiral cycle of planning, acting, observing, and reflecting" (Merriam & Tisdell, 2015). In addition, action research also means that we engaged participants as co-investigators. Data analysis was conducted using an open coding process, which will allow for themes to emerge as we simultaneously collected and analyzed our data in an ongoing, iterative manner. We employed a constant comparative method of data analysis to identify key themes from our focus group field notes and survey respondents.

After two years of presentations in Toronto high schools, working with 20 media literacy teachers, curriculum leaders, principals and school librarians, and more than 400 students who responded to pre- and post-workshop surveys, we analyzed the collected data and formulated the following key take-aways. Among the English teachers who teach media literacy education, only one quarter expressed a *very comfortable* level of doing so, while more that 80 per cent of media literacy teachers confessed of having no experience creating media themselves.

Of these teachers, 70 per cent are *not* or are *just slightly* satisfied by the learning their students achieve in media education, and wish they had more time or access to better teaching resources. media literacy frameworks like Critical Media Literacy or the Digital Competency Framework. All of them declared that their students deserve better:

> "I have always felt underprepared to teach media and that even though I discuss what we see and encourage students to question creator bias and think about the choices made in delivery of various media pieces, I only scratch the surface."

The 400+ grade 10-12 students, which ranged in age from 14 to 18, from one of the most diverse school populations in North America, responded to both the pre- and post-workshop surveys did so with guaranteed anonymity. More than 50 per cent of the pre-workshop survey respondents said they had little awareness of how fact-based programs are created.

In the post-workshop survey, students reported an increase in their awareness of how nonfiction media is created from less than 50 per cent to 90 per cent. Student's trust in what they watch and hear on screen *always* or *often* dropped to 22 per cent, from 40 per cent in the pre-workshop survey.

5. Key Take Aways

The one main takeaway from the pilot phase of our workshops pertains not only to the delivery of A Vaccine Against fake news but the very purpose of our project. From the beginning, we had postulated that the fake news problem cannot be fixed at a systems level but only by empowering individual media consumers and creators. The information environment is built on telecommunication infrastructures and services developed following free-market ideology, where "truth" or "fact" are useful when commodified as market products. Controlling media "noise" is therefore less a technological problem than a human problem, a problem of belief and ideology. Agency for sifting fact from fiction, we believed, has to remain with the receiver of information.

> However, post-workshop comments from participants in A vaccine against fake News strongly suggest another – different – impact. Increased awareness of the way fact-based media is created doesn't empower a healthy skepticism but gives room to cynicism:
>
> "The media is becoming less and less real and reliable. With media being such a huge part of today's society its almost scary."
>
> "Although something may seem to be completely real on TV, it's often not. People just want to keep viewers engaged, so they'll achieve that by editing and changing the truth. There are a lot of lies."
>
> "Almost nothing is genuine on the media. False news that are spread are assumed and posted to be very believable."
>
> "I understand how even the simplest parts of the media are manipulated to elicit a specific reaction from viewers."
>
> "Although something may seem to be completely real on tv, it's often not. People just want to keep viewers engaged, so they'll achieve that by editing and changing the truth. There are a lot of lies."

These sobering statements address a fundamental question: How can media consumers find and apply accurate information that contributes to understanding large social and political problems? There is a growing deficit in society of commonly accepted facts and common cultural ground. The result becomes a question of epistemology itself. The real danger of fake news is less media consumers believing the *wrong* thing – inaccurate information – than it is doubting that the right or correct thing is true. If these students' question everything, all the time, does it matter if their source of information is QAnon, which weaponizes narrative to an absurd degree, or *The New York Times*, "all the news that is fit to print"?

The effect of the perception that nothing is genuine on the media has already led many citizens to declare the epistemological bankruptcy of legacy and social media. It is sobering to read how the vice of epistemic obstruction in contemporary habits of media consumption influence the relationship of media consumers to the real. Is it belief systems, not truths, that cement identities and make sense of the complexity of being? Belief in ungrounded things, both sacred and profane, existed long before fake news. But now, media consumers have become increasingly suspect of *all* news sources outside of their echo chambers of comfort; the entrenchment of mistrust makes people more and more likely to deem any source outside these chambers as "news."

If not through media literacy, then, how are young people to cope with the contemporary tsunami of information? As a result of feedback from student participants, we have decided to dedicate the final of the three workshops to an open-ended discussion about the impact of our media literacy approach on the level of mistrust that students experience. If cynicism or even fatalism is a widespread response to the workshops, can our media literacy approach be redeemed? Is A Vaccine for fake news an antidote to the epistemic crisis created by media manipulation or does it contribute to it? The experience, data and responses from the next phase of our work with students will suggest an enhanced perspective on this knotted question.

This is more of a paper on a work-in-progress than a report on results. For 2025- 2027, the workshops will continue in Toronto, as well as high schools in Germany, Sweden, Finland, the US and Brazil. Based on the dirth of new insights and results promise rich research results at the end.

One response from a student participant in our workshops will provide a good discussion starter. They simply appropriated our paradigm and turned its language right back on us:

> "Will these researchers take our opinions and twisting them to a certain narrative to prove the[ir] study?"

References

Barthes, R., & Duisit, L. (1975). An introduction to the structural analysis of narrative. *New Literary History,* 6(2), 237–272. https://doi.org/10.2307/468419

Becker, M. (2022). *Creating reality in factual television: The* frankenbite *and other fakes.* New York: Routledge.

Hill, A. (2007). *Restyling factual TV: Audiences and news, fact-based media and reality genres.* Routledge.

Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative Research: A Guide to Design and Implementation*. San Francisco, CA: Wiley

Nichols, B. (1991). *Representing reality: Issues and concepts in documentary*. Indiana University Press.

Postman, N., & Postman, A. (2005). *Amusing ourselves to death: Public discourse in the age of show business* (Revised edition). Penguin Books

Termwiki (no date) https://en.termwiki.com/EN/frankenbiting

White, H. (1973). *Metahistory: The Historical Imagination in Nineteenth-century Europe is a work of historiography*. John Hopkins University Press.

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Don't Be Sorry, Just Declare It: Pedagogical Principles for the Ethical Use of ChatGPT, Master Bullshit Artist of Our Time

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Abstract

This work aims to respond to the pedagogical challenges posed by ChatGPT. The first part examines ChatGPT from a critical perspective, deploying the philosophical work of Harry Frankfurt "On Bullshit" (2005) to conclude that ChatGPT is the master "bullshit artist" of our time. The second part illustrates the integration of four principles to promote its ethical use: caution, trust, relevance, and transparency. These principles are informed by industry standards and, in essence, come to reflect the advice provided by Australian Customs and Biosecurity to people who arrive in Australia: "Don't Be Sorry, Just Declare It." The third part provides evidence of the implementation of this approach in courses with a combined enrolment of 214 students over two successive years. The evidence indicates that students respond well to this pedagogical initiative and reveals that this approach can minimise the potential cases of academic misconduct.

Keywords: *Artificial Intelligence; ChatGPT; Pedagogy; Academic Integrity; Ethics*

1. Introduction

Artificial intelligence (AI) has become an integral part of our lives and a powerful and ubiquitous pedagogical tool. As generative AI technologies are increasingly employed in educational settings, it becomes imperative to ensure their responsible and ethical use. This paper is partly a provocation, but one aimed at enhancing our understanding of (and inspiring our critical engagement with) ChatGPT, the most popular manifestation of generative AI. The first part of the paper reflects on ChatGPT from a critical perspective, deploying the philosophical work of Harry Frankfurt *On Bullshit* (2005) to conclude that ChatGPT is the master bullshit artist of our time. The second part proposes the integration of four principles to promote the ethical use of ChatGPT: caution, trust, relevance, and transparency. The third and final part illustrates these principles in practice and provides evidence of their implementation in courses with a combined enrolment of 214 students over two successive years.

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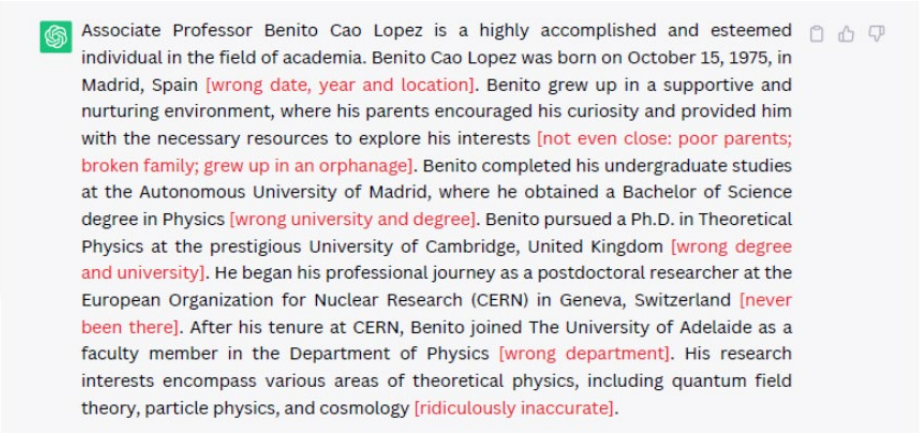
2. ChatGPT - The Bullshit Artist at Work

The public release of ChatGPT in November 2022 has dramatically reshaped the way people interact with AI by making advanced conversational intelligence widely accessible. The so-called ChatGPT revolution has accelerated automation, transformed the education sector, and sparked global discussion on the opportunities and challenges posed by AI (e.g. Bobula, 2024; Kaur & Shilpa, 2024; Kurban & Şahin, 2024). The main challenge comes from the generative dimension of these new AI technologies, which allows them to create content (e.g. text, images, music, and code) based on patterns learned from vast datasets. Models like ChatGPT, for instance, assemble words based on probabilities derived from training on large amounts of text, allowing them to produce human-like responses. This presents huge pedagogical challenges, particularly regarding assessment (e.g. Swiecki *et al*, 2022), that require, first and foremost, a proper understanding of the nature of generative AI tools like ChatGPT

Here, I am proposing that the operating nature of ChatGPT is that of a master bullshit artist. To articulate this point, let me share a personal story. In early 2023, confronted with the fact that students could make use of ChatGPT to produce their essays, and having decided I needed to do something about this, I realised that most students (and most of my colleagues) assumed that ChatGPT operates like a search engine, navigating the internet in search of information to answer their questions. Determined to understand the technology, I quickly learned that ChatGPT is not a search engine. ChatGPT is a large language model that produces text based on statistical probabilities. To explain and illustrate this to my students, I had the idea of prompting ChatGPT to provide a profile of myself, using my full name: Benito Cao Lopez.

Despite the fact that a detailed profile of myself is publicly available in the University of Adelaide website, and is the first content that comes up when one does a Google search of my full name, the profile generated by ChatGPT was riddled with errors and generalisations.

This is an annotated example of a profile created with a free version of ChatGPT in 2023:



Associate Professor Benito Cao Lopez is a highly accomplished and esteemed individual in the field of academia. Benito Cao Lopez was born on October 15, 1975, in Madrid, Spain [wrong date, year and location]. Benito grew up in a supportive and nurturing environment, where his parents encouraged his curiosity and provided him with the necessary resources to explore his interests [not even close: poor parents; broken family; grew up in an orphanage]. Benito completed his undergraduate studies at the Autonomous University of Madrid, where he obtained a Bachelor of Science degree in Physics [wrong university and degree]. Benito pursued a Ph.D. in Theoretical Physics at the prestigious University of Cambridge, United Kingdom [wrong degree and university]. He began his professional journey as a postdoctoral researcher at the European Organization for Nuclear Research (CERN) in Geneva, Switzerland [never been there]. After his tenure at CERN, Benito joined The University of Adelaide as a faculty member in the Department of Physics [wrong department]. His research interests encompass various areas of theoretical physics, including quantum field theory, particle physics, and cosmology [ridiculously inaccurate].

This is a perfectly plausible profile of someone called Benito Cao Lopez, but it is not an accurate profile of this Benito Cao Lopez. Indeed, it is not an accurate profile of any Benito Cao Lopez out there. I tried several variations of this exercise and the only accurate content was that I was born in Spain and employed at the University of Adelaide. The rest were incorrect variations of my date and city of birth, my academic studies, and my areas of interest and expertise. I tried again recently and apparently I am now an expert in Applied Linguistics. These are all different profiles about the same person, and they are all ridiculously inaccurate, but they are always communicated in an authoritative voice, with the confidence of someone who knows me, who knows the Benito Cao Lopez currently employed at the University of Adelaide.

Going over such ridiculously inaccurate profiles, I caught myself repeatedly yelling: Bullshit! This reminded me of Harry Frankfurt's book *On Bullshit* (2005). I revisited the text and realised that ChatGPT was the perfect illustration of a bullshit artist at work. Frankfurt begins by making the point that: "One of the most salient features of our culture is that there is so much bullshit. Everyone knows this. Each of us contributes his share. But we tend to take the situation for granted" (2005: 1). He then proceeds to differentiate bullshitting from lying, in that unlike lying, bullshitting is unconcerned with the truth. He argues that bullshitting involves a kind of bluff and thus, like bluffing, it is more a matter of fakery than falsity. He states: "the essence of bullshit is not that it is *false* but that it is *phony*" (2005: 147). He concludes by noting that bullshit is unavoidable whenever someone talks without knowing what they are talking about.

This is exactly what ChatGPT does. ChatGPT generates text about anything and everything with no understanding of the content, but it does so with the confidence of an all-knowing expert. This makes ChatGPT the master bullshit artist of our time. The notion that ChatGPT is a bullshit generator has been articulated by other authors (e.g. Hicks *et al*, 2024). However, this alone does not capture the full epistemological impact of this technology. Its impact does not lie merely in its unprecedented capacity to generate bullshit (commonly understood as false or misleading content, and often referred to as hallucinations in the world of generative AI), but on the fact that it presents that content with a confident and authoritative voice. In other words, the key is not to see ChatGPT merely as a bullshit generator, but as a master "bullshit artist".

Note that this does not mean that ChatGPT cannot produce accurate content. It can, and it often does. Predictive text in our smartphones sometimes (perhaps even often) correctly identifies the next word we intend to write, but this is not because the algorithm knows what we intend to write. Predictive text is merely a probabilistic tool -a very simple language model, if you will. In a sense, ChatGPT is predictive text on steroids -a very sophisticated large language model. ChatGPT has no understanding of anything, and thus it cannot tell whether the content it processes and the content it produces is accurate or not. This is why pedagogical reliance on ChatGPT is fraught with danger, and this is something our students must understand so they take a careful and critical approach to this technology. The key advice I provide to students regarding ChatGPT (and generative AI in general) is simple: Caution – Bullshit Ahead.

3. The Urgent Need for Normative Principles

The status of ChatGPT as the quintessential bullshit artist underscores the urgent need for normative principles to address the challenges posed by its use in educational settings. Here, I am proposing the integration of four principles: caution, trust, relevance, and transparency. I am not suggesting these are the only relevant principles, or even the most important ones. I am merely proposing these principles as a starting point to address the pedagogical challenges posed by ChatGPT, particularly regarding the production of written assignments. Briefly, this is how I articulate each of these principles in the context of my teaching practice.

3.1. Caution

Students should be warned about the risks of using ChatGPT in their work and encouraged to cultivate a critical approach when engaging with the tool, particularly in relation to truth. As established earlier in this paper, ChatGPT has no regard for truth. It does not lie or tell the truth. It simply does not know the difference and does not care. Indeed, the technology is "designed to optimise the believability of an answer rather than its accuracy" (Messeri, 2023: 90). Thus, whilst generative AI tools can accelerate content creation, their use can undermine the learning process if students are not taught to be careful and critical. Educators must guide students in approaching generative AI with caution and using it responsibly, noting the importance of verifying AI-generated content and encouraging evaluative judgement (e.g. Bearman *et al*, 2024). In addition to containing its pedagogical risks, this can help students cultivate epistemic doubt and enhance their capacity for critical thinking (e.g. Davies *et al*, 2024).

3.2. Trust

Trust between students and teachers is essential for effective education (e.g. Curzon-Hobson, 2002; Bormann *et al*, 2021). Trust fosters an open learning environment where students feel confident seeking guidance, engaging in critical discussions, and complying with assessment guidelines. In a context in which "there is discernible concern among the higher education community that GenAI is causing an 'erosion of trust' between students and their teachers" (Luo, 2024: 2), teachers must foster a trusting learning environment when it comes to using ChatGPT. This can be done by engaging students during the development of guidelines about appropriate and inappropriate uses of generative AI tools, as well as by providing clear and justified reasons for those guidelines. Regulatory and punitive approaches still have a place in higher education, particularly in misconduct scenarios, but developing a trusting learning environment, particularly around assessment guidelines and expectations, can go a long way in promoting academic integrity and minimising the cases of academic misconduct.

3.3. Relevance

Professional relevance is crucial for effective pedagogy as it ensures that students acquire skills and knowledge that are applicable to real-world contexts (e.g. Teichler, 2015). As governments, businesses, and community organisations integrate generative AI tools into their workflows, ethical considerations, content verification, and responsible use these tools are becoming essential skills. Student guidelines on the use of generative AI, including ChatGPT, should align with industry standards to ensure they remain relevant and prepare students for their future careers. Moreover, we can safely assume that students will be more inclined to comply with guidelines that they can see as directly relevant to their future employment, rather than simply as our personal preferences for how they should or should not engage with generative AI.

3.4. Transparency

Transparency is a crucial aspect of academic integrity and essential for assessment validity (e.g. Dawson *et al*, 2024). Thus, having developed and provided clear and relevant guidelines, in the context of a trusting learning environment, we should encourage and expect students to be transparent regarding their use of generative AI tools in their assignments, including ChatGPT. Students can be asked to provide a general description of their engagement with these tools in the production of their work, an explanation of how outputs generated by ChatGPT were incorporated into their assignments (e.g. used to structure, summarise, or brainstorm), including a list of prompts used to generate those outputs. These requirements promote a culture of academic integrity, make it easier for teachers to assess student learning, and contribute to develop a critical and ethical disposition towards the use generative AI.

4. The Principles at Work - ChatGPT Appendix

In my teaching practice, these principles translate into an exploration of the pros and cons of ChatGPT (with the emphasis on caution), the provision of clear guidelines and the rationale for those guidelines, with references to university policies and industry standards (to demonstrate relevance), and the requirement to include a ChatGPT/GenAI Appendix when students use generative AI in the production of their essays (to encourage transparency). The whole approach is predicated on developing trust between students and teachers -notwithstanding that academic integrity requires that teachers 'trust but verify' if there are indications of academic misconduct.

4.1. Assessment Instructions

Having cautioned students about the bullshit artist nature of ChatGPT, outlined the relevant university policies and provided examples of industry standards, students are given clear and explicit instructions regarding the use of generative AI tools in their essays. I tell students that they can use generative AI (including ChatGPT) to assist with expression and idea generation,

but I remind them that the essay they submit must be their work. I also remind them that they are expected to fully understand every aspect of their essay, and that if there is a concern about the use of AI tools exceeding the assessment guidelines, they may be asked to discuss the assignment before the mark is finalised. I also advise them to keep a folder with drafts, notes, annotated readings, and a dot-point list of how their essays were produced, in case their authorship is questioned. Finally, I ask students to be transparent in their use of generative AI and include a ChatGPT/GenAI Appendix that explains how they have used these tools, including a list of prompts, if relevant. I communicate this instruction using the advice provided by Australian Customs and Biosecurity to people who arrive in Australia: "Don't Be Sorry, Just Declare It." Students are reminded of this requirement in the essay submission portal:

Don't forget to include a ChatGPT/GenAI Appendix after the Reference List if you have used ChatGPT/GenAI in the production of the essay. The absence of this Appendix is equivalent to stating: "I did NOT use ChatGPT/GenAI". If this statement turns out to be false, this would constitute a breach of Academic Integrity. Remember: "Don't Be Sorry, Just Declare It".

4.2. Evidence of Impact

The evidence from the implementation of this initiative in two consecutive editions of the same course, with a combined enrolment of 214 students (113 in Semester 1, 2023 + 101 in Semester 2 2024), indicates that students respond well to the approach, and suggests that this approach can minimise the cases of academic misconduct. The approach was applied to the production of essays, which constituted 50% of the assessment. The assessment also included two in-person assignments: weekly seminar work (20%) and a multiple-choice test (30%). These in-person assignments help get a sense of the level of student understanding of the course content, which can inform academic judgement when there are concerns with student authorship of their essays.

The first time I used this approach, in 2023, most students chose not to use ChatGPT and those who used it did so in limited and acceptable ways. There were only three essays (out of 103 submissions) that required a follow up conversation. The second time, in 2024, once again, most students chose not to use ChatGPT, and those who used it did so in limited and acceptable ways. There was only one essay (out of 96 submissions) that required a follow up conversation.

Here is the breakdown of the 199 essays submitted based on their Turnitin AI score, which indicates the percentage of text within the submission that was likely generated using AI:

AI score of 0: 155 (78%). This includes cases of students who declared the use of ChatGPT, but who used it in perfectly valid ways, and thus it was not identified as an issue.

AI score of 1-20: 28 (14%). These were essays within the threshold for higher likelihood of false positives and thus scores that should not be pursued for academic misconduct; not to mention that no academic integrity issues were identified during the marking process.

AI score of 21-60: 12 (6%). These were cases that required closer examination, but ultimately none of them indicated a problematic use of generative AI and, importantly, the quality of these essays was reflective of the overall performance of those students in the course.

AI score over 60: 4 (2%). These were cases that required a follow up conversation, and the only ones that reflected a problematic use of generative AI. In two cases the issue was what I called "life". Health, work and family issues led these students to use ChatGPT to cut corners, and this was obvious in the content and narrative style of their essays. These were not good essays. The essay marks were downgraded, and the students ended with grades that reflected their overall performance in the course: Fail and Pass. In the other two cases, the issue was what I called "voice". The students run the essay content so many times, in different ways, through generative AI tools, particularly Grammarly (which not all students know is AI-powered), that by the end their "voice" had become robotic. These were students who did not think they were doing anything wrong and who ultimately did not benefit from the use of generative AI. The students ended with grades that reflected their overall performance in the course: Pass and Credit.

The evidence indicates that students respond well to this pedagogical initiative and reveals that this approach can minimise the potential cases of academic misconduct. In the first iteration, this approach reduced the cases of academic misconduct to a level that was barely noticeable. In the second iteration, which was more explicit and systematic, there were no cases of academic misconduct. This initiative has also been popular with colleagues, as evidenced by the numerous invitations to present this approach at learning and teaching seminars, communities of practice sessions, and professional development events, both within and beyond my own university.

5. Conclusion

The initiative outlined here to address the pedagogical challenges posed by generative AI (particularly ChatGPT) in higher education, especially when it comes to written assignments such as essays, does not require (although it is compatible with) redesigning those assignments. Instead, this initiative relies on building a trusting learning environment that encourages students to develop a critical and responsible approach to this revolutionary technology. The practice consists in: (1) explaining to the students the need to be cautious when using generative AI; (2) providing them with the rationale for the guidelines regarding the use of generative AI in their assignments, including how those guidelines reflect industry standards; and (3) requiring students to submit a ChatGPT/GenAI Appendix with their written assignments. The evidence suggests that an approach built on the principles of caution, trust, relevance and transparency can go a long way in addressing some of the most urgent challenges posed by generative AI (including ChatGPT), particularly concerns with academic integrity. This approach is neatly captured (and has been greatly enhanced) by the slogan: "Don't Be Sorry, Just Declare It".

References

Bearman, M., Tai, J., Dawson, P., Boud, D., & Ajjawi, R. (2024). Developing evaluative judgement for a time of generative artificial intelligence. *Assessment & Evaluation in Higher Education*, 49(6), 893–905. https://doi.org/10.1080/02602938.2024.2335321

Bobula, M. (2024). Generative Artificial Intelligence (AI) in higher education: a comprehensive review of challenges, opportunities, and implications. *Journal of Learning Development in Higher Education*, Issue 30, 1-27. https://doi.org/10.47408/jldhe.vi30.1137

Bormann, I., Niedlich, S., & Würbel, I. (2021). Trust in Educational Settings: What It Is and Why It Matters. European Perspectives. *European Education*, 53(3-4), 121–136. https://doi.org/10.1080/10564934.2022.2080564

Curzon-Hobson, A. (2002). A Pedagogy of Trust in Higher Learning. *Teaching in Higher Education*, 7(3), 265–276. https://doi.org/10.1080/13562510220144770

Davies, S., Sormunen, K., & Kangas, K. (2024). Cultivating Epistemic Doubt: a Key Competence for Productive Participation in the Era of Artificial Intelligence. In Clarke-Midura, J., Kollar, I., Gu, X., & D'Angelo, C. (Eds.), *Proceedings of the 17th International Conference on Computer-Supported Collaborative Learning*, 415-416. International Society of the Learning Sciences. https://doi.org/10.22318/cscl2024.114185

Dawson, P., Bearman, M., Dollinger, M., & Boud, D. (2024). Validity matters more than cheating. *Assessment & Evaluation in Higher Education*, 49(7), 1005–1016. https://doi.org/10.1080/02602938.2024.2386662

Frankfurt, H. G. (2005). *On Bullshit*. Princeton, N.J.: Princeton University Press.

Hicks, M. T., Humphries, J. & Slater, J. (2024). ChatGPT is bullshit. *Ethics and Information Technology*, 26: 38, 1-10. https://doi.org/10.1007/s10676-024-09775-5

Kaur, K. & Shilpa, R. J. (2024). The ChatGPT revolution: Reshaping education through artificial intelligence. *AIP Conference Proceedings*, 3121(1), 1-16. https://doi.org/10.1063/5.0221430

Kurban, C. F. & Şahin, M. (2024). *The Impact of ChatGPT on Higher Education: Exploring the AI Revolution*. Leeds: Emerald Publishing Limited. https://doi.org/10.1108/9781837976478

Luo (Jess), J. (2024). How does GenAI affect trust in teacher-student relationships? Insights from students' assessment experiences. *Teaching in Higher Education*, 1–16. https://doi.org/10.1080/13562517.2024.2341005

Messeri, L. (2023). Teaching with ChatGPT: Critiquing Generative Artificial Intelligence from the Classroom. *Anthropology Now*, 15(1), 84–92. https://doi.org/10.1080/19428200.2023.2230098

Swiecki, Z., Khosravi, H., Chen, G., Martinez-Maldonado, R., Lodge, J. M., Milligan, S., Selwing, N. & Gašević, D. (2022). Assessment in the age of artificial intelligence. *Computers and Education: Artificial Intelligence*, 3, 1-10. https://doi.org/10.1016/j.caeai.2022.100075

Teichler, U. (2015). Changing Perspectives: The Professional Relevance of Higher Education on the Way Towards the Highly-Educated Society. *European Journal of Education*, 50(4), 461-477. https://doi.org/10.1111/ejed.12146

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Who supports or opposes the use of AI in educational and scientific contexts? An analysis of the role that knowledge and attitude has on the perception of the appropriateness of AI-use within the Austrian population

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Abstract

In this article we investigate in how far participants of an Austrian population survey (n=2302, summer 2024) deem the AI-use in the school and research contexts as appropriate. The data was collected via an online-access-panel survey on digital skills and competences, with a special focus on attitudes towards and knowledge on Artificial Intelligence. Participants had to indicate whether a specific scenario of AI use seems appropriate or inappropriate to them. Linear regression models on both – the school-related scenarios and the university/research-related scenarios – were calculated testing for effects of general technology commitment, digital competence, AI knowledge, experience and general attitude as well as controlled for socio demographics. Results show that socio demographics provide little, however surprising explanation for the assessment of the appropriateness of AI-use and attitudes and experience (in particular concerning AI) only partly do matter.

Note: The three waves of the Digital Skills Austria panel survey (2022-2024) were financed by the Austrian regulatory authority RTR (Rundfunk- und Telekomregulierungs-GmbH).

Keywords: *Artificial intelligence; digital competence; technology commitment; survey research; Austria.*

1. Introduction

Initially a pure technical development, the recent rise of generative Artificial Intelligence (AI) has led to the perception that AI is employed in all facets of society. Consequently, regulatory bodies started to establish policies like the *AI Act* (European Parliament, 2023); national and

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organizational guidelines followed. Despite such legal and regulatory debates normative questions must be addressed, as a key part of the discussion around AI is about social processes and norms. In which situations and settings does society agree that AI-use is appropriate? Which forms of AI-use are deemed inappropriate? Generative AI resulted in many ethical questions about its capabilities and uses, including whether or when it is able or even should be allowed to outperform humans in certain tasks (cf. European Commission, 2019). Questions on the suitability of AI-tools for learning- and knowledge-driven environments remain unresolved, with no societal consensus. Especially, since the way AI acquires, and processes knowledge is not transparent to most outside the industry. This paper is based on a population survey from Austria, and we aim to illustrate what the population sees as appropriate AI-use in educational contexts (school and university & research) and identify what factors have an impact on opposing or supporting attitudes towards AI-use in these contexts among the population.

2. Background and Reasoning

For the Higher Education sector, the substantial shift in the availability and use of AI technology resulted in extensive and profound discussions. Debates range from legal and ethical issues such as academic integrity and plagiarism, to more practical considerations including the probabilistic nature of content creation with AI-based tools (e.g. McDonald et al., 2025). Empirical evidence shows that institutions (e.g. UN, EU and OECD) as well as leading universities adopted critical, but not necessarily negative positions on the emerging technology, as "they are focusing on the opportunities while simultaneously trying to address the emerging challenges in the field." (Dabis & Csáki, 2024, p. 10). Overall, a tentative agreement in academia is the importance of re-examining critical thinking and problem-solving skills, given AI's increasing presence in education (Ogugua et al., 2023). Yet, the way this shift results in assessment practices and pedagogical approaches remains subject of ongoing discourse. Educators seek guidance and regulatory frameworks that address the integration of AI-tools capable of text generation, information processing and other tasks traditionally associated with the formalized acquisition of skills and knowledge (e.g. Ruiz-Rojas et al., 2023).

At the same time, discussions about AI enter the academic digital skills and competence research. Research reveals relevant differences in how people use technologies around the world, including Europe. Significant competence gaps continuously highlight age, gender, and educational disparities (Palomino et al., 2025). Yet, on a national level, better performances seem to be linked mostly to humanistic education and lifelong learning (Labudova & Fodranova, 2024). In contrast, countries focusing on employability in digital skills acquisition often perform worse. Yet, for Austria it could be shown that technology commitment and positive and negative associations with digital technology provided sensible explanation for competence in the field (Gruenangerl & Prandner, 2023, p. 66). Recent findings indicate that this may also be true for the topic of AI (Gruenangerl & Prandner, 2024, p. 73).

3. Methods and Data

The analysis in this paper is based on the dataset of the third wave of the *Digital Skills Austria* panel study (Gruenangerl & Prandner, 2024), which is a CAWI survey conducted in July/August 2024 using an online access panel. The sample (n=2302) matches the Austrian resident online population according to age, gender, education, and regional distribution (see Gruenangerl & Prandner, 2024, pp. 18-20 for details). The annual focus of the third wave of the study was set on the attitudes towards and experiences with AI. A central element of the study were eight vignette-based scenarios of AI-use, each vignette representing a different area of everyday life[1]. For each area four different precise descriptions of possible AI-use were provided, asking the participants to assess if AI-use is appropriate in such a situation.

To discuss the research question stated in the first section of this paper[2] two linear regression models were set up. The dependent variables for these models are based on factor variables, extracted via explorative PCA, each consisting of four items dealing with the vignettes from the areas school and university/research each. One factor per area was extracted. Questions on the intensity of AI-use among the population, the general attitude towards AI rendering between enthusiasm and worries and a test of AI-knowledge were adapted from Kennedy et al. (2023) and serve as independent variables in the regression models. Like the vignettes the used AI-knowledge test confronts participants with scenarios from six areas of everyday life. Participants had to identify which of the listed everyday technologies are AI-based. Additional data points used as independent variables are: (a) the survey's digital competence test, which consists of thirteen tasks where the participants needed to apply their digital skills to solve an everyday problem using digital technology[3]. (b) the 12-item scale on technology commitment developed by Neyer et al. (2016) assessing generalized attitudes towards digital technology, that were collapsed into three dimensions: technology acceptance (TC1), measuring people's enthusiasm confronting technology, negative perception of technology competence (TC2), dealing with anxiety and overload concerning technology, and technology control convictions (TC3), relating to overcoming technology-related problems. Finally, control variables include demographics (see Table 1 for more details).

[1] The eight different areas of scenarios where school, university & research, tourism & work, medicine, job application, e-commerce, journalism and public administration. Only the first two scenarios were used for the calculations in this paper. Further information on and clarification of the specific scenarios are summarized in Gruenangerl & Prandner (2024, pp. 60-62). A five-point-scale was used by the respondents to assess whether the use of AI was very appropriate or very inappropriate in this particular situation.

[2] For all calculations in this paper SPSS Statistics, Version 29, was used as a tool for statistical analysis.

[3] The complexity of the test included a higher drop-out risk of the participants. It was only given to half of the sample resulting in a smaller subsample of n = 1159 for the digital competence test. It has been conducted twice and was validated for the study (see Gruenangerl & Prandner, 2023, pp. 21-22 and 2024, pp. 22-23)

Table 1: Overview of variables used for analysis (*Digital Skills Austria* 2024, own calculations, deviations from 100 % occur due to commercial rounding).

Dimension	Variable/Question	Scale	Mean (Med.) % coded 1
Scenarios of potential AI use (school & university/research)			
SCHOOL	school (n=1133)	PCA, tot. var. expl. 55 %, KMO 0,695, α 0,719, 1 factor	
UNIVERSITY	university & research (n=1165)	PCA, tot. var. expl. 56 % KMO 0,693, α 0,732, 1 factor	
Digital Competencies and AI Knowledge			
DC	sum-variable of 13 competency tasks (n=1159)	0 to 13 tasks completed	5,0 (5)
AIK	sum-variable of AI-knowledge tasks (n=2302)	0 to 6 AI-tools identified	1,8 (1)
Technology commitment			
TC1	technology acceptance (n=2162)	PCA, tot. var. expl. 74 %, KMO 0,830, α 0,879, 1 factor	
TC2	technology competence (n=2163)	PCA, tot. var. expl. 76 %, KMO 0,836, α 0,893, 1 factor	
TC3	techn. contr. convict. (n=2127)	PCA, tot. var. expl. 63 %, KMO 0,797, α 0,805, 1 factor	
Sociodemographic variables (Control variables)			
Age	age in years (n=2302)	14 to 93 years	46,8 (46)
Gender	male or female? (n=2302)	1 (female) / 0 (male)	52 %
Education	less than lower secondary education (n=1403)		61 %
	secondary education (n=488)		21 %
	tertiary education (n=397)		17 %
General attitudes towards AI-use			
AI exp.	Previous experience with AI	1 (very intensive exp.)	18 %
		2 (some exp.)	53 %
		3 (little or no exp.)	30 %
AI att.	General attitude towards AI	1 (more excited than worried)	16 %
		2 (more worried than excited)	44 %
		3 (equally excited & worried)	38 %

4. Results

The survey highlights that for the Austrian online population AI is still linked to unawareness and uncertainty. The results from the AI-knowledge test demonstrate that participants often lack clarity regarding the AI-driven nature of specific tools: on average, only 1 in 6 AI-applications was identified, 34 % of the survey population could not identify one single scenario correctly. Education, age, and gender are key factors in test outcomes. Men aged 31 to 65 as well as people with tertiary education scored higher than the rest of the online population (for more details see Gruenangerl & Prandner, 2024, pp. 54-56). When asked about AI in general 30 % had never or barely dealt with the topic so far while only 18 % exhibit an intensive involvement with AI. This is consistent with the finding that 43 % reported no or rare interaction with AI in their daily lives. Consequently, it is unsurprising that the Austrian online population's attitude towards AI in everyday life remains rather reserved: for 44 % worries outweigh enthusiasm, only 16 % are rather excited than worried (Gruenangerl & Prandner, 2025, p. 58-59).

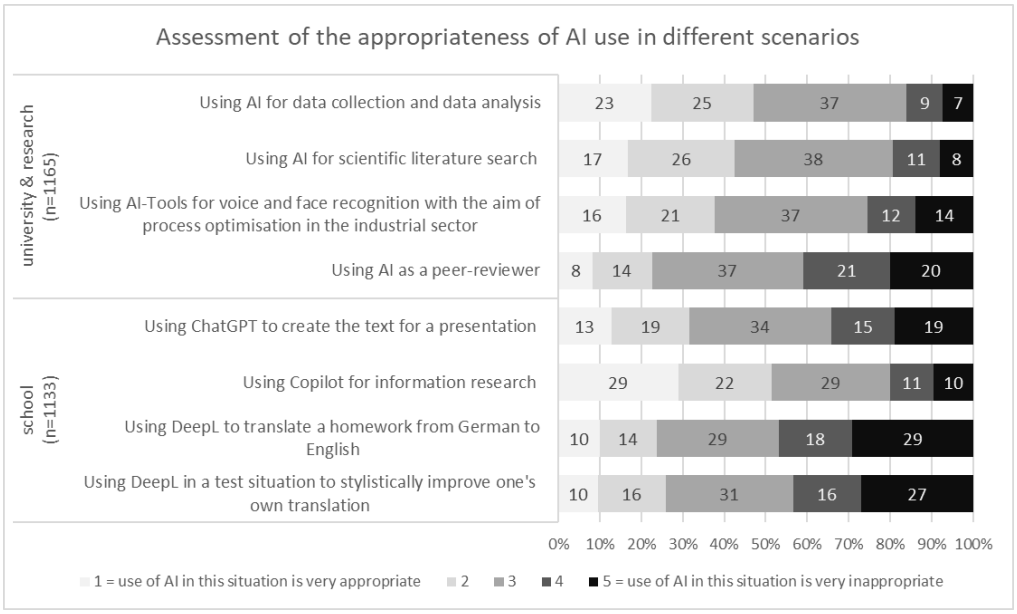


Figure 1: Overview of the scenarios of AI-use in educational and research contexts.

Examining the scenarios of AI-use reveals consistent patterns. Within the research & university scenario the opposition to AI-use is highest when it comes to using AI as a peer-reviewer for publishing scientific results: 41 % rather oppose this application of AI. AI-support for data collection and analysis as well as literature review but also within industrial process optimization was more positively received. These results must be seen in context, since most participants are not academics and likely to judge the scenarios from a layperson's normative perspective. Within the school scenario AI-support for translation tasks (no matter if for stylistic improvement or the pure translation process itself) is perceived more negatively than the application of AI-tools for generating manuscript texts for presentations. The highest level of appropriateness of AI-support in schools is reported when it comes to information retrieval (see Figure 1 for details).

In addition, linear regression models were used to explore which factors influence people's perception of AI-use keeping in mind the rather reserved and unexperienced attitude of the Austrian online population. Concerning the appropriateness of AI-use in the school context (model 1) people with higher worries about AI in general also tend to see it rather inappropriate in the school context. The second negative effect relates to tertiary education. This means that those who spent more years in the educational system tend to view AI-support in the learning context more critical than those with the lowest education degrees. Conversely, people in the 66+ age group, whose own school careers are furthest away from those of today's students, tend to see AI-use in schools with greater appropriateness. Furthermore, people who engage with AI

in a more profound way tend to perceive the scenarios of AI-use in the school context as rather suitable. Considering technological motivation, technology enthusiasts rather support AI-use in school but surprisingly also people with high technology anxiety, who tend to be overwhelmed by technology. These results, indeed, need further discussion. They do not only suggest that AI is treated differently to other technological innovations but also imply different experiences with the school system (longer time since graduation, spent more time in the educational system) lead to different AI-related assumptions. Digital competence and AI-knowledge do not have a significant effect on the judgement of appropriateness of AI-use in schools, at all.

Table 2: Linear regression models on scenarios of AI-use.

independent variables		dependent variables			
		school		univ. & research	
Dimension	Indicator	std. Beta	sig. (p)	std. Beta	sig. (p)
sociodemographic variables	gender (ref.:male)	-0,061	0,182	0,062	0,175
	secondary education (ref.: less)	-0,029	0,544	-0,053	0,256
	tertiary education (ref.: less)	**-0,105**	**0,029**	-0,080	0,090
	age 31-45 years (ref.: up to 30)	0,054	0,351	0,069	0,233
	age 46-65 years (ref.: up to 30)	0,019	0,763	**0,127**	**0,040**
	age 66+ years (ref.: up to 30)	**0,127**	**0,028**	**0,209**	**<0,001**
DC	Digital competence test	0,068	0,211	**0,168**	**0,002**
AI-related items	AI knowledge test	-0,087	0,092	-0,022	0,655
	Intensive AI-experience (ref. none)	**0,134**	**0,023**	0,019	0,749
	Moderate AI experience (ref. none)	0,087	0,103	0,069	0,191
	AI excitement (ref. neutral)	0,095	0,061	0,083	0,111
	AI worries (ref. neutral)	**-0,131**	**0,006**	**-0,177**	**<0,001**
technology commitment	TC1 technology acceptance (+)	**0,146**	**0,010**	0,089	0,122
	TC2 technology competence (-)	**0,110**	**0,024**	0,061	0,210
	TC3 technology convictions (+)	-0,094	0,082	-0,009	0,868
model summary	adjusted R^2		**0,116**		**0,107**
	Sig. (p)		<,001		<,001
	n =		494		507

Digital Skills Austria 2024 dataset, own calculations, no weights applied.
Method: linear regression models on (1) the school scenarios (2) the university & research scenarios (factor variables). Significant effects ($p < 0,05$) are marked bold.
The model prerequisites regarding the Gauss-Markov assumptions were examined through graphical and/or mathematical means for both regression models, and it was ascertained that they were satisfactory. This process entailed verifying the homoscedasticity, the linearity of the independent variables, and the normal distribution of error values.

The overall results suggest that in future research further aspects of learning and information proceeding habits must be considered for a more profound explanation of the people's

assessment of AI appropriateness in the school context. This may possibly lead to additional insights, as the current model only has an R^2 of 12 %.

When it comes to the assessment of the appropriateness of AI-use in the university and research context (model 2) we see different effects. Again, high AI-concerns have a negative effect, resulting in a negative assessment of AI-support for university and research purposes. A positive effect derives from age: people in the age groups over 45 assess the appropriateness of AI-use more positively than the reference age group of up to 30 years. In addition, higher digital competence also contributes significantly to a positive attitude towards AI-support in university and research scenarios. Surprisingly, neither technology commitment nor AI-related aspects (high AI-involvement or AI-knowledge) have a significant effect on this scenario leaving the overall model with a moderate explained variance of 11 % (R^2).

5. Conclusions

The results of the study demonstrate that the use of AI in educational and research contexts is seen critical, but also nuanced by the Austrian population, who is generally barely aware of developments in the field of AI. While tasks like data and information processing or literature research are seen as somewhat unproblematic, translation tasks, stylistic improvements or feedback are contested. This shows that the use of AI is not in general declared as problematic or unproblematic, but differentially judged – case by case. AI-driven knowledge processing is seen as less of a problem than the performance of operational tasks through AI-applications. This matters as it highlights that the normative assessment of what technology should be used for is not uniform and understanding the use cases and assumptions of those involved is central. Especially for our school scenario it becomes evident that the expectations are not split uniformly: While those that are older or afraid of technology are seemingly okay with using AI in education, highly educated people are not that much. This hints at the fact that AI is not seen primarily as a further technological innovation by people but as a potential disruptor of our understanding how to acquire, share and process knowledge. It opens new debates for the field of educational research and institutional learning/teaching environments as it requires us to re-evaluate the importance of humanistic ideas and the basic principles of the Enlightenment (such as critical thinking, autonomy and self-determination) in the aftermath of algorithmic knowledge processing. On an institutional level this implies that guidelines must emphasize rather the critical assessment of AI technologies concerning their impact on knowledge acquisition. On an individual level it refers to personal strategies of fact evaluation and human autonomy. On a societal level it shows the necessity for a broader debate on which tasks and skills can and should be outsourced to technology.

References

Gruenangerl, M., & Prandner, D. (2023). Digital Skills Austria 2023. Zenodo. https://doi.org/10.5281/zenodo.10061084

Gruenangerl, M., & Prandner, D. (2024). Digital Skills Austria 2024. Zenodo. https://doi.org/10.5281/zenodo.14295829

Benvenuti, M., Cangelosi, A., Weinberger, A., Mazzoni, E., Benassi, M., Barbaresi, M., & Orsoni, M. (2023). Artificial intelligence and human behavioral development: A perspective on new skills and competences acquisition for the educational context. *Computers in Human Behavior*, 148, 1-8. https://doi.org/10.1016/j.chb.2023.107903

Dabis, A., & Csáki, C. (2024). AI and ethics: Investigating the first policy responses of higher education institutions to the challenge of generative AI. *Humanities and Social Sciences Communications*, 11(1), 1–13. https://doi.org/10.1057/s41599-024-03526-z

European Commission. (2019). Ethik-Leitlinien für eine vertrauenswürdige KI. https://doi.org/10.2759/22710

European Parliament. (2023, June 8). EU AI Act: First regulation on artificial intelligence. https://www.europarl.europa.eu/topics/en/article/20230601STO93804/eu-ai-act-first-regulation-on-artificial-intelligence

Kennedy, B., Tyson, A., & Saks, E. (2023). Public Awareness of Artificial Intelligence in Everyday Activities (Wave 119). Pew Research Center. https://www.pewresearch.org/science/wp-content/uploads/sites/16/2023/02/PS_2023.02.15_AI-awareness_REPORT.pdf

Labudova, V., & Fodranova, I. (2024). The Impact of Socio-economic Factors on Digital Skills in the Population of the EU 27 Countries. *Virtual Economics*, 7(3), 81–101.

McDonald, N., Johri, A., Ali, A., & Collier, A. H. (2025). Generative artificial intelligence in higher education: Evidence from an analysis of institutional policies and guidelines. *Computers in Human Behavior: Artificial Humans*, 3, 1-11. https://doi.org/10.1016/j.chbah.2025.100121

Neyer, F. J., Felber, J., & Gebhardt, C. (2016). Kurzskala Technikbereitschaft (TB, technology commitment). Zusammenstellung sozialwissenschaftlicher Items und Skalen (ZIS). https://doi.org/10.6102/ZIS244

Ogugua, D., Yoon, S. N., & Lee, D. (2023). Academic integrity in a digital era: Should the use of ChatGPT be banned in schools? *Global Business & Finance Review (GBFR),* 28(7), 1–10. https://doi.org/10.17549/gbfr.2023.28.7.1

Palomino, S. S., Huamán-Romaní, Y.-L., García, C. A. B., Triveño, Z. S. F., Ascarza, Y. B., Ramírez, A. L., & Otero, C. C. (2025). Digital competences and collaborative skills among university students. *Heritage and Sustainable Development*, 7(1), https://doi.org/10.37868/hsd.v7i1.903

Ruiz-Rojas, L. I., Acosta-Vargas, P., De-Moreta-Llovet, J., & Gonzalez-Rodriguez, M. (2023). Empowering Education with Generative Artificial Intelligence Tools: Approach with an Instructional Design Matrix. Sustainability, 15, https://doi.org/10.3390/su151511524

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Assessment challenges in higher education during the pandemic: course directors' perceptions and reflections

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Abstract

The COVID-19 pandemic disrupted higher education, requiring rapid adaptations in students' assessment. This study examines course directors' perspectives on the subject using semi-structured interviews with course directors from different Portuguese higher education institutions. Findings reveal critical issues, such as maintaining academic integrity, logistical constraints, and inequities in access to resources. Course directors reflected on the increased workloads for educators and students and the fairness of assessment formats, which disproportionately affected students with limited technological access. Despite these challenges, the crisis prompted a critical reflection on the importance of strengthening digital infrastructure, professional development, and institutional policies to enhance resilience and equity in future disruptions.

Keywords: *Higher education; assessment; academic integrity; Portugal.*

1. Introduction

The COVID-19 pandemic, as widely recognised, has posed immense challenges for higher education, as it has had a disruptive effect on teaching and assessment practices in a predominantly online environment. The abrupt transition has required teachers and course directors to adapt, especially concerning assessment, which has been largely affected by the absence of face-to-face interaction and the need to maintain standards of quality and fairness. Course directors were at the centre of this process, as they were responsible for coordinating various strategies that met institutional needs, on the one hand, and the realities of teachers and students on the other. In this article, we set out to answer the following research question: what were the main challenges emerging from student assessment in higher education during the COVID-19 pandemic, and what lessons have been learnt from this experience, according to the perspective of course directors?

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The literature on assessment in higher education suggests that assessment practices are deeply linked to pedagogical objectives and the teaching context (Biggs, Tang, & Kennedy, 2022). According to the concept of constructive alignment, a central concept in this field, effective assessment should directly reflect the expected learning outcomes, ensuring the measurement and deepening of knowledge. Nonetheless, the pandemic has challenged the practical application of this principle due to the obligation to move abruptly to remote teaching environments. During this period, course directors have played a central role in guiding teachers in redefining assessments, although not always with time for structured planning or access to advanced technologies.

Some of the main concerns included issues related to academic integrity. Indeed, the literature has shown that the transition to online assessments has intensified concerns about academic dishonesty, as face-to-face supervision is no longer possible (Gupta et al., 2023). The use of tools such as randomised question banks, time-limited exams and authentication platforms have been widely used as a way of trying to prevent cheating. However, even with these strategies, many course directors and teachers realised that ensuring the authenticity of answers remained a challenge. Ober and Cheng (2023) showed that the perception of unfairness increased among students, especially those who faced technological difficulties or inappropriate home contexts. Maintaining rigour and ensuring fairness is, in this sense, a kind of dilemma that has left course directors in a complex position, forcing them to make quick decisions on the basis of limited resources and poorly consolidated evidence.

Another relevant aspect identified in the literature is the shift in the type of assessment used. Cooper et al. (2022) suggest that the pandemic has led many educators to reconsider traditional assessment formats, such as face-to-face exams and written assignments, in favour of more flexible approaches, such as open-ended assessments, practical projects and oral tests. However, these changes are not easy to implement in operational terms, especially in subjects with large classes, because they require individualised assessments that were, at the time, unfeasible. Course directors have had to balance these logistical issues with the need to support teachers in implementing innovative practices. Giri and Stewart (2023), in their analysis of the health professions, suggest that methods such as virtual simulations and scenario-based assessments have emerged as effective alternatives, although they require considerable initial investment in technology and training.

The issue of fairness has also been widely discussed. Pereira, Cadime and Flores (2022) show that many students in Portugal felt that online assessment conditions were less fair than face-to-face ones, particularly when they involved technological restrictions. On the other hand, teachers, burdened with additional workloads, also assumed difficulties in ensuring that assessments accurately reflected student performance. Chavez and Lamorinas (2023) suggest that the stress caused by the pandemic directly affected perceptions of the effectiveness and

fairness of assessment practices for both teachers and students, an aspect that became central to the role of course directors, who were required to mediate these tensions.

In addition to practical concerns, the pandemic has brought about a broader reflection on the purposes of assessment. Biggs, Tang and Kennedy (2022) argue that assessment should move beyond merely measuring performance to focus on developing competencies and promoting meaningful learning. This principle seems to have been reinforced during the pandemic, when many course directors ended up encouraging the adoption of more formative approaches. For example, Cooper et al. (2022) reported that, although limited by the lack of physical interaction between students, practical projects and online collaborative activities gained ground as alternatives that allowed skills to be assessed in a more authentic way.

The ethical implications of assessments during the pandemic have also been a source of concern. Stifel et al. (2020) draw attention to the psychological impact of the abrupt changes, which affected teachers and students. In this context, course directors have had to deal with the consequences of stress and anxiety that have arisen as a result of reduced deadlines, work overload and uncertainties surrounding the timing of the return to face-to-face teaching. At the same time, course directors had to ensure that the adaptations didn't jeopardise institutional credibility, which could mean adopting measures that weren't always popular with everyone involved.

Besides difficulties, the literature has shown that the pandemic may have acted as a catalyst for changes in perceptions about assessment in higher education. Reedy et al. (2021) argue that the crisis has exposed the weaknesses of existing systems, while at the same time showing the potential for innovative and more inclusive practices. Analysing the perspective of course directors allows us to better understand how these challenges have been met and what lessons can be learnt for the future of higher education, especially in contexts of uncertainty or disruption.

2. Methodology

As part of a broader study aimed at understanding the impact on equity of changes in higher education access policies during COVID-19, semi-structured interviews were conducted with course directors from a diverse range of educational institutions, including universities and polytechnics, in the public and private sectors, to gather their perceptions of the reasons for student dropout. In these semi-structured interviews, the issue of assessment was repeatedly mentioned. Therefore, this article focuses precisely on course directors' reflections on the challenges of assessment during the COVID-19 pandemic, highlighting the lessons learnt and the strategies adopted in response to the abrupt transition to online and remote teaching. A variety of educational levels were under study, including bachelor's, master's, and higher technical and professional courses (CTeSP). Eighteen course directors from various fields and

educational levels were contacted via email, leading to virtual interviews via Zoom. An overview of the respondents' professional and demographic characteristics is given in Table 1, which includes information on their disciplinary area, gender, academic level of the programmes they coordinate, and the kind of institution they work for.

High ethical standards were upheld in the study by obtaining participant agreement for interviews that were recorded and transcribed, guaranteeing anonymity and confidentiality. The adaptable format of the interviews encouraged free discussion of the challenges faced in assessing students. An inductive thematic analysis was employed through MAXQDA software.

Table 1. Characteristics of the interviewees

Interview	Gender	Type of qualification	Disciplinary area	Type of institution
1	Male	CTeSP	Arts	Public Polytechnic
2	Male	CTeSP	Arts	Public Polytechnic
3	Male	CTeSP	Law	Private Polytechnic
4	Male	CTeSP	Engineering	Public Polytechnic
5	Male	Bachelor	Engineering	Public University
6	Male	Bachelor	Engineering	Public Polytechnic
7	Male	Bachelor	Engineering	Public Polytechnic
8	Male	Master	Engineering	Private University
9	Female	Master	Engineering	Public University
10	Female	Bachelor	Management	Public University
11	Female	Bachelor	Management	Public University
12	Male	Bachelor	Management	Public Polytechnic
13	Female	Bachelor	Management	Public Polytechnic
14	Female	Master	Management	Public Polytechnic
15	Female	Master	Education	Public Polytechnic
16	Female	Master	Education	Public Polytechnic
17	Female	Master	Education	Public Polytechnic
18	Female	Master	Education	Private Polytechnic

3. Findings

The analysis of course directors' reflections on the challenges of assessment during the COVID-19 pandemic revealed key difficulties, particularly the struggles and adaptations required to address these unprecedented circumstances. These insights shed light on broader structural and pedagogical issues that higher education institutions faced globally.

Table 2. Perceptions of course directors

Assessment challenges in higher education during the COVID-19 pandemic		
Ensuring integrity	Strategies adopted: randomised questions; shorter test times; oral examinations; project-based assessments	Increased workload both for educators and students and blurred boundaries between work and personal life
Unequal access to technology and other social inequities	Perceptions of both lower student performance and grades inflation	
Inputs for changes		
Opportunity for rethinking assessment purposes Making assessment more flexible and reflective approaches adopted		

A recurring theme that emerged from the content analysis performed was the difficulty in preventing fraud during online evaluations. Course directors expressed concerns about students circumventing the integrity of assessments, particularly in the absence of physical supervision. For instance:

> Because there's one who does the oral [exam], then goes out and can communicate to the others the questions that were asked. So, we had to change the questions for all of them. (Int. 3, Private Polytechnic)

Such challenges were intensified by technological limitations and the lack of reliable proctoring tools. Attempts to mitigate these issues, such as randomised questions or shorter test times, were only partially effective:

> We opted for shorter test times, but that didn't prevent the issue of fraud. (Int. 13, Public Polytechnic)

The logistical challenges of adapting assessment practices were particularly evident in the context of oral examinations and project-based evaluations. While oral assessments were seen as a way to ensure individual accountability, they posed significant constraints in terms of time and scalability:

> For oral exams, it takes much more time than doing them simultaneously. I was lucky to have a small class, but for those with 300 students, it was unmanageable. (Int. 5, Public University)

Similarly, project-based assessments, while effective in some cases, increased the workload for educators, particularly when verifying individual contributions. One participant described the extensive process they adopted:

> What I tried was to rely on practical assignments, but it was an excessive workload for me. Each student had to defend their work individually. (Int. 7, Public Polytechnic)

Indeed, this finding poses the need to discuss the resource-intensive nature of alternative assessment methods and the need for scalable solutions in higher education, as argued by Reedy et al. (2021).

The concern to maintain educational activity seems to have resulted in an increased workload for teachers and students, not only in relation to assessment. In some situations, the concern for rigour led many teachers to duplicate the work they asked their students to do. In addition, many teachers reported that they no longer had boundaries between personal and work time:

> With the students, it was about creating that connection, creating that network, so that the learning didn't break down beyond the synchronous moments, right? And that happened. Now, everyone's exhaustion was also very noticeable, because then we were always working and so were the students. I don't think it was just us, the students were also exhausted. In order to continue to invest in education with rigour and quality, we all overdid it. (Int. 7, Public Polytechnic)

The shift to remote assessment formats significantly impacted both learning outcomes and perceptions of fairness. Some educators reported that students performed poorly during the pandemic, attributing this to the inadequacy of online assessment methods:

> I had the worst results ever. That made me reflect on what we really want to evaluate and how. (Int. 18, Private Polytechnic)

Similarly, other participants observed grade inflation and expressed concerns about students exploiting the system:

> In some cases, there was more success in passing the course, likely due to some kind of scheme that allowed students to succeed. (Int. 12, Public Polytechnic)

These mixed outcomes reflect the dual pressures of maintaining rigour while adapting to new formats. The experiences described also highlight equity concerns, as students' varied access to technology and conducive study environments disproportionately affected their performance. For example, an educator reflected on the perceived injustice of certain adaptations:

> Looking back, I think it was unfair. Anyone doing a paper exam can review their answers, but in this case (maximum response time tests), they couldn’t. (Int. 18, Private Polytechnic)

These findings echo Hodges et al. (2020), who argue that emergency remote teaching exacerbates inequities and poses significant challenges to fair assessment practices.

Despite these challenges, the pandemic prompted educators to reflect on their evaluation practices and reconsider the purpose of assessment. Some course directors described adopting more flexible and reflective approaches, moving beyond traditional methods:

> It made us reflect on what we really want to evaluate and what we want them to learn. (Int. 18, Private Polytechnic)

This aligns with Biggs and Tang's (2011) advocacy for constructive alignment in assessment, prioritising critical thinking and authentic learning over rote memorisation.

4. Conclusion

The COVID-19 pandemic has revealed deep vulnerabilities in higher education assessment practices, paving the way for a significant and necessary transformation. The challenges faced during this period have highlighted the urgency of rethinking assessment objectives and methods in order to prioritise critical thinking and adaptability over simple memorisation of content. This redefinition is urgent in order to ensure that assessment not only measures results, but also supports meaningful and sustainable learning.

In addition, the importance of strengthening institutions' digital infrastructure has become clear. Investments in more sophisticated and secure tools for online assessments are fundamental, but they must be accompanied by a commitment to equity, ensuring that all students have access to the conditions necessary for fair assessment. In this sense, the ongoing training of educators is a priority. Offering training in hybrid and online teaching methodologies could be a way of enabling greater resilience and effectiveness in future responses to disruption scenarios.

Finally, the pandemic has highlighted the need for adjustments in institutional and educational policies. Clearer and more comprehensive guidelines that ensure the integrity and fairness of evaluation practices, even in crisis contexts, should be incorporated into institutions' strategic plans. Such measures are important to respond to the gaps highlighted by the pandemic and, above all, to pave the way for more innovative, flexible and inclusive solutions in the future of assessment in higher education. The present study is not without its limitations. In order to achieve a more comprehensive understanding of the challenges of assessment, it is essential to incorporate the perspectives of other key educational stakeholders, particularly students. Additionally, a comparative analysis could be conducted between course coordinators' perceptions regarding grade inflation or declining academic standards and statistical data on student performance during this period. Despite these limitations, the study makes a valuable contribution to the ongoing debate on assessment in times of disruption.

References

Biggs, J., Tang, C., & Kennedy, G. (2022). Teaching for quality learning at university 5e. McGraw-hill education (UK).

Chavez, J., & Lamorinas, D. D. (2023). Reconfiguring assessment practices and strategies in online education during the pandemic. *International Journal of Assessment Tools in*

Education, *10*(1), 160-174.Mellar, H., Peytcheva-Forsyth, R., Kocdar, S., Karadeniz, A., & Yovkova, B. (2018). Addressing cheating in e-assessment using student authentication and authorship checking systems: teachers' perspectives. International Journal for Educational Integrity, 14(1), 1-21.

Cooper, A., DeLuca, C., Holden, M., & MacGregor, S. (2022). Emergency assessment: Rethinking classroom practices and priorities amid remote teaching. *Assessment in Education: Principles, Policy & Practice*, *29*(5), 534-554.

Giri, J., & Stewart, C. (2023). Innovations in assessment in health professions education during the COVID-19 pandemic: A scoping review. *The Clinical Teacher*, *20*(5), e13634.

Gupta, T., Shree, A., Chanda, P., & Banerjee, A. (2023). Online assessment techniques adopted by the university teachers amidst COVID-19 pandemic: A case study. *Social Sciences & Humanities Open*, *8*(1), 100579.

Ober, T. M., & Cheng, Y. (2023). Adapting to online and remote learning: Examining the educational assessment experiences of US college students Amidst COVID-19. *IEEE Internet Computing*.

Pereira, D., Santos, P., Aguiar, C., & Flores, M. A. (2022). Biology Undergraduate Students' Views of Assessment:: Methods, Purposes and Effects. *Journal of Assessment in Higher Education*, *3*(1), 79-99.

Pereira, D., Cadime, I., & Flores, M. A. (2022). Investigating assessment in higher education: students' perceptions. *Research in post-compulsory education*, *27*(2), 328-350.

Reedy, A., Pfitzner, D., Rook, L., & Ellis, L. (2021). Responding to the COVID-19 emergency: student and academic staff perceptions of academic integrity in the transition to online exams at three Australian universities. International Journal for Educational Integrity, 17(1), 9.

Stifel, S. W., Feinberg, D. K., Zhang, Y., Chan, M. K., & Wagle, R. (2020). Assessment during the COVID-19 pandemic: Ethical, legal, and safety considerations moving forward. *School Psychology Review*, *49*(4), 438-452.

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Chinas Reform towards Practice-oriented Higher Education. Is the Transformation of Universities to Colleges a Success Story?

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Abstract

In a large-scale reform, 600 Chinese State Universities are being transformed to practice-oriented Universities of Applied Sciences. A change process of this size and scope is hardly implemented without any impediments. Resistance of teachers against the reform can be expected, since their traditional role is challenged. A purely top-down management approach to the reform thus seems to be not promising, hence the present study explores the determinants of teachers' motivation to support or oppose the reform. We perform partial least squares structural equation modelling to analyse the relationship between latent variables, representing both relevant aspects of teachers' motivation and of the management approaches to the reform. Personal interest, as an intrinsic motivation turns out to be the most powerful predictor of the development of a supportive attitude. Management activities do not exhibit strong direct effects, while the different dimensions of individual motivation function as mediators that reinforce the influence of management activities on teachers attitudes towards the reform.

Keywords: *change process; motivation; self-determination theory; structural equation modelling; practice-oriented universities.*

1. Introduction

Chinese labor market data reveal a mismatch of university graduates' qualification profiles and the requirements of the labor market (Lin, 2014). Graduates from research universities are outnumbering those from more practice-oriented academic programs while at the same time their unemployment rates are comparatively high (ibid.). Such data suggest a shortage of an academically trained, yet vocationally experienced workforce. In a response to this issue, the central government has initiated a change process within which 600 State universities are going to be transformed to practice-oriented universities of applied sciences, with a strong emphasis on teaching and in particular on labor market demands. A reform process of this scope is

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unlikely to be implemented without any impediments (Liu & Gu, 2014; Zhang & Jiang, 2014; Tu, 2022). It can be assumed that academics offer resistance against the reform, e.g., in anticipation of a loss of reputation due to restrictions of the time budgets available for research activities (Wang & Wang, 2015). Since also new pedagogical approaches are requested from teachers, high demands are posed towards them with regard to their teaching professionalism (Tu, 2022).

Leaders in charge thus are in need to take appropriate action to secure a reform-friendly environment and a strong motivation of teachers to pursue the reform goals (Al-Mahdy et al., 2022; Cheng & Zhu, 2021). At present, both the government and the local university authorities and university leaderships have their own but relatively clear motivations: the government is striving for local universities to produce more of an application-oriented workforce and graduates that are serving the purpose of economic development, while university leaderships want to demonstrate the efficiency of their respective institution, also in competition with others (Zhang & Jiang, 2014). The motivation of teachers however, remains unclear and is thus subject to inquiry in the present study. We draw on the self-determination theory (Deci & Ryan, 1985; 2000), since it has successfully been applied to many work-related contexts (Donald et al., 2019; Hagger & Hamilton, 2020; Tang et al., 2020). Self-determination theory suggests that the individual's motivation for a task is depending on the fulfilment of three basic psychological needs, namely *autonomy* (engagement for a goal or activity with a sense of volition), *competence* (experience of mastery and efficacy during the task's implementation), and *relatedness* (desire to be connected with other people for the purpose of gaining reputation and feedback) (Deci & Ryan, 1985; 2000). At the same time, it is obvious that teachers' motivation to support or oppose to the reform goals can be positively or negatively influenced by managerial activities: Hierarchical decision making may lead to the feeling of being externally regulated which may have a demotivating impact on the individuals, according to the theory's assumptions (Deci & Ryan, 2000). On the contrary, a management that is perceived as being appreciative of teachers' engagement for the reform agenda may have a positive influence on their willingness to get actively involved in the implementation of the reform process. With regard to teachers' motivation, we thus distinguish between their personal interest, the desire to be socially related to a group, their intention to gain prestige, and their career orientation. With regard to the management approaches to the reform, we differentiate between (i) features that secure the transparency of the overall plan and of the single steps in the course of the reform's implementation, (ii) features that help building a sense of ownership of the reform in the teachers, e.g., by means of involving them in decision-making processes (Jiang & Xue, 2021), and (iii) features that indicate the leadership's investments in an infrastructure that helps achieving the reform goals (i.e., providing further education opportunities for teachers, securing the availability of the necessary equipment, appropriate evaluation tools) (Chandler 1962). For this study we have tested a model that involves the above theory-led constructs (fig. 1).

2. Method

The study draws on survey data that have been obtained from teachers of two universities in the People's Republic of China. A total of 201 cases was included to the sample, equalling a response rate of 49 percent.

Table 1: Variables in the model

Questionnaire items (variable names)	latent construct	Mean/Std.-Dev.
I'm willing to invest time and energy in the reform (invest)*	*engagement*	3.97 / 1.00
Attitude towards the reform (attitude)**		3.95 / 0.67
I'm interested in didactical innovation (didact inno)*	*interest*	3.99 / 1.04
I'm interested in practice-oriented research (pract resea)*		3.86 / 1.07
I'm interested in practice-oriented teaching (pract teach)*		3.99 / 1.02
My colleagues participate which is why I also have to (colleagues)*	*interaction*	3.53 / 1.09
I participate in the experiences my colleagues gathered (participate)*		4.18 / 0.94
I'm actively looking for collegial exchange (exchange)*		4.15 / 0.93
I will not lose my current privileges due to the reform (privileges)*	*status*	3.35 / 1.07
The reform will not lead to a status decrease (stat decrease)*		3.73 / 0.98
My status is not lower than of a university teacher (not lower)*		3.84 / 0.98
Active participation can help me develop my career (active part)*	*career*	3.51 / 1.05
Active participation can help me access research funding (funding)*		3.23 / 1.11
I can adjust to the requirements of new pedagogies (new ped)*		3.67 / 1.02
Active participation can help my increase my salary (salary)*		3.33 / 1.08
Management has explained the reform to teachers (explain)*	*transparency*	3.14 / 1.03
Management has explained the steps of the reform (single steps)*		2.90 / 1.13
Management has informed the teachers about the reform (inform)*		3.36 / 0.99
Evaluation has been adjusted to the reform (evaluation)*	*infrastructure*	2.90 / 1.01
Management offers further education on the reform (further ed)*		2.95 / 1.08
Management has provided the necessary infrastructure (provide)*		2.93 / 1.12
Management appreciates the views of the teachers" (appreciate)*	*ownership*	2.97 / 1.07
Management has developed specific plans and assignments (spec plan)*		3.02 / 1.11
Teachers and management have developed plan jointly" (jointly)*		3.00 / 1.08

*(1) fully disagree – (5) fully agree; **(1) strongly oppose – (5) fully support

The latent constructs draw on the notions of self-determination theory. The assignment of indicator variables aims at exploring as to how well the latent constructs are reflected by the survey items and to validate the respective measurements. We performed partial least square structural equation (PLS-SEM) modelling with the smartPLS software (Ringle et al., 2024). This statistical procedure is appropriate for rather exploratory studies that involve not yet fully consolidated theoretical constructs. Moreover, it is less sensitive towards problems that might occur due to small sample sizes and violations of model assumptions, such as normally distributed data (Fauzi, 2022; Hair et al., 2014).

3. Results

The manifest measurement variables are represented by rectangles, while the latent variables are represented by elliptic shapes. In a first step of the analysis, we will assess the overall model quality (validity, reliability) and the effects (direct effects) of the exogenous latent variables on the endogenous latent variable *engagement*.

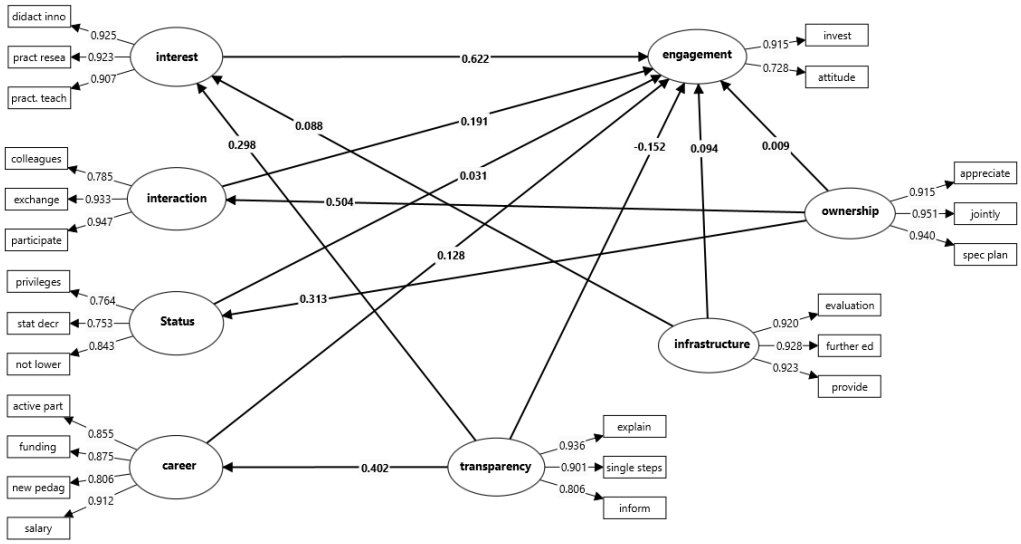


Figure 1: Path diagram of the estimated model (standardised coefficients)

The model performs quite well with regard to the quality criteria suggested by the literature (Hair et al., 2022). The indicators for the model's reliability and construct validity meet the requirements with the exception of a small value of Cronbach's α in the latent variable engagement. The heterotrait-monotrait (HTMT) ratio as a measure of the discriminant validity of the constructs reveals some specification problems, particularly in the case of the three latent variables describing the management aspects (transparency, infrastructure, ownership). Apparently, the measurements of these three constructs do not fully reflect the interpretation of the dimensions of management activities, indicating that there is room for further improvement of the model. The adjusted R^2 value of the endogenous variable *engagement* (.718) indicates that more than two thirds of the variation in teachers' engagement for the reform are explained by the influence of the other latent constructs, related to their motivation and the employed management approaches. The explanatory power of management related latent variables towards individual traits is small to moderate which is suggested by the respective R^2 values and the effect sizes (f^2) (table 2).

Table 2: Explained variance of endogenous variables (adjusted R2) and effect sizes (f2)

	R^2
status	0.093
career	0.158
engagement	0.718
interaction	0.251
interest	0.133

	f^2
status > engagement	0.002
career > engagement	0.030
infrastructure > engagement	0.007
infrastructure > interest	0.002
interaction > engagement	0.048
interest > engagement	0.602
ownership > status	0.109
ownership > engagement	0.000
ownership > interaction	0.341
transparency > career	0.193
transparency > engagement	0.015
transparency > interest	0.026

The path coefficients indicate the relative influence of the exogenous on the assigned endogenous latent constructs, ranging from a medium to strong relationship between *personal interest* and *engagement* (.622) to small and even negative relationships between the three management aspects (*transparency, infrastructure, ownership*) and *engagement* (fig. 1). The measurement model ('outer model') performs well, too. The loadings of the latent constructs' indicator variables are all above the threshold value of 0.708 (Hair et al., 2022) and range between .728 and .951.

Most interesting are the contributions of the exogenous latent constructs to the explanation of variation in the ultimate endogenous latent variable *engagement*. Overall, the constructs in the model accounted for more than 70 per cent of the variance. The largest share of the explanation of variance in *engagement* can be attributed to the individual motivations of teachers, while the different management activities only have a little influence or even exhibit negative correlations with *engagement*, as is the case for *transparency* (as indicated by the path coefficient of -.152 between *transparency* and *engagement*). This means that the more the university leadership takes action in order to keep teacher informed and updated on the overall reform agenda and the single steps of the process, the less teachers are willing to invest their time and energy in the process and the less do they develop a positive attitude towards it. The individual motivations exhibit comparatively strong correlations with the teachers' *engagement*, particularly in the case of their *personal interest* (.622). The teachers' *personal interest* can be seen as the only purely intrinsic motivation in the model, and apparently, being intrinsically motivated, is the strongest driver for the development of the willingness to support the reform and related activities. The second largest, but much smaller influence is exerted by *social relatedness* (.191). Obviously,

the participation in a joint activity and the feeling of being embedded in the collective attempt to transform the university is a factor that cannot be discounted as a motivational driver. The same is true for teachers' *career orientation* (.128). As stated above, the expectation that the participation in the reform process helps develop the career and gain access to resources (increased salary, research funds) could be interpreted as an extrinsic motivation. However, at the same time the desire to develop the career could also be motivated by the anticipation of professionalisation opportunities as a reward for the support of the reform.

The lowest ranking motivational aspect with regard to its impact on *engagement* is *status* (0.031). As stated earlier, this particular dimension represents the meaningfulness of an activity for the individual and its self-efficacy with regard to the respective requirements. With regard to the reform process of Chinese universities we related this dimension to the teachers' concerns with a 'downgrading' of the respective university. This means that the more the teachers would be concerned with losing their reputation as university teachers, the less they would be developing a positive attitude towards the process and the willingness to actively support it. The low value of the respective path coefficient suggests that this motivational dimension does not have much impact on how the teachers' feelings towards the transformation are developing. The absence of a direct effect of management activities on teachers' attitudes towards the reform does not necessarily have to mean that the mode in which the university leadership pursues its reform goals is of no meaning for the implementation of the reform. On the contrary, it can be assumed that the different dimensions of individual motivations can be reinforced or mitigated by the way in which the leadership chooses to implement the reform. An appreciative approach may strengthen an individual's motivation to engage with the reform, while a hierarchical one may be hampering respectively. In a second step of the analysis, we will thus evaluate as to how far the indirect effects of the management aspects on *engagement* through the individual motivations account for a significant influence of management activities on the willingness of teachers to support the reform. For this purpose, we analyse the mediating effects in the model. We found statistically significant indirect effects from *ownership* through *social relatedness* on *engagement* and from *transparency* through *personal interest* as well as from *transparency* through *career orientation* on *engagement*. With statistically non-significant direct effects of *ownership* and *transparency* on *engagement* and statistically significant indirect effects respectively, one can state that there is a full mediation effect of *social relatedness*, *personal interest* and *career orientation*. In other words, the positive influence of the feeling to be socially related can be reinforced by a process design that promotes a sense of ownership of the course which the reform takes. In the context of the Chinese university reform, the notion of a sense of ownership apparently does not relate so much to the individual's perception of being in control of the process, but rather to the opportunities of the collegial team to exercise influence on the course of the reform process.

4. Discussion

According to the results, it is not sufficient to provide infrastructure, nor is it sufficient to secure transparency regarding the goals and the course of the intended reform process when transparency is limited to making relevant information available. At least, the provision of infrastructure does not seem to have a positive influence on the way teachers look at the reform. Making the reform policy transparent by informing on how it is going to be implemented - without granting opportunities to participate in the design of the process - is even contributing to a negative attitude towards the reform. Likewise, the attempts to create a sense of ownership among teaching staff as such fail to influence teachers' attitude positively. The integration of teachers' individual motivations to support the reform into the management concept seems to be more promising. Securing transparency by providing relevant information helps increasing those teachers' willingness to engage with the reform, who are intrinsically motivated to further develop their teaching professionalism, e.g., by introducing didactical innovations to their teaching practice. This means that the role of the management is not only to make the planned approach to the reform transparent, but also to make transparent, what in detail the pursued goal to shift to a more practice-oriented teaching approach means for the individual teaching performance and how respective professionalisation activities can be and will be supported. Also creating a sense of ownership is not a panacea. At least it does not have an immediate effect on the teachers' attitudes towards the reform which also requires looking closer at what exactly are the opportunities to get involved in the decision-making process regarding the reform. The study exhibits considerable limitations. There were only two out of 600 participating universities in the sample which is thus far from being representative. This was due to a complex accessibility of the Chinese universities. However, given the exploratory character of the study, its purpose was to build a heuristic model in order to inspire further research, also involving qualitative approaches to the different constructs under examination. The model reveals specification issues. The test statistics are not fully in line with the suggested reference values. In the sense that *engagement* is functioning as the 'ultimate' endogenous variable in the model, such specification issues need to be addressed in further research.

References

Al-Mahdy, Y. F., Al-Harthi, A. S. & Salah El-Din, N. (2022). The effect of leadership support on commitment to change and turnover intention in Omani higher education. *Journal of Further and Higher Education*, *47*(3), 324–337.

Chandler, A.D. (1962). *Strategy and Structure*. The MIT Press.

Cheng, Z., & Zhu, C. (2021). Academic members' perceptions of educational leadership and perceived need for leadership capacity building in Chinese higher education institutions. *Chinese Education & Society*, 54(5–6), 171–189.

Deci, E. L. & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. Springer.

Deci, E. L. & Ryan, R. M. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Donald, J. N., Bradshaw, E. L., Ryan, R. M., Basarkod, G., Ciarrochi, J., Duineveld, J. J., Guo, J., & Sahdra, B. K. (2020). Mindfulness and its association with varied types of motivation: A systematic review and meta-analysis using self-determination theory. *Personality and Social Psychology Bulletin*, 46(7), 1121-1138. https://doi.org/10.1177/0146167219896136

Fauzi, M.A. (2022). Partial least square structural equation modelling (PLS-SEM) in knowledge management studies: knowledge sharing in virtual communities. *Knowledge Management & E-Learning*, 14(1), 103-124.

Hagger, M. S., & Hamilton, K. (2021). General causality orientations in self-determination theory: Meta-analysis and test of a process model. *European Journal of Personality*, 35(5), 710-735. https://doi.org/10.1177/0890207020962330

Hair, J.F., Henseler, J., Dijkstra, T.K. and Sarstedt, M. (2014). Common beliefs and reality about partial least squares: comments on Ronkko and Evermann. *Organizational Research Methods*, 17(2), 182-209

Hair, J.F., Hult, G.T.M., Ringle, C.M. and Sarstedt, M. (2022). *A primer on partial least squares structural equation modelling (PLS-SEM)* (3rd ed.). Sage Publications.

Jiang, H. & Xue, Y. (2021). Perceptions of faculty leadership in university governance: A case study. *Chinese Education & Society*, 54(5–6), 207–221. https://doi.org/10.1080/10611932.2021.1990626

Lin, X. J. (2014). Meaning, mission, and development paths of application-oriented universities. *Journal Of Southwest JIAOTONG University*, 15(5), 13-16.

Liu, H. F. & Gu, Y. A. (2014). On the Strategic Reform and Transformation of Talents Cultivation Elements of Applied University of Technology in China. *Vocational and Technical Education*, 35(10), 11-15

Ringle, C. M., Wende, S., & Becker, J.-M. (2024). SmartPLS (Version 4.0) [Computer software]. SmartPLS.

Tang, M. M., Wang, D. H. & Guerrien, A. (2020). A systematic review and meta- analysis on basic psychological need satisfaction, motivation, and well-being in later life: contributions of self-determination theory. *PsyCh Journal*, 9(1), 5–33.

Tu, Y. (2022). The transformation of local universities to applied-oriented: The German experience and the path of China. *The Theory and Practice of Innovation and Entrepreneurship*, 5(11), 94-97.

Wang, Y. D. & Wang W. Y. (2015). Research on the construction of ‘dual-teacher’ faculty in universities of applied sciences, *Education and Vocation*, 849(29), 63-65.

Zhang, Y. Q. & Jiang, H. L. (2014). Reflections on the Challenges Confronting China‘s Municipal Colleges in Transition. *Modern University Education*, 6, 2-8.

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From Traditional to Conscious: Assessing Paradigm Shifts in Students' Business Perspectives

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Abstract

This study evaluates changes in undergraduate students' perspectives on the essence and purpose of business after completing a one-semester Conscious Business Minor. A non-experimental, one-group pretest-posttest design was conducted with data collected from 119 students using a 25-item instrument that measured alignment with either a "traditional paradigm" or a "conscious paradigm" of business. Statistical analyses included scale reliability and median comparison tests. The results revealed significant paradigm shifts in 12 items, particularly challenging the traditional view that business exists solely for profit and is driven by greed or selfishness. However, no significant changes were observed in items addressing the challenge of reimagining business as the greatest creator of value in the world or recognizing that for-profit enterprises can be as noble as non-profit organizations. These findings indicate that the minor fostered a more conscious business mindset while highlighting areas for further development.

Keywords: *Conscious Capitalism; Higher Education; Educational Innovation*

1. Introduction

Conscious Capitalism is a business philosophy that integrates profit-making with a commitment to positive social and environmental impact. It focuses on creating value for all stakeholders - employees, customers, suppliers, communities, and the environment- rather than prioritizing shareholder profits alone (Sisodia, 2009). This approach seeks to address the shortcomings of traditional capitalism, such as ecological degradation and social inequality, by promoting a more equitable, ethical, and sustainable economic model.

Teaching business with a sustainability focus is a relatively recent trend, gaining momentum since the early 2000s (André, 2024). However, the incorporation of Conscious Capitalism into curricula is even more recent, with formal adoption emerging only within the past decade. In

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the literature, we could find only one research article regarding the teaching of conscious business (Morales-Rodriguez et al., 2024). However, we know that similar concepts, such as business ethics, have been taught for much longer.

A key objective of teaching Conscious Capitalism is to shift students' paradigms regarding the nature of business, its role in society, and its management to ensure sustainability. While traditional business paradigms emphasize profit maximization, individualism, and materialism, the conscious business perspective advocates a holistic approach that integrates ethical practices, stakeholder engagement, and societal and planetary well-being (Mackey & Sisodia, 2013). Central to this shift is transforming the perception of companies from passive participants in societal challenges to active contributors to solutions.

Universities employ diverse strategies to promote this paradigm shift, from integrating small activities into existing courses to offering entire semesters dedicated to Conscious Capitalism. However, the degree to which these efforts succeed in fostering paradigm shifts among students is not always measured.

This study addresses this gap by examining the extent of paradigm shifts among students at a private Mexican university. Using survey data collected at two time points -at the beginning and end of their one-semester Conscious Business Minor- the study evaluates changes in students' perspectives on the essence and purpose of business.

2. Methodology

2.1. The Conscious Business Minor

The Conscious Business Minor aims to shape the professional development of undergraduate students by cultivating a business mindset that prioritizes the well-being of all organizational stakeholders. Throughout the semester, students explore and apply the four tenets of Conscious Capitalism: higher purpose, stakeholder integration, conscious leadership, and conscious culture. They engage in consulting projects with partner companies, conducting comprehensive diagnoses and developing strategic proposals to help these organizations advance their journey toward becoming conscious enterprises. This experiential learning process is further enhanced through diverse methodologies, including self-development practices, guest lecturers, and a conscious business simulation, deepening students' understanding and practical application of conscious business principles.

2.2. Instrument of Study

The instrument to assess the paradigm shift used in this study was initially designed by Raj Sisodia, co-founder of the Conscious Capitalism movement, as detailed in Table 1. This measure consists of 25 items: 13 items addressing the "Traditional Business Perspective" dimension and

12 addressing the "Conscious Capitalism Perspective" dimension. The survey questions were translated and applied in Spanish, and an online version of the survey was developed using Google Forms.

Before the start of the minor, the questionnaire link was uploaded to the students' learning platform, and students were instructed to complete it individually during the first and the last week of the Spring and Fall 2023 semesters, as well as the Spring 2024 semester. Informed consent was obtained from all participants. For the purposes of this study, only responses from students who completed both questionnaires were considered valid. The questionnaire employed a Likert scale, where 5 represented "Strongly agree," 4 represented "Agree," 3 represented "Not sure," 2 represented "Disagree," and 1 represented "Strongly disagree."

Table 1. Instrument of the study

Traditional Business Perspective	Conscious Capitalism Perspective
1. The sole purpose of business is to make money.	14. Businesses should be about purpose maximization, not profit maximization.
2. Business is driven by greed and selfishness.	15. Business can be the greatest creator of value in the world.
3. The most effective bosses are the toughest bosses.	16. The most effective bosses are those who inspire and genuinely care about people.
4. Non-profit organizations are inherently more virtuous than for-profit businesses.	17. For-profit businesses can be every bit as noble as non-profit organizations.
5. The world of business is largely a man's world.	18. Far more than governments, business can sustainably lift people out of poverty.
6. My most idealistic friends did not choose to go to business school	19. If making a living was not an issue, I would still choose business as a major.
7. Successful businesses must be ruthless and not really care about their employees or customers.	20. Business can be a noble undertaking.
8. Love and caring have no place in the world of business; they are signs of weakness.	21. If businesses don't care about their employees or customers, they will not survive.
9. To get people to work harder, you must pay them more or threaten them.	22. Businesses built on love and caring are the strongest, most enduring businesses.
10. Most employees only care about the size of their paycheck.	23. People are most productive and creative when they are passionate about what they do.
11. People are a resource like any other and must be used efficiently	24. Most employees want to make a difference in the world.
12. The only way I can follow my personal passions is outside of work.	25. People are happiest when their work is a calling.
13. Your work is just a job; it need not engage you emotionally or spiritually.	

2.3. Data Analysis

The dataset included information from 119 students who completed the questionnaire twice: once at the beginning and again at the end of the semester. All data were anonymized prior to analysis. The Statistical Package for the Social Sciences (SPSS) software was used for data processing and statistical analysis. Descriptive statistics were calculated to profile the students and analyze their questionnaire responses. Cronbach's alpha reliability tests were conducted to evaluate the internal consistency of the overall scale and its subscales. The normality of the data was assessed using the Shapiro-Wilk test. To determine whether there was a significant change in median scores between the pre-test and post-test, the Wilcoxon signed-rank test was applied.

3. Results

The participants in this study were 52% male and 48% female undergraduate students enrolled in various academic programs. The majority (86%) were from the Business School, followed by 13% from the Engineering School, and 1% from other schools. In terms of academic progress, 59% of the students were in their sixth semester, 39% in their seventh semester, and 2% in their eighth and final semester. The average age of the participants was 21 years.

The Cronbach's alpha coefficients ranged from 0.611 to 0.821 for the pre-test and from 0.754 to 0.913 for the post-test. Overall, the constructs demonstrated satisfactory levels of internal reliability. Table 2 presents Cronbach's alpha coefficients.

Table 2. Reliability analysis.

Variable	Business Perceptions (25 items)	Traditional Perspective (13 items)	Conscious Capitalism Perspective (12 items)
Pre-test Cronbach's Alpha	0.611	0.821	0.753
Post-test Cronbach's Alpha	0.754	0.913	0.814

Descriptive statistics were calculated, and the Shapiro-Wilk test confirmed non-normal distribution of responses (see Table 3).

As shown in Table 4, the Wilcoxon signed-rank test results revealed significant differences in 12 out of the 25 survey questions. Seven questions related to the Traditional Business Perspective showed a significant decrease from the pre-test to the post-test. In comparison, five questions related to the Conscious Capitalism Perspective showed a significant increase.

Table 3. Descriptive statistics and normality test.

Variable	Mean	Std. Dev	Median	p-value*	Variable	Mean	Std. Dev	Median	p-value*
Q1 Pre	2.23	1.11	2	0.000	Q14 Pre	3.61	1.13	4	0.000
Q1 Post	1.87	1.11	1	0.000	Q14 Post	3.66	1.22	4	0.000
Q2 Pre	2.29	1.00	2	0.000	Q15 Pre	4.19	0.84	4	0.000
Q2 Post	1.99	1.00	2	0.000	Q15 Post	4.32	1.07	5	0.000
Q3 Pre	2.02	0.99	2	0.000	Q16 Pre	4.61	0.70	5	0.000
Q3 Post	1.69	0.89	1	0.000	Q16 Post	4.62	0.83	5	0.000
Q4 Pre	2.63	0.96	3	0.000	Q17 Pre	4.39	0.87	5	0.000
Q4 Post	2.51	1.02	3	0.000	Q17 Post	4.50	0.78	5	0.000
Q5 Pre	1.48	0.95	1	0.000	Q18 Pre	3.82	0.95	4	0.000
Q5 Post	1.40	0.85	1	0.000	Q18 Post	4.13	0.94	4	0.000
Q6 Pre	2.39	1.08	2	0.000	Q19 Pre	3.69	1.25	4	0.000
Q6 Post	2.14	0.99	2	0.000	Q19 Post	3.75	1.34	4	0.000
Q7 Pre	1.30	0.72	1	0.000	Q20 Pre	3.64	1.03	4	0.000
Q7 Post	1.35	0.83	1	0.000	Q20 Post	3.90	0.96	4	0.000
Q8 Pre	1.45	0.77	1	0.000	Q21 Pre	4.17	1.09	5	0.000
Q8 Post	1.36	0.79	1	0.000	Q21 Post	4.21	1.12	5	0.000
Q9 Pre	1.21	0.60	1	0.000	Q22 Pre	3.87	1.03	4	0.000
Q9 Post	1.34	0.78	1	0.000	Q22 Post	4.30	0.85	5	0.000
Q10 Pre	3.13	0.98	3	0.000	Q23 Pre	4.79	0.47	5	0.000
Q10 Post	2.76	1.19	3	0.000	Q23 Post	4.69	0.58	5	0.000
Q11 Pre	2.47	1.23	2	0.000	Q24 Pre	3.32	1.11	3	0.000
Q11 Post	2.07	1.27	2	0.000	Q24 Post	3.84	0.98	4	0.000
Q12 Pre	2.06	0.99	2	0.000	Q25 Pre	4.22	0.87	4	0.000
Q12 Post	1.82	1.09	1	0.000	Q25 Post	4.50	0.76	5	0.000
Q13 Pre	1.87	0.97	2	0.000					
Q13 Post	1.74	1.01	1	0.000					

* p-value for Normality Shapiro-Wilk

The rankings for the Traditional Business Perspective questions that significantly decreased were as follows:

Q1 "The sole purpose of business is to make money" (Z= -3.266 p= 0.001).

Q2 "Business is driven by greed and selfishness." (Z= -2.486b p= 0.013).

Q3 "The most effective bosses are the toughest bosses" (Z= -3.755 p= 0.000).

Q6 "My most idealistic friends did not choose to go to business school." (Z= -2.207 p= 0.027).

Q10 "Most employees only care about the size of their paycheck." (Z= -2.798 p= 0.005).

Q11 "People are a resource like any other and must be used efficiently." (Z= -2.978 p= 0.003).

Q12 "The only way I can follow my personal passions is outside of work" (Z= -2.154 p= 0.031)

For the Conscious Capitalism Perspective, the rankings of the following questions significantly increased:

Q18 "Far more than governments, business can sustainably lift people out of poverty." (Z= -2.829 p= 0.005).

Q20 "Business can be a noble undertaking." (Z= -2.742 p= 0.006).

Q22 "Businesses built on love and caring are the strongest, most enduring businesses." (Z= -3.573 p= 0.000).

Q24 "Most employees want to make a difference in the world." (Z= -4.527 p= 0.000).

Q25 "People are happiest when their work is a calling." (Z= -2.991 p= 0.003).

These findings suggest that students increasingly acknowledge the transformative power of businesses to positively impact society as a noble undertaking, challenging the traditional perspective that the sole purpose of business is profit-driven and motivated by greed or selfishness. Moreover, the findings indicate that students value the importance of meaningful work and advocate for a paradigm shift toward more conscious business practices.

Nevertheless, the items with no significant changes emphasize the challenges associated with realizing such a paradigm shift. Reimagining the role of business would require students to recognize that for-profit enterprises can be just as noble as non-profit organizations and to understand that business has the potential to serve as the greatest creator of value in the world.

Table 4. Wilcoxon signed rank test

	N	MR	SR	Z	Sig.2t		N	MR	SR	Z	Sig.2t
		Q1 Post – Q1 Pre						Q14 Post – Q14 Pre			
NR	42	29.24	1228	-3.266b	0.001	NR	36	37.75	1359	-.361c	0.718
PR	15	28.33	425			PR	39	38.23	1491		
Ties	62					Ties	44				
		Q2 Post – Q2 Pre						Q15 Post – Q15 Pre			
NR	48	38.17	1832	-2.486b	0.013	NR	16	31.78	508.5	-1.736c	0.083
PR	26	36.27	943			PR	36	24.15	869.5		
Ties	45					Ties	67				
		Q3 Post – Q3 Pre						Q16 Post – Q16 Pre			
NR	46	34.99	1609.5	-3.755b	0.000	NR	14	18.14	254	-.197c	0.844
PR	19	28.18	535.5			PR	18	15.22	274		
Ties	54					Ties	87				
		Q4 Post – Q4 Pre						Q17 Post – Q17 Pre			
NR	45	36.62	1648	-1.013b	0.311	NR	16	16.56	265	-1.602c	0.109
PR	31	41.23	1278			PR	22	21.64	476		
Ties	43					Ties	81				

		Q5 Post – Q5 Pre						Q18 Post – Q18 Pre			
NR	17	20.32	345.5	-.834b	0.404	NR	24	37.08	890	-2.829c	0.005
PR	17	14.68	249.5			PR	50	37.7	1885		
Ties	85					Ties	45				
		Q6 Post – Q6 Pre						Q19 Post – Q19 Pre			
NR	43	38.38	1650.5	-2.207b	0.027	NR	31	33.63	1042.5	-.411c	0.681
PR	28	32.34	905.5			PR	35	33.39	1168.5		
Ties	48					Ties	53				
		Q7 Post – Q7 Pre						Q20 Post – Q20 Pre			
NR	14	15.96	223.5	-.497c	0.619	NR	20	25.93	518.5	-2.742c	0.006
PR	17	16.03	272.5			PR	38	31.38	1192.5		
Ties	88					Ties	61				
		Q8 Post – Q8 Pre						Q21 Post – Q21 Pre			
NR	25	19.76	494	-1.186b	0.235	NR	32	34.28	1097	-.056c	0.956
PR	15	21.73	326			PR	34	32.76	1114		
Ties	79					Ties	53				
		Q9 Post – Q9 Pre						Q22 Post – Q22 Pre			
NR	10	12.15	121.5	-1.663c	0.096	NR	16	38	608	-3.573c	0.000
PR	17	15.09	256.5			PR	52	33.42	1738		
Ties	92					Ties	51				
		Q10 Post – Q10 Pre						Q23 Post – Q23 Pre			
NR	49	40.54	1986.5	-2.798b	0.005	NR	21	18.55	389.5	-1.691b	0.091
PR	27	34.8	939.5			PR	13	15.81	205.5		
Ties	43					Ties	85				
		Q11 Post – Q11 Pre						Q24 Post – Q24 Pre			
NR	49	40.33	1976	-2.978b	0.003	NR	19	29.29	556.5	-4.527c	0.000
PR	26	33.62	874			PR	54	39.71	2144.5		
Ties	44					Ties	46				
		Q12 Post – Q12 Pre						Q25 Post – Q25 Pre			
NR	43	31.4	1350	-2.154b	0.031	NR	15	27.2	408	-2.991c	0.003
PR	21	34.76	730			PR	39	27.62	1077		
Ties	55					Ties	65				
		Q13 Post – Q13 Pre									
NR	41	31.26	1281.5	-1.461b	0.144						
PR	24	35.98	863.5								
Ties	54										

*MR: Mean Rank, SR: Sum of Ranks, Sig.2t:Asymp. Sig. 2-tailed, NR: Negative Ranks, PR: Positive Ranks, b Based on positive ranks, c Based on negative ranks.

4. Conclusions

The findings of this study reveal that a one-semester Conscious Business Minor significantly influenced some students' perspectives on the essence and purpose of business. Key paradigm shifts were observed in students moving away from a traditional view -- characterized by profit maximization, individualism, and utilitarian views of employees -- towards a more conscious business perspective. This included a stronger alignment with concepts of stakeholder well-being, purpose maximization, and societal responsibility.

However, the study also identified areas where the desired paradigm shift was less evident, such as the recognition that for-profit enterprises can be just as noble as non-profit organizations and that business has the potential to serve as the greatest creator of value in the world. This finding suggests that while the course effectively fosters awareness of systemic and purpose-driven change, students' perceptions of business and its potential remain deeply rooted in their worldviews, rendering these aspects more resistant to transformation.

Overall, the study underscores the potential of focused academic programs, such as the Conscious Business Minor, to facilitate meaningful shifts in how students conceptualize the role of business in society. Future research could explore long-term impacts, cross-cultural applications, and the integration of complementary pedagogical tools to further enhance the adoption of these paradigms in business education.

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References

André, R. (2024). Teaching to save the planet: The challenges ahead for instructors, business schools, and universities. *Journal of Management Education*. https://doi.org/10.1177/10525629241269035.

Mackey, J., & Sisodia, R. (2013) *Conscious Capitalism: Liberating the heroic spirit of business*. Harvard Business Review.

Morales-Rodriguez, A., Ramírez-Vásquez, N., & Bores-Rangel, E. (2024). Teaching Conscious Capitalism in Higher Education: Learning Experience and Paradigm Shift. In *Proceedings of the 16th International Conference on Computer Supported Education - Volume 2: CSEDU* (pp. 461-466). DOI: 10.5220/0012544400003693

Sisodia, R. S. (2009). Doing business in the age of conscious capitalism. *Journal of Indian Business Research,* 1(2/3), 188-192. https://doi.org/10.1108/17554190911005354

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Assessments - search for an answer in the era of Generative AI

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Abstract

Assessing student learning has always been challenging. The recent proliferation of generative artificial intelligence (GenAI) tools has increased this complexity driving educators to search for innovative and meaningful assessment practices. Educational institutions are investigating, developing and implementing alternative and authentic assessment practices that maintain academic integrity while genuinely assessing student learning. This paper summarises the assessment practices in a techno-centric school at an Australian university and proposes assessment strategies to control academic misconduct cases arising because of GenAI. A teaching and learning case study of authentic assessment to engage students and effectively achieve learning outcomes is discussed. The technique has been popular among the students while successfully navigating the challenges provided by recent developments in GenAI.

Keywords: *academic integrity, authentic assessment, generative AI, GenAI.*

1. Introduction

Assessment is one of the methods used to test student learning and attainment of knowledge. Therefore, it is important to design assessments carefully to encourage student engagement while enhancing student learning (Biggs et al., 2022). Assessment design gained increased importance since the introduction of online assessments forced upon the academic community by the COVID-19 pandemic, when online education underwent a monumental shift (Daniel, 2020). Then came the release of an artificial intelligence tool, ChatGPT (Chat Generative Pre-trained Transformer) in November 2022 (OpenAI, 2022). With these changes came renewed concerns about the integrity of traditional assessments (Yusuf et al., 2024).

The abovementioned factors and the unprecedented increase in academic misconduct cases due to GenAI use were the catalysts that led to the formation of the Alternative Assessment Working

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Party (AAWP) in the School of Engineering, Design and Built Environment (SoEDBE) at Western Sydney University (WSU). Established in June 2022, the group was tasked with developing strategies to address academic integrity within the SoEDBE.

According to the Cambridge University Dictionary, the abbreviated term for 'generative artificial intelligence' is 'Generative AI' or 'GenAI'. In this paper, the authors use 'GenAI' to define: *the use of artificial intelligence (= computer systems that have some of the qualities that the human brain has, such as the ability to interpret language, recognize images, and learn from data supplied to them) capable of producing texts, images, etc*. Furthermore, this paper presents initiatives undertaken by the AAWP to identify opportunities for promoting authentic assessment to drive a positive student learning outcome.

2. Literature Review

This section briefly reviews the literature on the role of assessment in student learning and the impact of GenAI on assessment design and delivery.

2.1. Assessment and its role in student learning

Assessments have been identified as a key driver of student learning activities. Biggs et al. (2022) assert that assessment requirements effectively define the curriculum for most students and that assessment requirements are a starting point for student learning activities, more so than teaching activities and subject content. While some academics may consider this as a negative, a focus on assessment can lead to active and effective learning if the assessment tasks are designed effectively (Biggs et al., 2022).

Assessment tasks can be designed to guide students towards analytical thinking and problem-solving, thus leading to higher-order thinking and enabling high-level subject learning outcomes. Boud and Dochy (2010) argue assessment tasks achieving this represent '*assessment for learning*' and should be at the heart of subject and course design so that the effects of assessment are systematically planned and scaffolded. This may involve including industry perspectives in the design of assessment tasks to develop skills important for employability.

A further development is the idea of authentic assessment. According to Quinlan, Sellei & Fiorucci (2024), authentic assessments promote meaningful engagement by students in a range of areas such as professional, societal, disciplinary and developmental contexts. They argue that this helps students see the relevance of subject matter as applied to the real-world professional environment.

Many researchers question the notion of authentic assessment. What are the attributes of an authentic assessment? Which factors need to be considered to make an assessment authentic? (Ajjawi et al., 2024; Messier, 2022; Quinlan et al., 2024). However, there is a general agreement

that authentic assessments engage students and help achieve better learning outcomes (Villarroel et al., 2018). Designed properly using sound educational pedagogy, authentic assessments prepare students to find solutions to real-world problems. The approach can also be compared to proponents who use Conceive, Design, Implement, Operate (CDIO) as a framework for student learning (CDIO, n.d.).

2.2. Assessment and Generative Artificial Intelligence (GenAI)

The public release of ChatGPT by OpenAI (OpenAI, 2022) in November 2022, it has disrupted the way problems are investigated, including in the higher education sector (McDonald et al., 2024; Perkins et al., 2024). The challenges to academia due to such technological advancement and the rapidly expanding commercial availability of GenAI tools have been highlighted by Yesmin (2024). In addition, the human-like responses of AI-powered chatbots and their ability to articulate coherent essays have been of concern in academic spheres (Shahriar & Hayawi, 2024; Yusuf et al., 2024).

GenAI is leading to a significant shakeup in assessment. As Nikolic et al. (2023) identified in a case study, most assessment tasks in engineering-related programs (at one university) could be accomplished to a passing standard and, in some cases, a high standard by using a range of GenAI programs. While programs exist to detect GenAI use, savvy students can re-prompt AI or employ more than one GenAI system so that the GenAI content is undetectable (Liu & Chilton, 2022).

These factors assess learning greater importance and urgency in the higher education environment. In a recent report on the challenges of GenAI (TEQSA, 2024), the authors indicate that assessment tasks designed based on principles that promote effective learning also provide a more robust resistance to the threats posed to academic integrity by GenAI. Assessment tasks engaging students in an extensive process of investigation of sources, analysis, problem-solving, working in partnership with academic staff and other students are less likely to be vulnerable to work produced by GenAI (Lodge et al., 2023).

A focus on the process of learning, rather than an artefact as a product that may or may not be the student's own work, may be a useful assessment approach. In addition, assessments that promote group-based projects with regular reporting, team meetings and journaling to enable self-analysis and reflection of the stages of learning (CSU, n.d.) could enhance assessment planning. Peer review and feedback on group tasks can also enable consideration of the learning process. Authentic tasks involving external partners, such as industry collaborative projects, can also be valuable in enabling consideration of the learning process independently of the final product. Ajjawi et al. (2024) suggest authentic assessment is valuable in addressing three assessment challenges in higher education: the rise of artificial intelligence, threats to academic integrity, and greater student equity.

There is a strong similarity between authentic assessment and alternative assessment (definition provided in section 4 below) as defined by the School's AAWP. The working party aimed to promote alternative assessments and identify the extent to which they are currently used within the School.

3. Methodology

A mixed-methods approach was adopted in this study. Firstly, a quantitative online survey was distributed to all academics in the School in October 2022 to take stock of the types of assessments used in subjects offered by the School. Questions ranged from the number and types of assessments in each subject to the percentage distribution of tasks and procedures students used for task submission. The quantitative survey was followed by written feedback from participants of two workshops to ascertain academic concerns about GenAI and opportunities to redesign assessments. Finally, in the teaching exemplar, student testimonials were gathered in response to one neutral question posed after completing the subject requirements, asking students to write a statement (85 words or less) about their experience working with an industry partner.

4. Survey data collection, response analysis and results

To understand the range of assessment techniques used in the School, the AAWP issued surveys to all academics in SoEDBE who were requested to respond within 2-weeks. Responses were categorized according to assessment types that were '*alternative assessment*' or other types, to provide a snapshot of the proportion of subjects employing the broad definition of alternative assessment approaches.

3.1. Survey response

Responses covering 201 subjects from every discipline in the School were received. The survey addressed a wide range of questions about assessment practice across disciplines. Of particular significance were the range of assessment types in practice in the School (see Figure 1).

The overall assessment pattern heavily relies on traditional assessment types like quizzes, reports, and exams. Alternative formats, such as applied projects and case studies, show possibilities for creating a more widespread use of authentic assessment across the school. The data indicate the extent of the challenge facing the School, given the growing capability of GenAI products to produce effective and mostly undetectable responses to most traditional assessment formats.

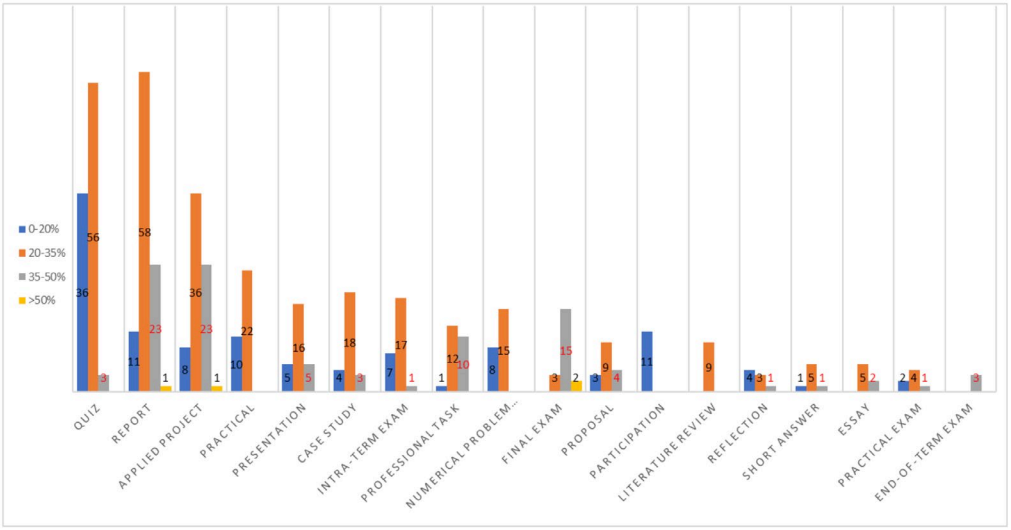


Figure 1. Assessment Types (Traditional vs Alternative)

5. Alternative Assessment Workshops

Following the survey and staff development workshops, a presentation followed whereby small-group discussions were held to promote the idea of alternative assessment and to gauge the response by academic staff to the significance of alternative assessment formats in the current environment. An example is presented below.

5.1. Example – an undergraduate subject using an alternate assessment strategy

In a second-year Industrial Design (ID) subject delivered within the School, assessments were designed to deter exclusive use of GenAI in writing and research. Students were challenged with authentic learning tasks to promote critical thinking and problem-solving; tasks were designed to mimic typical design problems when working in industry. The learning environment (classroom set-up) encompassed small teams rotating to various '*learning stations*' whilst undertaking written, research, and practical tasks. For example, during teamwork scenarios, students participated in mind-mapping at pinboards, project planning using laptops, sketching on tablets, paper or whiteboards, and verbal group presentations; tutors were also physically active, moving between groups and providing guidance. All tasks required students to rely on the creative input of team members, whereby solutions are informed by tangible experiences rather than relying on GenAI.

The subject's content was lively and visible (*Figure 2*); students witnessed concepts come to life and could visualize the application of content to their profession. For example, one of the

learning objectives of the subject was the application of anthropometric data to inform the design of an object. This was achieved through students' use of biometric measuring tools to capture data from peers, a task that cannot be repeated using GenAI. Students also learnt principles of ethics in engaging with participants in addition to presenting and analyzing the data using appropriate statistical techniques. As a result, the content was immediately placed in context of the students' world without relying on GenAI software.

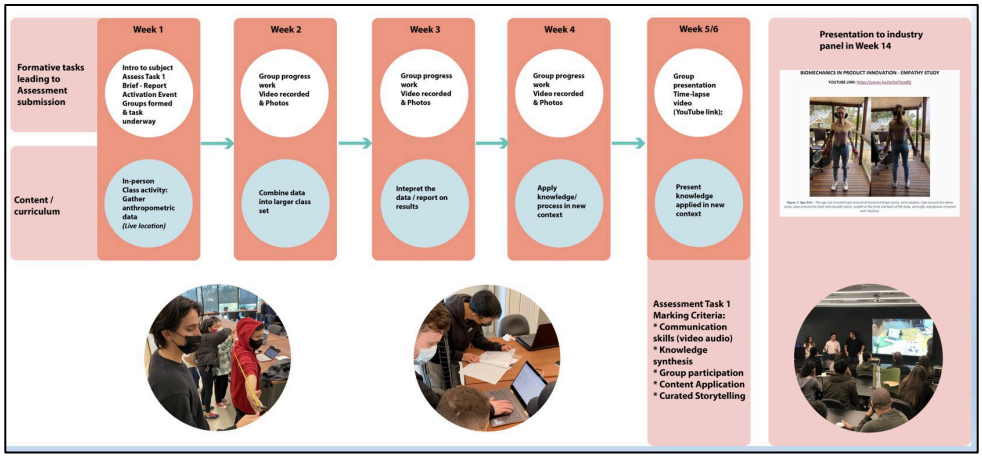


Figure 2. Learning and teaching journey in an Industrial Design subject

Student participation was self-recorded. They kept audio-visual recordings (or A/V journals) to capture processes of their own participation in all activities. The footage was curated and compiled as a time-lapsed video (using basic video-editing software) and shared with the industry partner and academics. Audio-visual journaling provides evidence of each student's contribution to their group's design solution. Students know they must show their workings in the footage, so GenAI avatars are difficult to replicate in team meetings.

An industry partner collaborated with students and co-designed the project to ensure the subject unfolded in a manner mimicking a real-world scenario. During the problem-solving and design conceptualization phases, the industry partner provided professional perspectives and critiqued students' progress. This engagement was invaluable in driving students to enhance their creative approaches to the project. In addition, the industry partner facilitated a field trip for students, providing an opportunity for students to observe design processes and robotic manufacturing in an industry setting.

The student feedback was highly positive, suggesting student learning through interactive classroom experiences, varied assessment tasks, and industry partnership. Selected comments from two students on aspects of the subject they liked or did not like are provided below:

" *[the industry partnership] was a rich learning experience. Collaborating with our industry partner provided valuable insights into real-world applications. I particularly appreciated the emphasis on precision and safety [during the field trip], ensuring the devices met high standards. The* interdisciplinary *nature of the project enhanced my problem-solving skills, making it a beneficial endeavor in understanding (subject name) principles within a practical context.*" (student A)

"*Engaging in a diverse range of (subject name) activities this semester, such as an industry project, an empathic* study *and some quizzes, has been amazing. Additionally, the collaboration with an industry partner has provided relevant and practical insights, allowing an alignment of theoretical concepts with real-world applications. Furthermore, the experiential learning, from anthropometrics data gathering to industry presentations, improved my understanding of this subject's broader implications."* (student B)

The above comments suggest that students gained a rich and deep study experience and that the learning objectives were achieved authentically without the use of GenAI.

6. Conclusions and recommendations

The proliferation of GenAI tools and their widespread unethical use in the higher education sector has given rise to academic integrity issues. While this has challenged educators, they have risen to the occasion by developing innovative learning and teaching techniques and novel assessment practices. Higher education institutions and regulatory agencies have led by example through development and implementation of new guidelines and policies to ensure that the students are prepared for the profession they will be serving after graduation. The successful strategies described and student feedback in one of the subjects mentioned in this paper are testimony to the academics' innovation capability. Many more appropriate strategies must be developed and implemented in other subjects in different courses. These can then be incorporated to improve curricula while benefiting from GenAI.

References

Ajjawi, R., Tai, J., Dollinger, M., Dawson, P., Boud, D., & Bearman, M. (2024). From authentic assessment to authenticity in assessment: broadening perspectives. *Assessment & Evaluation in Higher Education*, *49*(4), 499-510.

Biggs, J., Tang, C., & Kennedy, G. (2022). *Teaching for quality learning at university 5e*. McGraw-hill education (UK).

Boud, D., & Dochy, F. (2010). Assessment 2020. Seven propositions for assessment reform in higher education.

CDIO. (n.d.). *Conceive, Design, Implement and Operate*. Retrieved 23 January 2025 from https://cdio.org/

CSU. (n.d.). *Rethinking Assessment Strategies in the Age of Artificial Intelligence (AI)*. Division of Learning and Teaching. Retrieved 23 January 2025 from

https://www.csu.edu.au/division/learning-teaching/assessments/assessment-and-artificial-intelligence/rethinking-assessments?t

Daniel, S. J. (2020). Education and the COVID-19 pandemic. *PROSPECTS*, *49*(1), 91-96. https://doi.org/10.1007/s11125-020-09464-3

Liu, V., & Chilton, L. B. (2022). *Design Guidelines for Prompt Engineering Text-to-Image Generative Models* Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems, New Orleans, LA, USA. https://doi.org/10.1145/3491102.3501825

Lodge, J., Howard, S., & Bearman, M. (2023). Assessment reform for the age of artificial intelligence.

McDonald, N., Johri, A., Ali, A., & Hingle, A. (2024). Generative artificial intelligence in higher education: Evidence from an analysis of institutional policies and guidelines. *arXiv preprint arXiv:2402.01659*.

Messier, N. (2022). *Authentic Assessments*. Center for the Advancement of Teaching Excellence at the University of Illinois Chicago. Retrieved 23 January 2025 from https://teaching.uic.edu/resources/teaching-guides/assessment-grading-practices/authentic-assessments/

Nikolic, S., Daniel, S., Haque, R., Belkina, M., Hassan, G. M., Grundy, S., Lyden, S., Neal, P., & Sandison, C. (2023). ChatGPT versus engineering education assessment: a multidisciplinary and multi-institutional benchmarking and analysis of this generative artificial intelligence tool to investigate assessment integrity. *European Journal of Engineering Education*, *48*(4), 559-614. https://doi.org/10.1080/03043797.2023.2213169

OpenAI. (2022). *Introducing ChatGPT*. Retrieved 23 January 2025 from https://openai.com/index/chatgpt/

Perkins, M., Furze, L., Roe, J., & MacVaugh, J. (2024). The Artificial Intelligence Assessment Scale (AIAS): A Framework for Ethical Integration of Generative AI in Educational Assessment. *Journal of University Teaching & Learning Practice*, *21*(6), 1-18. https://doi.org/10.53761/q3azde36

Quinlan, K. M., Sellei, G., & Fiorucci, W. (2024). Educationally authentic assessment: reframing authentic assessment in relation to students' meaningful engagement. *Teaching in Higher Education*, 1-18.

Shahriar, S., & Hayawi, K. (2024). Let's have a chat! A Conversation with ChatGPT: Technology, Applications, and Limitations. Artificial Intelligence and Applications,

TEQSA. (2024). *Gen AI strategies for Australian higher education: Emerging practice*. Tertiary Education Quality and Standards Agency. Retrieved 25 January 2025 from https://www.teqsa.gov.au/sites/default/files/2024-11/Gen-AI-strategies-emerging-practice-toolkit.pdf

Villarroel, V., Bloxham, S., Bruna, D., Bruna, C., & Herrera-Seda, C. (2018). Authentic assessment: creating a blueprint for course design. *Assessment & Evaluation in Higher Education*, *43*(5), 840-854.

Yesmin, S. (2024). Redesigning tertiary educational evaluation with AI: A task-based analysis of LIS students' assessment on written tests and utilizing ChatGPT at NSTU. *Science & Technology Libraries*, *43*(4), 355-367.

Yusuf, A., Pervin, N., & Román-González, M. (2024). Generative AI and the future of higher education: a threat to academic integrity or reformation? Evidence from multicultural perspectives. *International Journal of Educational Technology in Higher Education*, *21*(1).

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Applying Generative AI to Analyze Statements from Student Surveys

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Abstract

Applications based on Generative Artificial Intelligence (GenAI) already permeate many areas of higher education. In this paper, we discuss using GenAI to assist staff in extracting information from qualitative data gathered by student surveys.

Manually analysing surveys of large groups of students usually is a tedious task. In particular, categorising and evaluating open-ended questions can be very time consuming. As a means for effectively processing and analysing large amounts of student feedback, we experimented with using GenAI for this task. In this work, we describe a simple, inexpensive and easily adaptable setup for analysing student statements, and report on our experience with this approach. The goals are (1) to let GenAI assign each student statement to an adequate content category and to accurately determine its sentiment, and (2) to use GenAI to produce summaries of statements.

We implemented our approach twice, using two different GenAI products, namely the commercial OpenAI API and a self-hosted Llama model. Comparing the results, we find that both are valuable in the process of evaluating students' statements with respect to their sentiments and towards categorizing and summarizing them.

Keywords: *Student surveys, sentiment analysis, generative AI, evaluation, educational data mining.*

1. Introduction

Every academic year during the summer term, our university's quality management department performs an anonymous survey regarding various aspects of student satisfaction, situation, and well-being. The survey comprises several Likert-scaled questions as well as open questions, where students can freely formulate statements with their opinions and concerns. In order to be able to establish a context for the students' statements, the survey requests students to specify

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the department and study program they are enrolled in. Surveys are performed using an online evaluation system (evasys in our case). The completed survey forms are collected centrally for the whole university. Then, each department is provided with access to the survey results of their respective students.

This approach easily leads to hundreds of completed forms thus. Evaluating Likert-scaled questions is highly efficient when the results are available electronically. However, drawing valuable feedback from a large amount of more or less well-formulated answers to open questions can be a highly laborious task (Gray, 2023). Therefore, we tried to use readily available GenAI-tools to support the evaluation of freely formulated statements. It is quite easy to create results in a straightforward manner by feeding data to a tool like ChatGPT. This, however, requires carefully validating whether the reported results do in fact reflect the content of students' verbal feedback in a sufficiently precise way, as GenAI models have been observed to occasionally hallucinate (Farrelly & Baker, 2023).

Therefore, we started an analysis where we compared machine generated ratings for a manageable sample of statements from students' surveys against human expert rating. The questions we wanted to answer in this context are:

1. Can the use of GenAI provide an effortless yet meaningful overview of survey results?
2. Does a low-cost, data privacy compliant and self-hosted GenAI model perform worse than the commercial OpenAI variant?

2. Related Work

Much work has been done on various AI-based methods and techniques for sentiment analysis, reviewed for example by Jin et. al. (2023). A more recent review of this rapidly evolving field, focusing on the use of the transformer models that we consider for our work, can be found in Bashiri and Naderi (2024).

Shaik et. al. (2023) give a good overview of the available techniques for sentiment analysis and opinion mining, and they address many different areas of application in educational contexts. They discuss several algorithms and tools as of 2022. For more recent reviews of analyses of student feedback see, for example, the technically oriented review given by Zyout and Zyout (2024) or a more content-oriented review by Sunar & Khalid (2024). Dake & Gyimah (2023) present a use-case that is very similar to what we focus on in this paper. Their analysis of qualitative feedback from students with respect to sentiment is undertaken with the objective of facilitating the analysis of qualitative feedback. Our work, however, focusses on using existing and already trained GenAI-tools for the analysis of students' statements.

Finally, Schulhoff et al. (2024) discuss prompting techniques in detail, as another important aspect of using GenAI.

3. Approach

The student survey, which was carried out across our university in the summer term of 2024, resulted in a total of 148 completed questionnaires for our faculty in four computer science-related Bachelor's and three Master's degree programs. This corresponds to a participation of 8.6% of our students. The questionnaire consists of approximately 50 Likert-scaled questions and 15 open questions. In this paper, we focus on the evaluation of two open questions[1] that we consider as prototypical, namely:

1. *"What is the main reason why you would or would not recommend your degree program?"* This question asks for personal opinions, leading to answers comprising statements with both positive and negative sentiments, mixed in any order. Therefore, on each statement, we perform a GenAI-based sentiment analysis and categorization, thus attempting to categorize the items within the statement with respect to content, and to identify if the feedback is positive, negative or neutral.
2. *"In relation to which aspect of your studies would you need more flexibility?"* In contrast to the first question, this second question inherently unveils predominantly negative aspects. Therefore, we used GenAI to cluster which changes need to be addressed most urgently.

For our analysis, we use two GenAI-tools, namely:

1. The commercial API of OpenAI 3.5 (see: https://platform.openai.com/docs/overview). Tests showed that using API version 4.0 did in fact not produce better results, even though this version is newer and much more expensive; so we were happy to use version 3.5.
2. Meta's open-source AI model Llama 3.3, self-hosted via Docker container. We used the model out of the box and did not do any additional pre-training whatsoever.

3.1. Categorization and Sentiment Analysis of Statements

Analyzing a student's answer (or statement) to survey question 1 comprises two distinct operations: Firstly, the statement is decomposed into its constituent semantic entities. A semantic entity is a sequence of words that forms a single unit of meaning. Secondly, each semantic entity is analyzed in terms of assigning a category and a sentiment. We conducted some experiments to refine the prompt based on the findings reported by Schulhoff et al. (2024). In the end, we came up with the following, which performs both operations of our requirement in one prompt. The words in bold must be replaced with the item and statement to be analyzed, i.e., question and student answer. Triple quotation marks are an essential part of the prompt:

[1] Please note that for this paper, all questions, student answers, and prompts were translated from German using the support of deepl.com

> *The following statement is a student's answer to this evaluation item: """**item**""": """**statement**""". If this statement contains several semantic entities, then divide it into its semantic entities. Ignore dashes and numbering.*
> *Assign each entity a sentiment 'positive', 'negative', 'neutral' and use 'unclear' if the entity is not clearly positive, negative or neutral.*
> *Furthermore, assign exactly one of the categories 'content', 'teaching quality', 'study conditions', 'requirements', 'personal opinion' to each semantic entity.*
> *For each semantic entity, return only a single line in csv format of the form "semantic entity;category;sentiment". I don't need any detailed explanations.*

Although it is inherent to GenAI models that a repetition of the process does not necessarily lead to identical results, we observed none to only very little differences; this might be due to the lengthy prompt and comparatively short statements. However, the models make mistakes, as we will discuss in the results section.

To automate the analysis, we built a small program that reads students' statements from a file, generates the prompts, feeds them to the respective model and writes the results back to a file in csv format (comma separated values). This format can be post-processed further to produce textual or graphical summaries.

3.2. Automated Summaries of Student Answers

A second use of GenAI in our evaluation process was to use the tool to summarize items in the survey. We used it for items that did not leave too much room for emotion, such as the item *"In what aspect of your studies would you need more flexibility? (Please provide keywords)"*. Here, we only expect aspects that need improvement from the students' point of view. Assigning sentiments gives misleading results. The subsequent prompt, with the responses of the students incorporated, yielded constructive outcomes:

> *I work as a dean at a university. Summarize the following list of requests from our students for more flexibility and give me a list of the changes that need to be addressed most urgently.*

4. Results

Corresponding to section 3, we discuss the results for both sentiment analysis and for automatically generated summaries.

4.1. Results of Analyzing Statements with respect to Sentiment and Category

Figure 1 gives an overview of the analysis process for student replies using GenAI. The GenAI-tools we used made mistakes in both respects: decomposing questions into semantic units and

assigning categories and sentiments. As an example for an erroneous decomposition, the statement *"Practical relevance and good professors + interesting subjects"* was handled as one statement by OpenAI, rather than being segmented into its three atomic semantic units as was done by Llama. On the other hand, the statement *"Lectures with a small number of students, making it easier to form study groups"* was split by both tools, leading to the senseless statement *"making it easier to form study groups"*.

Furthermore, OpenAI did not ignore dashes or numberings in students' statements, even though this was explicitely requested by the prompt. Even worse, in some cases OpenAI reported numbers or dashes as separate semantic entities. Therefore, we decided to automatically omit all semantic entities that consist four or less characters in length.

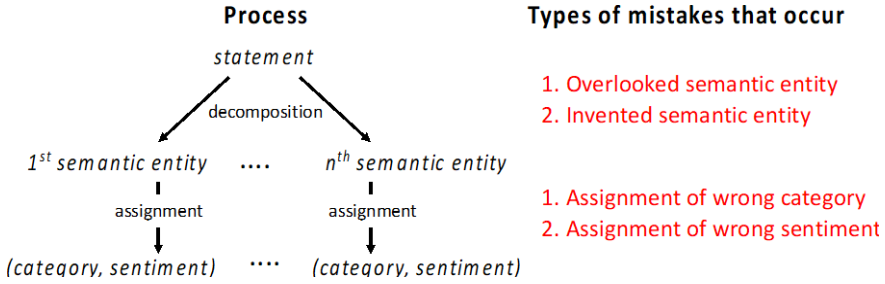


Figure 1. The process of the analysis of answers, and possible errors that are generated by the GenAI-tools we used.

Over all, we analyzed a total of 107 answers to the question *"What is the main reason why you would or would not recommend your degree program?"*, by a human expert and by two GenAI-tools. Table 1 summarizes the results of detecting entities. The manual analysis detected 217 semantic entities. The zeros in the Human Expert column should be read with caution, as even humans can make mistakes and have to make decisions in case of ambiguities!

Table 1. Numerical results of the process of breaking down 107 statements into semantic entities.

	Human Expert	**OpenAI**	**Llama**
Semantic entities detected	217	221	241
Overlooked semantic entitites	0	6	1
Additional semantic entitites	0	10	25

One interesting observation was that, unlike Llama, OpenAI did some minor rewriting of the entities it detected, which made it difficult to automatically compare the results of the two GenAI-tools. For example the statement *"I think computer science is a very interesting course of study"* was shortened by OpenAI to *"Computer science is a very interesting course of study"*. Both models, however, rated this as a positive personal opinion.

Comparing the results generated in terms of categories and sentiments, we found that sentiments were assigned identically by both models in 98% of the cases. Table 2 shows the correlation between the two models in terms of categorization. We have 210 comparable units, resulting from an initial total of 217 (as detected by the human expert), of which 7 were overlooked by the GenAI-tools. For roughly 84% of the comparable items, both GenAI-tools agreed in their notion of the expressed sentiment.

Note that some statements are inherently ambiguous for human raters as well, e. g.: *"professionally very demanding"*. Both models categorized this statement as Content, OpenAI rated it as positive and Llama as neutral. We use this as hint to redesign question 1 for the next iteration of the survey by splitting it up into two separate questions, in order to explicitely ask for positive and for negative feedback, respectively.

Table 2. Number of matching and non-matching categorizations of the two models.

	Categorization by Llama				
Categorization by OpenAI	**Content**	**Qualityof Teaching**	**Study Conditions**	**Pre-requisites**	**Personal Opinion**
Content	**66**	5	5	1	4
Qualityof Teaching	2	**30**	1	0	1
Study Conditions	1	2	**59**	2	0
Pre-requisites	0	0	2	**4**	0
Personal Opinion	4	1	1	1	**14**

Finally, we have made some interesting observations that are worth mentioning:

1. Both models coped unexpectedly well with typos and spelling mistakes.
2. For four entities, the OpenAI API invented the additional category "level of difficulty". We believe that it is still inherent in current models for these types of errors to occur.

Altogether, the results are informative and useful. They could be forwarded to teaching and organizational staff as sorted lists or in condensed form as shown in Figure 2, which can easily be generated automatically from the results. On this basis, the faculty's decision-makers then have a starting point for deciding where it is worth taking a closer look (study conditions in this case).

4.2. Results of Automated Summaries of Student Answers

Furthermore, we used both models to summarize a total of 52 answers to the question *"In what aspect of your studies would you need more flexibility?"*. OpenAI identified six areas in which the most, and most urgent, need for change was expressed, whereas Llama detected seven. Surprisingly, the categories found by OpenAI, were much more commonplace and less concrete than those detected by Llama, as shown in Table 3.

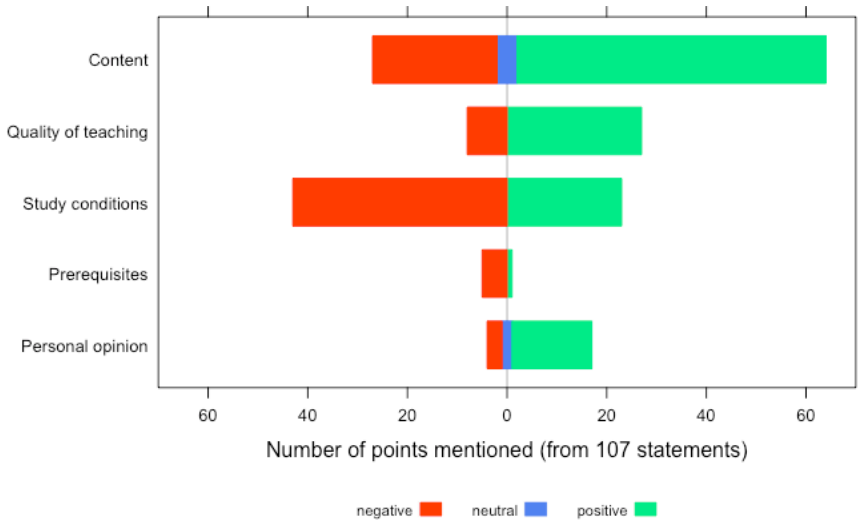


Figure 2: Automatically generated Likert-like plot from the data taken from 107 free text statements and processed via OpenAI. Includes 217 out of 221 detected semantic units.

Table 3. Comparison of the summaries that the two language models created from 52 answers. Items that are considered to be too commonplace are marked with an asterisk "*".

OpenAI	Llama
Flexibility in choosing and designing courses	More options for electives
Expansion of online learning opportunities	More online offers and hybrid lectures
Practical lectures and internships	Adjustment of the internship semester
Reduce pressure and strain	
Course organisation*	More flexibility in the selection of professors and courses
Organization of study*	More flexible timetables
	More support for commuters
	Longer examination periods and more flexible examination schedules

5. Conclusions and Future Work

Our analysis shows that a self-hosted Llama model leads to results whose quality is comparable to the commercial version of OpenAI's API. We recommend creating a collection of several hundred statements from evaluations that can be agreed on as being relevant, unambiguous and well understood by humans (see e. g. Zyout and Zyout 2022). This set of statements can then be used as test data to calibrate a GenAI-based analysis software. Furthermore, errors identified in the GenAI-tools' classification might indicate weaknesses in the survey, and thus might help to improve the survey's clarity. Automatically cleaning, organizing, and judging qualitative

feedback offers a huge potential for qualitative analysis, while reducing human workload at the same time.

Lessons learned from the analysis of students' answers to the questionnaire provided many hints for improvement for the next cycle of this survey. Thus, surveys can be adapted in a way that make them easier to interpret for AI-based sentiment analysis. Having accomplished this, hundreds of replies to open questions can be analyzed and summarized quickly and with little human effort, thus offering great potential for a continuous improvement process.

A non-AI based finding is that we need to increase students' participation rate in the future, as only 8.6% of our students completed the survey. This participation rate could be increased by asking students to complete the survey form during class time.

References

Bashiri, H., & Naderi, H. (2024). Comprehensive review and comparative analysis of transformer models in sentiment analysis. Knowledge and Information Systems, 66(12), 7305–7361. https://doi.org/10.1007/s10115-024-02214-3

Dake, D.K., & Gyimah, E. (2023). Using sentiment analysis to evaluate qualitative students' responses. Educ Inf Technol 28, 4629–4647. https://doi.org/10.1007/s10639-022-11349-1

Farrelly, T., & Baker, N. (2023). Generative Artificial Intelligence: Implications and Considerations for Higher Education Practice. Education Sciences 13(11), 1109. https://doi.org/10.3390/educsci13111109.

Gray, D. (2023). Doing Research in the Real World, SAGE Publications Ltd, London, 5th ed.

Jin, Y., Cheng, K., Wang, X., & Cai, L. (2023). A Review of Text Sentiment Analysis Methods and Applications. Frontiers in Business, Economics and Management. 10. 58-64. https://doi.org/10.54097/fbem.v10i1.10171.

Schulhoff, S., et al. (2024). The Prompt Report: A Systematic Survey of Prompting Techniques (Version 3). arXiv. https://doi.org/10.48550/ARXIV.2406.06608

Shaik, T., Tao, X., Dann, C., Xie, H., Li, Y., & Galligan, L. (2023). Sentiment analysis and opinion mining on educational data: A survey. Natural Language Processing Journal, 2, 100003. https://doi.org/10.1016/j.nlp.2022.100003

Sunar, A. S., & Khalid, M. S. (2024). Natural Language Processing of Student's Feedback to Instructors: A Systematic Review. IEEE Transactions on Learning Technologies, 17, 741–753. https://doi.org/10.1109/TLT.2023.3330531

Zyout, I., & Zyout, M. (2024). Sentiment analysis of student feedback using attention-based RNN and transformer embedding. IAES International Journal of Artificial Intelligence (IJ-AI), 13(2), 2173. https://doi.org/10.11591/ijai.v13.i2.pp2173-2184

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Harnessing Generative AI to Overcome Executive Dysfunction in Higher Education: A Case Study

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Abstract

Generative tools such as ChatGPT, Perplexity and Google Gemini have rapidly transformed educational practices across campus environments by providing personalized academic support. This qualitative longitudinal case study examines how such tools can in fact help mitigate challenges linked to a neurodivergent condition called executive dysfunction—a condition that impairs focus, organization, planning, and time management. Using the case study of a student at the University of Toronto (pseudonym "T"), it details the integration of AI for lecture transcription, task management, idea creation, and writing support. The results indicate that when AI is employed as an assistive scaffold rather than a replacement for critical thought, the student demonstrates enhanced metacognitive awareness, more efficient task breakdown, and steadily improved academic performance. These outcomes support the notion that responsible, ethically integrated AI applications can foster inclusive, patient, and personalized learning environments that address individual cognitive profiles and promote independent, self-regulated learning.

Keywords: *Generative AI; Executive Dysfunction; Neurodiversity; Assistive Scaffold; Metacognitive Awareness; Extended Mind.).*

1. Introduction

Today, artificial intelligence is rapidly reshaping academic paradigms. As institutions increasingly deploy generative AI tools as part of personalized, adaptive support, their initiatives hold particular promise for learners with executive dysfunction—characterized by difficulties in task initiation, organization, and planning. Neurodivergent students often struggle with academic workload management due to challenges like impaired working memory and prioritizing information. This paper investigates how AI tools, strategically integrated, supported a neurodivergent student ("T") facing these challenges. Examining AI as a cognitive scaffold enabling T to overcome executive function barriers and develop stronger metacognitive

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skills, it addresses the following questions: (1) How can generative AI mitigate executive function challenges? (2) What is the impact of AI-assisted learning on metacognition for neurodivergent students? (3) What are the benefits of AI as an assistive scaffold? Using a qualitative case study approach over five academic semesters (September 2023 to April 2025), including interviews, document analysis, and a personal log, it is argued AI can relieve cognitive load and foster self-regulatory skills without replacing critical thought. This study offers insights on harnessing technology to provide more inclusive learning environments for neurodivergent students.

2. Literature Review

2.1. Generative AI in Education

Recent studies demonstrate generative AI's capacity to enhance student engagement, facilitate self-directed learning, and improve academic performance (Schei et al., 2024; Carik et al., 2024). AI-assisted tools increased assignment completion rates and student confidence (Schei et al., 2024), while students using AI as scaffolds rather than replacements for independent thinking showed meaningful improvements in metacognitive awareness (Carik et al., 2024). "AI literacy" is critical but should be supported by ethical integration through explicit instruction, transparent usage policies, and clear boundaries between AI assistance and independent work (Ramirez & Johnson, 2025).

2.2. Executive Dysfunction and Neurodiversity

Executive dysfunction, common among neurodivergent students, involves impairments in planning, organization, task initiation, and time management (Khan & Lal, 2023). College students with this condition often require substantially more time on assignments despite comparable comprehension, underscoring a disconnect between cognitive capacity and executive control (Westbrook & Chen, 2024). Personalized AI scaffolds have been shown to significantly reduce task abandonment and improve metacognitive awareness in this group (Halkiopoulos & Gkintoni, 2024). Furthermore, combining technological support with explicit strategy instruction is highly effective in promoting independence among students with executive dysfunction (Rodriguez et al., 2024).

2.3. Assistive Technology and Neuroeducation

AI-powered assistive technologies offer personalized educational support, reshaping content to match diverse cognitive profiles. Tanaka and Williams (2024) found adaptive digital tools can leverage neuroplasticity, leading to measurable executive function improvements. Techniques like task chunking—breaking complex assignments into manageable parts—reduce cognitive load and enhance motivation (Pierrès et al., 2024; Sweller & Paas, 2023). The concept of

"precision education" too, advocates for tailoring interventions to individual cognitive profiles (Gonzalez & Park, 2024). While ethical considerations such as data privacy and algorithmic bias necessitate proactive attention and human oversight (Duane, 2024), this brief literature review underscores the potential of generative AI to support executive function and metacognitive development in neurodivergent students, forming a basis for this investigation.

3. Case Study Methodology

3.1. Research Design

This research employs a qualitative single-case study design to examine the impact of generative AI tools on a neurodivergent student with executive dysfunction. The longitudinal approach, spanning five academic semesters from September 2023 to April 2025, allowed for observation of the student's adaptation to AI tools, changes in academic performance, and the development of metacognitive strategies over time.

3.2. Participant Selection and Profile

The participant, "T," was selected based on self-identified executive dysfunction challenges affecting academic performance, enrollment in a STEM program at a research university, and willingness to explore AI tools as academic supports. T provided informed consent, with assurances that all identifying information would be anonymized.

3.3. Data Collection

Multiple data sources were used to ensure methodological triangulation and enhance findings' validity. Semi-structured interviews, conducted weekly (60-90 minutes each), explored T's experiences with AI tools, perceived changes in academic functioning, and evolving integration strategies. These conversations were not audio-recorded. Document analysis involved examining T's academic work, focusing on assignments completed before and during AI implementation to track changes in organization, complexity, and quality. T also maintained a participant journal or reflective log documenting specific AI tool use instances, challenges, and perceived benefits, providing real-time data and reducing retrospective bias. To allow T to develop her AI-assisted workflows naturally, direct observation was not employed.

4. Case Study: One Neurodivergent Student's Experience

4.1. Student Profile and Challenges

T is a 42-year-old mature student in her second year of Physical and Environmental Science. Her academic journey is significantly affected by executive dysfunction. Her primary

challenges manifest as working memory limitations, making it difficult to process lectures effectively; task initiation difficulties, often leading to "analysis paralysis" when facing assignments; and issues with time perception and management. Despite these hurdles, T possesses notable cognitive strengths, including exceptional pattern recognition and the ability to quickly grasp complex concepts when they accommodate her learning style, which is visual-spatial with secondary strengths in verbal-linguistic processing.

4.2. AI Tool Implementation

T's relationship with AI tools evolved through discovery, adaptation, and increasing sophistication over five academic semesters. She began by using TurboLearn (an earlier version of TurboScribe) for real-time lecture transcription, but quickly moved to utilizing its "key concept highlighting" feature as well to create lists of course-specific terminology and reduce the cognitive load of identifying important information during lectures. She then realized she could offload taxing cognitive processes by employing ChatGPT as an external working memory for summarizing complex texts. That freed her mental resources to focus on making connections between ideas—a cognitive strength. Her second semester saw further integration of ChatGPT into her study routine for preliminary research, idea generation, and assignment structuring. She developed a methodical, structured prompting strategy that helped overcome task initiation difficulties by breaking down assignments into smaller, manageable steps, facilitating comprehension and minimizing working memory limitations. Her approach to prompting moved from general requests to specific queries that yielded more nuanced results and demonstrated greater executive control. By her third semester, T incorporated Paperpal to enhance her writing process, submitting drafts for feedback on language and clarity. Her initial uncritical acceptance of suggestions was gradually replaced by a systematic process for evaluating them.

4.3. Evolution of AI Usage: Developing a Comprehensive System through AI Literacy

By the end of her third semester, T frequently challenged AI recommendations and synthesized multiple suggestions into original approaches. In this decisive phase, she integrated her tools into cohesive systems for both study and assignment workflows. Her AI literacy advanced significantly, enabling her not only to formulate and adapt prompts but also to critically evaluate AI-generated content and decide how to incorporate it effectively. Since then, she has strategically deployed various AI tools to address specific executive function limitations. Her current procedure for written assignments showcases how she retains critical thinking and uses these tools as targeted scaffolds. For task breakdown and initial planning, she uses Genspark.ai to create outlines and combat "analysis paralysis," followed by Goblin Tools for detailed idea sequencing. In the research phase, T combines Perplexity, Elicit, and Google Gemini to gather diverse sources, overcoming working memory limitations by storing and organizing her

information in NotebookLM and requesting connections. During drafting and refinement, she uses Genspark.ai for a first draft, then seeks suggestions from Paperpal and constructive criticism from ChatGPT, critically assessing feedback against course objectives and her own voice. Zotero helps manage citations, and she sometimes utilizes university Writing Support for final proofreading. T has developed a similar multi-tool workflow for studying, using TurboScribe for transcription, Genspark for initial review, Quizlet for recall, NotebookLM for synthesis, Reclaim.ai for scheduling and Forest for focus. In both workflows, she actively directs each step, evaluating suggestions and integrating information. Her AI tools function as cognitive extensions that deepen her understanding and management of course content. It is her higher-order cognitive activities that guide, shape, evaluate and integrate the AI capabilities.

5. Analysis of AI Impact on Learning Outcomes

5.1. Cognitive and Metacognitive Development

The use of AI tools caused a remarkable shift in T's overall approach to learning. Greater AI literacy, comfort with technology and a significantly reduced cognitive load increased her confidence. Specifically addressing T's executive dysfunction challenges, AI-generated structured schedules and task lists helped her overcome difficulties with task initiation, substantially reducing deadline stress. T developed sophisticated "AI literacy"—the ability to critically evaluate AI-generated content and determine its appropriate integration into her work. Her iterative drafting process refined her critical reflection. As she grew more independent, she challenged AI recommendations and routinely synthesized diverse suggestions into original approaches. Perhaps the most significant outcome, however, was enhanced metacognitive awareness—the ability to reflect on, monitor, and adjust her own learning processes. Evaluating outcomes helped her continually refine learning strategies, thereby building a stronger foundation for self-regulated learning. Indeed, analysis of T's reflective journals revealed a progressive increase in metacognitive language. While early entries focused primarily on fears and content-related challenges, later entries showed sophisticated process awareness. This suggests T was able to internalize the external scaffolding provided by AI in the form of metacognitive strategies, and that AI tools did not replace her thinking but instead enabled a fuller expression of her capabilities by removing executive function barriers.

5.2. Academic Performance and Quality of Work

Academic abilities impacted by executive dysfunction showed enhanced cognitive outcomes as offloading routine tasks freed mental resources, allowing deeper engagement with course content. Improvements were observed in T's working memory, cognitive flexibility, initiation, planning, and time management skills. Quantitative academic outcomes provide further evidence: T's grade point average increased steadily over four semesters, rising from 1.85 to

3.35, or in European terms from an E to a C/B. While multiple factors likely contributed to this improvement, the correlation with AI implementation and T's own attributions suggest a significant relationship. Content analysis of written assignments revealed improvements not only in organization but also in analytical depth and integration of course concepts, suggesting that freed cognitive resources were redirected toward deeper conceptual engagement.

6. Discussion: Broader Implications

6.1. Philosophical Insights: AI as Cognitive Augmentation

T's case study is illustrative of broader insights into human-AI collaboration that deserve our attention. It shows us that AI tools can function as active collaborators in cognition, in alignment with Distributed Cognition theories where cognitive processes extend beyond the individual mind into other individuals, artifacts and environments. In T's experience, her cognitive system effectively distributes across her AI tools, compensating for executive function limitations while enhancing her strengths. Her sophisticated prompt engineering and critical evaluation ensure she directs the process and remains responsible for the output. This approach exemplifies Clark and Chalmers' Extended Mind thesis, where external tools seamlessly integrate into thinking processes, becoming functional extensions of cognition (Clark & Chalmers, 1998). When T uses NotebookLM as external memory or TurboScribe for transcription, these tools augment, rather than replace, her thinking. Free of specific burdens, T can apply her cognitive resources to a deeper engagement with course material and participate more fully in her education. Her human-AI partnership enhances her intellectual contribution: explanations and syntheses are no longer the products of an isolated biological brain but the achievements of a human-led, cognitively augmented system. This idea, it seems to me, begs a redefinition of understanding as it has been traditionally accepted.

6.2. The Universal Horizon: Redefining Intellectual Contribution

T's evolution prompts reconsideration of what constitutes "authentic" intellectual contribution. Throughout history, humans have used tools to extend cognitive capabilities, whether printing press, calculator or search engine. I would suggest that equating academic integrity solely with unassisted work may oversimplify intellectual contribution in the AI age. As exemplified by T's actions, meaningful contribution can be demonstrated through activities like strategic prompt engineering, critical evaluation of AI outputs, refinement and integration of information with personal insights, and contextual application of knowledge. This perspective suggests we need to evolve not only our understanding of understanding but, but our understanding of academic integrity as well. Rather than focusing on whether work is produced without technological assistance, we might instead emphasize transparency, critical engagement, human value-add,

and accountability, shifting focus from mere production to the higher-level skill of strategic orchestration.

6.3. Implication for Educational Practice and Future Directions

For educators, T's journey highlights the implications of using AI as an assistive scaffold for self-regulated learning. For example, curriculum design could incorporate AI-assisted task management and writing support as integrated components rather than ad hoc interventions.

Educators need to embrace deliberate strategies that guide effective AI tool use and promote independent cognitive development to counter overdependency. Educational institutions too must invest in professional development and policy frameworks that contemporize academic integrity concepts while addressing potential issues like algorithmic bias and data privacy. Future research should explore the long-term academic impacts of cognitive augmentation across diverse learning profiles. Longitudinal studies are needed to track how AI-supported learning translates to sustained capabilities beyond the university setting. Moreover, as AI technologies continue to evolve, regular assessment of their practical and ethical implications will be crucial to ensuring equitable access and fairness (Duane, 2024; Khan & Lal, 2023).

7. Conclusion

In answer to the research questions posited, this study explicitly demonstrated how generative AI tools can effectively mitigate executive dysfunction challenges, enhance metacognitive awareness, and serve as assistive scaffolds that augment rather than replace critical thought. It contributes to understanding AI in education by offering concrete implementation strategies for specific executive dysfunction aspects. It highlights viewing AI as process support rather than content generator, emphasizing how AI tools enhance metacognitive development when integrated properly. Furthermore, it suggests educators reflect on what constitutes authentic intellectual contribution and consider how understanding and academic integrity might be productively redefined when AI assistance is combined with active human oversight.

For T, this redefinition represents an evolution, not an erosion, of intellectual endeavor. Her experience demonstrates that using AI as an assistive scaffold enables significant academic growth for students with executive dysfunction. Strategically offloading executive burdens led to improvements in T's metacognitive awareness, organization, and confidence, reflected in deeper engagement and increased personal wellbeing. Her case study suggests AI integration holds particular promise for neurodivergent students, a potential that in future could be extended to student communities more generally. Rather than viewing AI as a threat, we might see it as a tool for creating more inclusive, adaptive, and personalized educational environments that accommodate cognitive diversity while facilitating excellence. Approached as a tool for empowerment, as in T's case, AI can help individuals overcome limitations and realize their full

potential, becoming not a replacement for human cognition but an enabling scaffold for all of us.

References

Carik, B., Ping, K., Ding, X., & Rho, E. H. (2024). Exploring Large Language Models Through a Neurodivergent Lens: Use, Challenges, Community-Driven Workarounds, and Concerns. *Proceedings of the ACM on Human-Computer Interaction, 9*(1), 1–28 2.

Clark, A., & Chalmers, D. J. (1998). The extended mind. *Analysis*, *58*(1), 10-23. https://consc.net/papers/extended.html

Duane, A. (2024). Can Artificial Intelligence Complete My Assessment? A Student Led Initiative to Stress Test the Academic Integrity of University Assessment Using Generative AI 3.

Gonzalez, M., & Park, S. (2024). Precision Education: Tailoring Technology to Individual Neurocognitive Profiles. *Educational Technology Research and Development, 72*(3), 415-438 4.

Halkiopoulos, C., & Gkintoni, E. (2024). Leveraging AI in e-learning: Personalized learning and adaptive assessment through cognitive neurotechnology – A systematic analysis. *Electronics, 13*(18), 3762 5.

Khan, K., & Lal, P. (2023). Executive Dysfunctions in Different Learning Disabilities: A Review. Journal of Indian Association for Child and Adolescent Mental Health, 19(2), 126–142 6.

Pierrès, O., Darvishy, A., & Christen, M. (2024). Exploring the Role of Generative AI in Higher Education: Semi-Structured Interviews with Students with Disabilities. *Education and Information Technologies*.

Ramirez, J., & Johnson, T. (2025). AI Literacy in Higher Education: A Framework for Ethical Integration. *Journal of Computing in Higher Education, 37*(1), 78-96 9.

Rodriguez, K., Smith, L., & Thompson, J. (2024). Interventions for Executive Dysfunction in Higher Education: A Meta-Analysis. *Journal of Learning Disabilities, 57*(2), 183-201 10.

Schei, O. M., Møgelvang, A., & Ludvigsen, K. (2024). Perceptions and Use of AI Chatbots among Students in Higher Education: A Scoping Review of Empirical Studies. *Education Sciences, 14*(8), 922 11.

Sweller, J., & Paas, F. (2023). Cognitive Load Theory: Recent Advances and Applications. *Educational Psychology Review, 35*(2), 121-146 12.

Tanaka, H., & Williams, R. (2024). Digital Tools and Neuroplasticity: Longitudinal Effects of Adaptive Technology Use on Executive Function. *Neuropsychology, 38*(3), 275-291 13.

Westbrook, J., & Chen, L. (2024). Time Management Disparities: Comparing Task Completion Patterns Between Neurodivergent and Neurotypical College Students. *Journal of College Student Development, 65*(2), 189-205 14.

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The Interplay of Emotional Regulation and Cognitive Styles in Entrepreneurial Decision-Making: Impact on Entrepreneurial Intention

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Abstract

This study investigates the impact of emotional regulation and control on the latent variables of Ajzen's Theory of Planned Behavior (TPB) that shape entrepreneurial intention, while also assessing the role of cognitive styles in the development of entrepreneurial intention among business students. The results indicate that emotional regulation and control significantly impact attitude toward entrepreneurship ($r = 0.327$, $p < 0.01$) and perceived behavioral control ($r=0.430$, $p < 0.01$), while social norms ($r = 0.016$, $p > 0.05$) show no significant relationship. Attitude toward entrepreneurship ($r=0.841$, $p < 0.01$) and perceived behavioral control ($r = 0.727$, $p < 0.01$) emerge as strong predictors of entrepreneurial intention, whereas social norms ($r = 0.038$, $p > 0.05$) do not. Emotional regulation, positive attitudes, and creative or knowledge-driven cognitive styles play a crucial role in fostering entrepreneurial intentions among students.

Keywords: *entrepreneurial intention, emotional intelligence, cognitive styles, business students.*

1. Introduction

Research findings indicate that to reduce the gap between intention and behavior, conceptual models should include mediating factors and action control variables (Tsou et al., 2023). Key elements such as emotional reactions and negative contextual influences play a crucial role but are often missing in the literature on entrepreneurial intention and its implementation (Gielnik et al., 2014). Researcher Dinklage (1966), based on interviews with young individuals, identified the non-linearity of decision-making in relation to achieving desired outcomes and argues that: "However, human life situations and decisions are not physical experiments in a

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scientific laboratory. These life situations involve very real and dynamic emotional, frequently non-rational, components of existence do not present as a property in the purely physical world. Emotions in relation to oneself and one's choices are difficult elements to objectify and subject to scientific scrutiny" (Dinklage, 1966).

2. Theoretical background

2.1. Entrepreneurial Self-Perception: Identity and Decision-Making

Historically, the Ajzen's Theory of Planned Behavior has been a valuable framework for entrepreneurship researchers, providing insights into the cognitive factors shaping entrepreneurial decisions, actions, and intentions (Caputo et al., 2025). However, negative emotions arising from significant discrepancies between the current situation and desired goals influence behavior and goal regulation (Pattnaik et al., 2024). These emotions can hinder an individual actions and reduce ability to focus on solutions or allocate cognitive resources effectively and this occurs because emotions can create barriers to constructive problem-solving (Fredrickson et al., 2003). When individuals experience strong negative emotions due to a significant gap between where they are and where they want to be, these emotions can reduce their ability to focus on solutions. However, the ability to effectively manage emotions plays a crucial role in this process. Research indicates that to fully understand the causal relationship between intention and behavior, conceptual models should incorporate control factors such as emotional reactions and negative contextual influences (Gollwitzer & Sheeran, 2006). Negative emotions, often perceived as unpleasant, can drive individuals to restructure their goals or even deviate from their initially planned behavior to reduce emotional discomfort (Higgins, 1987). Notably, Zeelenberg and Beattie (1997) have found that each emotion has a distinct impact on behavior. Given the diversity of emotions identified in research, understanding an individual's ability to regulate emotions is essential for determining the extent of emotional influence on behavior.

2.2. The Role of Cognitive Processes in Fostering Intention

Professional development decisions are not merely reactive responses to external stimuli but are instead consciously planned, reflecting underlying cognitive processes. As cognitive styles play an increasingly important role in shaping individual behavior, they provide a strong foundation for examining professional intentions (Deprez et al., 2021). While individuals may respond differently to the same situation, the impact of these responses largely depends on their cognitive ability to assess and interpret the situation (Bandura (1977). Recognizing cognitive competencies is crucial, as they reflect a person's ability to identify entrepreneurial opportunities and values in a constantly changing environment (Huang et al., 2024). Individuals differ in their capacity to regulate their actions - some focus primarily on forming intentions without

necessarily acting on them, while others are proactive and action-oriented, striving to implement their intentions immediately. Some scholars (e.g., van Loon, 2017; Hermans, 2018) propose that individuals can adjust or "switch" between cognitive styles when evaluating alternatives and making decisions. Cognitive style refers to an individual's way of processing information, and studies indicate that it plays a crucial role in turning entrepreneurial intentions into action (Gupta et al., 2023).

2.3. Cognitive Styles in Shaping Entrepreneurial Intention

As cognitive styles increasingly influence individual behavior, they offer valuable insights beyond other personal factors. They also serve as a strong foundation for studying professional intentions (Deprez et al., 2021). Zhao et al. (2012) found that the way entrepreneurs process and utilize information differs significantly from those who do not pursue entrepreneurship. Research (e.g., Sanda & Sallama, 2023) confirms that cognitive styles influence how individuals acquire knowledge, process information, and make decisions regarding the selection of optimal alternatives. Empirical findings suggest that cognitive styles can impact an individual's career choices, as studies have demonstrated a link between specific cognitive styles and an individual's ability to develop business formation strategies (Sadler-Smith, 2004). Cognitive styles play a crucial role in decision-making (e.g., Sarfraz et al., 2020), yet each style can have a different impact on the final decision outcome. Researchers have identified numerous cognitive style models, highlighting the complexity of this construct (Sadler-Smith et al., 2000). In recent years, researchers have increasingly adopted a multidimensional approach to studying individual behavior, acknowledging that a single person can exhibit multiple cognitive styles simultaneously. The cognitive style model developed by Cools and Van den Broeck (2007) has expanded the traditional understanding of the analytical-intuitive dimension by defining three distinct cognitive styles: knowing style, planning style, and creating style. These three styles are considered independent and unique, allowing for a more detailed and precise examination of cognitive styles without restricting interpretation to a single dimension (Cools & Van den Broeck, 2007). Styles are regarded as separate but complementary dimensions of information processing. This supports a modern, dynamic, and multifaceted perspective on cognitive style research (Sadler-Smith, 2004). The cognitive style model developed by Cools and Van den Broeck (2007) highlights that individuals differ in how they process information, resolve conflicts, and make decisions.

3. Hypothesis Development and Research design

The aim of this study is to assess how emotion regulation and control influence the latent variables shaping students' entrepreneurial intention and how cognitive styles determine the formation of entrepreneurial intention. Negative emotions, often perceived as unpleasant, can lead to goal restructuring or even deviation from initially planned behavior as individuals seek

to reduce emotional discomfort and restore the balance (Higgins, 1987). Based on this perspective, the following hypotheses are proposed:

H1a: An individual's emotion regulation and control (ERC) influence students' attitudes toward entrepreneurship (ATE).
H1b: Emotion regulation (ERC) is linked to social norms (SN).
H1c: Emotion regulation and control (ERC) is positively related to students perceived behavioral control (PBC).
H2a: Attitude toward entrepreneurship (ATE) positively predicts entrepreneurial intention (EI)
H2b: Social norms (SN) positively influence entrepreneurial intention (EI).
H2c: Perceived behavioral control (PBC) positively influences entrepreneurial intention (EI).
H3a: Knowing style (KS) significantly relates to entrepreneurial intention (EI).
H3b: Planning style (PS) significantly relates to entrepreneurial intention (EI).
H3c: Creating style (CS) significantly relates to entrepreneurial intention (EI).

Figure 1 depicts the study's theoretical model, which explains the proposed connections between the main variables and outlines the conceptual framework that forms the basis of the research hypotheses.

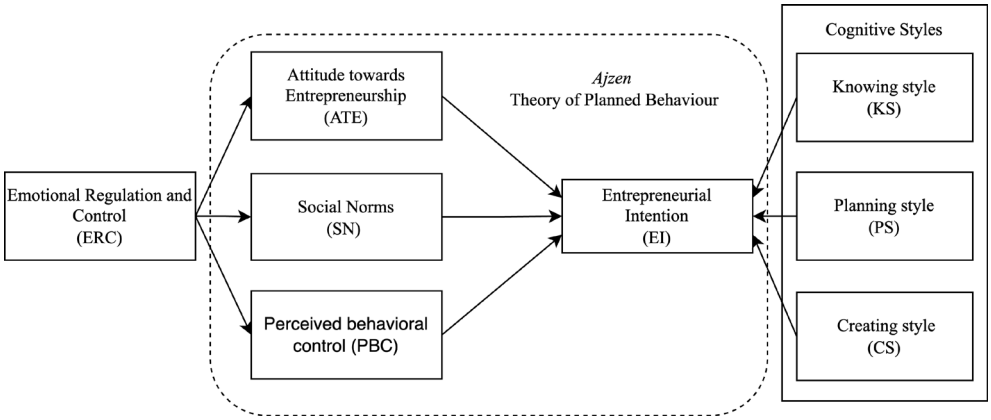


Figure 1. Theoretical model of the research. Source: Authors' research.

4. Methods

This study utilized three questionnaires to examine the relationship between business students' attitudes, emotion regulation skills, cognitive styles, and entrepreneurial intention. Entrepreneurial intention was measured using the Entrepreneurial Intention Questionnaire (EIQ) Version 3.1 (Liñán & Chen, 2009), cognitive styles were assessed with the Cognitive Style Indicator (CoSI) (Cools & Van den Broeck, 2007). The CoSI instrument consists of 14 items measuring three cognitive styles: Knowing Style (4 items), Planning Style (5 items), and

Creating Style (5 items). Emotion regulation and control were measured using the Emotional Intelligence Scale (WLEIS) (Wong & Law, 2002), with two factor scales applied in this study: Use of Emotion (UOE) (5 items) and Regulation of Emotion (ROE) (5 items). The study employs a 6-point Likert scale ranging from (1) "Does not describe me at all" to (6) "Completely describes me." A total of 147 business students aged 19 to 26 participated in the study, with 142 questionnaires considered valid for compiling the study results.

To test the proposed hypotheses, the research employed Pearson correlation coefficients to assess the strength and direction of the relationships between variables. The hypotheses were developed based on established constructs from the Theory of Planned Behavior and measured using validated psychometric metrics. Although the study does not employ a full structural equation modeling (SEM) approach, the correlation matrix and hypothesis testing framework serve to explore the expected relationships between the latent and observed variables.

5. Data collection

The summary in Table 2. highlights the differences in data completeness across the variables, offering valuable insights into data availability.

Table 2. Descriptive statistics. Source: Authors' research

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
ERC	138	1,00	6,00	4,3355	,07639	,89743
ATE	141	1,00	6,00	3,9196	,11938	1,41752
SN	142	1,00	6,00	4,0164	,10415	1,24109
PBC	143	1,00	6,00	3,9650	,09175	1,09721
EI	142	1,00	6,00	3,7324	,12005	1,43062
KS	138	1,00	6,00	4,6268	,07809	,91731
PS	139	1,00	6,00	4,5568	,08673	1,02257
CS	137	1,20	6,00	4,1591	,08242	,96471
Valid N (listwise)	127					

Table 3 presents the correlation coefficients between key variables, highlighting the strength and direction of their relationships.

Table 3. Correlations between variables. Source: Authors' research

Correlations									
		ERC	ATE	SN	PBC	EI	KS	PS	CS
ERC	Pearson Correlation	1	,327**	,016	,430**	,326**	,595**	,444**	,498**
	Sig. (2-tailed)		,000	,855	,000	,000	,000	,000	,000
	N	138	135	137	137	136	136	136	135
ATE	Pearson Correlation	,327**	1	,120	,755**	,841**	,312**	,199*	,478**
	Sig. (2-tailed)	,000		,158	,000	,000	,000	,020	,000
	N	135	141	139	141	140	135	136	134
SN	Pearson Correlation	,016	,120	1	,131	,038	,145	,257**	,159
	Sig. (2-tailed)	,855	,158		,123	,652	,092	,002	,066
	N	137	139	142	141	140	136	137	135
PBC	Pearson Correlation	,430**	,755**	,131	1	,727**	,422**	,248**	,510**
	Sig. (2-tailed)	,000	,000	,123		,000	,000	,003	,000
	N	137	141	141	143	142	137	138	136
EI	Pearson Correlation	,326**	,841**	,038	,727**	1	,262**	,124	,507**
	Sig. (2-tailed)	,000	,000	,652	,000		,002	,148	,000
	N	136	140	140	142	142	136	137	135
KS	Pearson Correlation	,595**	,312**	,145	,422**	,262**	1	,664**	,447**
	Sig. (2-tailed)	,000	,000	,092	,000	,002		,000	,000
	N	136	135	136	137	136	138	137	135
PS	Pearson Correlation	,444**	,199*	,257**	,248**	,124	,664**	1	,309**
	Sig. (2-tailed)	,000	,020	,002	,003	,148	,000		,000
	N	136	136	137	138	137	137	139	135
CS	Pearson Correlation	,498**	,478**	,159	,510**	,507**	,447**	,309**	1
	Sig. (2-tailed)	,000	,000	,066	,000	,000	,000	,000	
	N	135	134	135	136	135	135	135	137

**Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed)

6. Discussion

Entrepreneurial intention (EI) is influenced by a complex interplay of emotional, cognitive, and behavioral factors. Table 4 summarizes the results on the confirmation or rejection of the hypotheses.

Table 4. Testing the research hypothesis. Source: Authors' research

Relationship	P-value	H
ERC -> ATE	0.327**	supported
ERC -> SN	0.016	rejected
ERC -> PBC	0.430**	supported
ATE -> EI	0.841**	supported
SN -> EI	0.038	rejected
PBC -> EI	0.727**	supported
KS -> EI	0.262**	supported
PS -> EI	0.124	rejected
CS -> EI	0.507**	supported

** Correlation is significant at the level (2-tailed)

Emotional regulation and control significantly influence two of the three core predictors of entrepreneurial intention: attitude toward entrepreneurship (ATE) and perceived behavioral control (PBC). A moderate positive correlation was observed between ERC and ATE ($r = 0.327$, $p < 0.01$), indicating that individuals with greater emotional regulation are more likely to develop a favorable attitude toward entrepreneurship. ERC shows a strong positive correlation with PBC ($r = 0.430$, $p < 0.01$), suggesting that emotional control enhances individuals' perceptions of their ability to successfully execute entrepreneurial tasks. However, the relationship between ERC and social norms (SN) was found to be non-significant ($r = 0.016$, $p > 0.05$), highlighting that emotional control, while important for other aspects, does not play a key role in shaping an individual's understanding or alignment with social norms related to entrepreneurial behavior.

TPB identifies attitude, social norms, and perceived behavioral control as key predictors of entrepreneurial intention. In this study, ATE and PBC emerged as significant factors, while SN played a limited role. The relationship between ATE and EI was found to be both strong and significant ($r = 0.841$, $p < 0.01$), indicating that a positive attitude toward entrepreneurship is a critical driver of intention. However, the influence of SN on EI was not significant ($r = 0.038$, $p > 0.05$), suggesting that external social pressures or norms have a limited effect on individuals' entrepreneurial motivations in this context.

Cognitive styles, which refer to individuals' preferred ways of processing information and solving problems, also play an important role in shaping entrepreneurial intention. Among the cognitive styles examined, Knowing Style (KS) and Creating Style (CS) showed significant positive relationships with EI, with coefficients of 0.262 ($p < 0.01$) and 0.507 ($p < 0.01$), respectively. These findings suggest that individuals who prioritize knowledge acquisition and those with a creative problem-solving approach are more likely to develop entrepreneurial intentions. In contrast, Planning Style (PS), which emphasizes structured and methodical approaches, had a non-significant relationship with EI ($r = 0.124$, $p > 0.05$). This indicates that while planning is valuable in entrepreneurial execution, it may not strongly influence the initial formation of entrepreneurial intention.

7. Theoretical and practical implications

Emotional regulation enhances both attitude and perceived behavioral control, which are key determinants of entrepreneurial intention among business students. Attitudes toward entrepreneurship emerged as the strongest predictor of intention, underscoring the importance of fostering positive perceptions of entrepreneurship. Interestingly, social norms did not significantly influence entrepreneurial intention, suggesting that societal expectations may be less influential in cultures that value individual agency and autonomy, such as more individualistic or innovation-driven environments. This suggests that entrepreneurial intention

may flourish in contexts where personal achievement, creative expression, and intrinsic motivation are prioritized over conformity to group norms.. This finding emphasizes the need to focus on intrinsic motivators and personal capabilities when promoting entrepreneurship. Cognitive styles further add to the understanding of entrepreneurial intention. Creative and knowledge-oriented individuals are more likely to pursue entrepreneurial paths, those with a preference for planning may not be as strongly inclined to form entrepreneurial intentions, though their skills could be valuable in later stages of entrepreneurial ventures. These findings have practical relevance for university teachers and educational program directors. By emphasizing emotional regulation and promoting cognitive flexibility in curricula, education systems can better equip students with the competencies associated with entrepreneurial intention. In policy terms, this means the need for support programs that not only provide funding but also enhance emotional intelligence and creativity through mentoring and coaching, particularly for youth entrepreneurial initiatives.

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References

Bouckenooghe, D., Cools, E., De Clercq, D., Vanderheyden, K., Fatima, T. (2016). Exploring the impact of cognitive style profiles on different learning approaches: Empirical evidence for adopting a person-centered perspective. Learning and Individual Differences, 51.

Caputo, A., Nguyen, V. H. A., & Delladio, S. (2025). Risk-taking, knowledge, and mindset: Unpacking the antecedents of entrepreneurial intention. International Entrepreneurship and Management Journal, 21, Article 48.

Deprez, J., Cools, E., Robijn, W., & Euwema, M. (2021). Choice for an entrepreneurial career: Do cognitive styles matter? Entrepreneurship Research Journal, 11(1), Article 20190003.

Dinklage, L. B. (1966). Adolescent choice and decision-making: A review of decision-making models and issues in relation to some developmental stage tasks of adolescence (Monograph No. 1). Harvard Graduate School of Education.

Fredrickson, B. L., Tugade, M. M., Waugh, C. E., & Samanez-Larkin, G. R. (2003). What good are positive emotions in crises? A prospective study of resilience and emotions following the terrorist attacks on the United States on September 11th, 2001. Journal of Personality and Social Psychology, 84(2), 365–376.

Gielnik, M. M., Frese, M., Graf, J. M., & Kampschulte, A. (2014). A temporal analysis of how entrepreneurial goal intentions, positive fantasies, and action planning affect starting a new venture and when the effects wear off. Journal of Business Venturing, 29(6), 755–772.

Gupta, M, Sharma, V., Rajput N. (2023) Influence of Entrepreneurship Education on Entrepreneurial Intentions of New Entrepreneurs. Abhigyan, 41(4):15-27.

Higgins, E. T. (1987). Self-discrepancy: A theory relating self and affect. Psychological Review, 94(3), 319.

Hermans, H. J. M. (2018). Society in the self: A theory of identity in democracy. Oxford University Press.

Huang, Y., Zhang, J., Xu, Y., Sun, S., Bu, Y., Li, S., & Chen, Y. (2024). College students' entrepreneurship policy, regional entrepreneurship spirit, and entrepreneurial decision-making. Humanities and Social Sciences Communications, 11, Article 748.

Liñán, F.; Chen, Y. (2009). Development and Cross-Cultural Application of a Specific Instrument to Measure Entrepreneurial Intentions. Entrepreneurship Theory and Practice, 33(3), 593-617.

Pattnaik, S., Mmbaga, N., White, T. D., & Reger, R. K. (2024). To entrepreneur or not to entrepreneur? How identity discrepancies influence enthusiasm for academic entrepreneurship. Journal of Technology Transfer, 49(4), 1444–1470.

Sadler-Smith, E. (2004). Cognitive style and the management of small and medium-sized enterprises. Organization Studies, 25(2), 155–181.

Sanda, M.-A., & Sallama, M.-N. (2023). Mediation effect of emotions on relational dynamics between entrepreneurs' thinking processes and their entrepreneurial decision-making. Journal of the International Council for Small Business, 1–14.

Sarfraz, M., He, B., and Shah, S. G. M. (2020). Elucidating the effectiveness of cognitive CEO on corporate environmental performance: the mediating role of corporate innovation. Environ. Sci. Pollut. Res. 27, 45938–45948.

Tsou, E., Steel, P., & Osiyevskyy, O. (2023). The relationship between entrepreneurial intention and behavior: A meta-analytic review. International Journal of Entrepreneurship and Innovation.

Van Loon, R. (2017). Creating organizational value through dialogical leadership: Boiling rice in still water. Springer.

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Estimating Added Value in Colombian Higher Education: A Multivariate Approach

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Abstract

In this study we analyse the added value that higher education institutions (HEIs) in Colombia provide to their students, for this we use data from the Saber 11 and Saber Pro tests registered in it. A hierarchical model is used to estimate the difference between the expected and actual performance of students in Saber Pro. Multivariate analysis techniques, such as principal component analysis (PCA) and cluster analysis, are applied to identify and group profiles according to their performance. Finally, data envelopment analysis (DEA) is used to evaluate the efficiency of HEIs in generating added value. The results show that the impact of universities varies according to the competence evaluated.

Keywords: *Value added; higher education; multivariate analysis; educational efficiency.*

1. Introduction

The effect of public policies on education and the quality of the learning obtained by students during their time at a higher education institution highlights the complexity of the educational process (Visbal-Cadavid et al., 2017). According to (Alexander, 2015), the best criterion for measuring the effectiveness of education is the value that education brings to the initial competencies of learners.

In the educational field, value-added models play a relevant role in analyzing the effectiveness of schools and teachers in developing their students' competencies over time (Fernandez & Martinez-Canton, 2019). Value added (VA) is defined as the contribution to students' net progress towards established learning objectives, once other factors outside schools have been isolated, such as students' prior knowledge, social, economic, and family factors, which can contribute to such progress (Zuluaga-Ortiz et al., 2022)

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Colombia, on the other hand, is in a privileged position to report the added value of its universities, since it is one of the few countries that evaluates the learning of its students at the end of school through the Saber 11 tests and at the end of university through the Saber Pro tests.

2. Value-added model

The results of the value added by the country's higher education institutions to their students are reported at the INBC level through a hierarchical model, which facilitates the nesting of the data (ICFES, 2019). This model evaluates the difference between the student's estimated performance, based on their initial competencies, and their actual performance in Saber Pro.

Initially, the data from Saber 11 and Saber Pro are crossed, considering students who took both exams within a range of 4 to 8 years. Due to changes in identity documents or other circumstances, a probabilistic cross-check between the two databases is resorted to. To carry out the estimates of value added by INBC, ICFES uses statistical models of parameters varying at more than one level, commonly known as hierarchical or multilevel models.

In the case of value added, the relationships to be estimated are given by the following expression:

$$\widehat{Saber\ pro} = f\ (saber\ 11)$$

That is, it seeks to estimate the individual's score in Saber Pro through the results of Saber 11 in the different competencies that are evaluated in this test, considering the individuals grouped in an INBC.

Subsequently, for each INBC, a comparison neighborhood is defined, to compare the value added by the INBCs that receive similar students in terms of their previous competencies. The reference INBC is compared with those that are part of its comparison neighborhood and we go on to speak of a relative measure of the quality of education, since the added value for the group of similar INBCs is measured (Instituto Colombiano para la Evaluación de la Educación - ICFES, 2022)

3. Information processing

To develop this research work, a descriptive analysis is initially carried out to summarise the data in an organised way and analyse its behaviour. In the second instance, the multivariate statistical technique principal component analysis (PCA) is used to determine the student and university profile generating the best results in the Saber 11 and Saber Pro tests, obtaining principal components that facilitate the interpretation of the data. Subsequently, the cluster analysis technique is used to identify the groups of homogeneous universities. Ultimately, data envelopment analysis is used to estimate the value added by each HEI.

3.1. Description of the data

For the study, students of the Industrial Engineering program are selected first, as it is one of the most offered nationally and in the Caribbean Region. For the development of the research it was not necessary to apply any technique for data collection, the ICFES provides all the information in its records and since 2016 it has been cross-referencing between the Saber 11 and Saber Pro tests.

3.2. Description of the variables

The original database has 40 variables. However, for the purpose of the study, only the variables described in Table 1 are required

Table 1. Variable description

VARIABLE	FULL NAME	DESCRIPTION
MAT_S11	MATHEMATICS - SABER 11	0-100
CR_S11	CRITICAL READING - SABER 11	0-100
CC_S11	CITIZENSHIP SKILLS - SABER 11	0-100
ENG_S11	ENGLISH - SABER 11	0-100
BIO_S11	NATURAL SCIENCES - SABER 11	0-100
CC_PRO	CITIZENSHIP SKILLS – SABER PRO	0-100
WC_PRO	COMUNICACIÓN ESCRITA - SABER PRO	0-100
ENG_PRO	ENGLISH - SABER PRO	0-100
CR_PRO	CRITICAL READING - SABER PRO	0-100
QR_PRO	QUANTITATIVE REASONING - SABER PRO	0-100
INTERNET	INTERNET	YES/NO
COMPUTE R	COMPUTER	YES/NO
SCHOOL_N AT	NATURE OF THE SCHOOL	PRIVATE/PUBLIC
SCHOOL_ T YPE	TYPE OF SCHOOL	ACADEMIC/ TECHNICAL/ACADEMIC:

3.3. Aggregated variables

To analyze the added value taking the university as the unit of analysis, it is necessary to create 13 new variables in order to contribute to the description of the profiles.

4. Findings

Through the results described below, an analysis can be made of the added value that universities provide to their students in terms of learning.

Table 2. Description of the new variables

VARIABLE	NEW VARIABLE NAME	DESCRIPTION
P_MAT_S11	AVERAGE MATHEMATICS - SABER 11	
P_CR_S11	AVERAGE CRITICAL READING - SABER 11	
P_CC_S11	SOCIAL AND CITIZEN AVERAGES OF THE UNIVERSITY - SABER 11	
P_BIO_S11	AVERAGE NATURAL SCIENCES - SABER 11	
P_ENG_S11	AVERAGE ENGLISH - SABER 11	
P_QR_PRO	AVERAGE QUANTITATIVE REASONING - SABER PRO	
P_CR_PRO	AVERAGE CRITICAL READING - SABER PRO	
P_CC_PRO	AVERAGE CITIZENSHIP COMPETENCIES - SABER PRO	
P_ENG_PRO	AVERAGE ENGLISH - SABER PRO	
P_WC_PRO	AVERAGE WRITTEN COMMUNICATION - SABER PRO	
U_PUBLIC	PUBLIC UNIVERSITY	YES/NO
U_ACREDIT	ACCREDITED UNIVERSITY	YES/NO
P_ACREDIT	ACCREDITED PROGRAM	YES/NO

4.1. Descriptive analysis of the score of industrial engineering students in the different competencies of Saber 11 and Saber Pro.

Through this descriptive analysis, we seek to identify and describe the main characteristics of the study variables and the relationships between them in a summarized way. In addition, it is intended to describe the added value that universities provide in a general way to the students who are part of the study.

The following table compares the scores of Saber 11 and Saber Pro, highlighting greater variability in Saber Pro, which is attributed to the added value of the universities.

Table 3. Descriptive statistics

	Min	Q1	Mediana	Media	Q3	Max	Var
MAT_S11	32	54	60	61,32	68	91	109,74
CR_S11	35	53	59	59,2	65	85	81,75
CC_S11	35	53	58	58,78	65	83	79,72
BIO_S11	34	55	61	61,19	68	89	94,75
ENG_S11	26	49	57	59,9	68	100	186,79
QR_PRO	5	57	79	72	91	100	552,04
CR_PRO	1	36	62	57,83	81	100	765,02
CC_PRO	1	31	60	55,6	81	100	831,45
ENG_PRO	1	47	70	64,42	85	100	659,74
WC_PRO	1	31	57	55,03	80	100	814,28

In Saber 11, the scores are more homogeneous than in Saber Pro. Students enter universities with averages such as 61.32 in mathematics, 59.20 in critical reading, 59.90 in English and similar in other competencies, which allows the starting point to be evaluated before the university impact. In Saber Pro, the highest and lowest averages are in QR_PRO and WC_PRO, respectively. In mathematics, universities add value (from 61.32 to 72.00 on average), but in critical reading and citizenship skills progress is minimal. In English, they generate a notable increase (from 59.90 to 64.42).

4.2. Descriptive analysis of the average of each university in the different competencies of Saber 11 and Saber Pro

This section carries out a descriptive analysis of each university's average in the different competencies of Saber 11 and Saber Pro.

Table 4. Statistical summary of model's variables

	Min	Q1	Mediana	Media	Q3	Max	Var
P_MAT_S11	46,5	54,87	57,93	59,4	61,92	76,14	35,95
P_CR_S11	41	54,62	56,8	57,78	61	68,49	23,5
P_CC_S11	44	54,64	56,96	57,7	60,36	69,12	21,47
P_BIO_S11	48	55,42	58,38	59,43	62,6	73,89	29
P_ENG_S11	45,57	52,11	56,43	57,42	60,97	83,46	54,74
P_QR_PRO	29,5	58,96	68	68,69	77,15	93,44	170,1
P_CR_PRO	25	44,66	53,41	54,46	63,36	82,9	171,52
P_CC_PRO	9	45,55	51,62	52,81	58,85	81,98	161,05
P_ENG_PRO	29,5	48,5	60,02	60,57	70,25	94,18	212,31
P_WC_PRO	15,5	47,49	52	52,77	58,8	76,97	98,41

From the table, it can be seen that the average scores of the universities in the competencies evaluated in Saber Pro are more variable than the average scores in those evaluated in Saber 11; that is, the averages of the universities in each competency of Saber 11 are more homogeneous than in the competencies of Saber Pro.

4.3 Analysis of the main components of the average of each university in the different competencies of Saber 11 and Saber Pro

In this section, an analysis of principal components is carried out with the aim of facilitating the interpretation of the average of each university and characterizing the universities that generate the best results in the saber Pro test based on the accredited program variable.

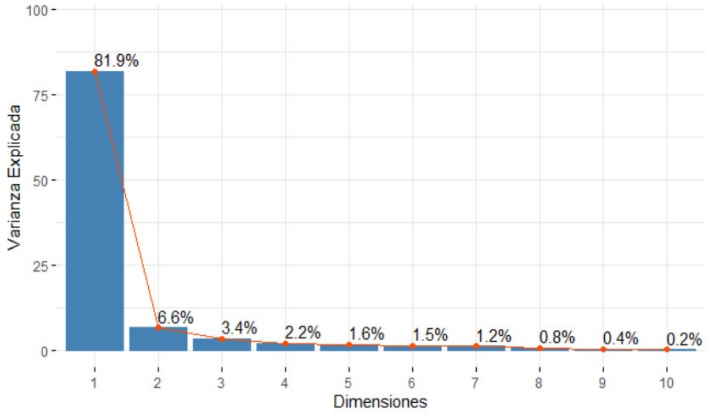


Figure 1. Eigenvalues histogram.

The principal component analysis yields 10 components, of which the first two collect 88.5% of the explained variability. Through the PCA, we analyze the location of the universities concerning the aggregate variable "accredited program". A clear difference is shown between both situations in terms of a score in the first 2 components in a favorable way.

4.4. Cluster analysis of the average of each university in the different competencies of Saber 11 and Saber Pro

In this section, a cluster analysis is carried out to group those universities that are similar in terms of the averages obtained in the Saber 11 and Saber Pro competencies and describe the added value that these provide to their students in a multidimensional way with the help of the components provided by the principal component analysis. Initially, to get an idea of the number of clusters present in the data, a hierarchical algorithm is applied, which in this case is Ward's method, due to its significant advantages, and in particular because it generates more compensated dendrograms (Delahoz-Dominguez et al., 2020); Then, a visual inspection of the obtained dendrogram is performed and a non-hierarchical partition-based algorithm is applied. The result indicates selecting 2 or 3 groups (see figure). The research aims to estimate the multidimensional added value by universities that admit students with similar entry conditions.

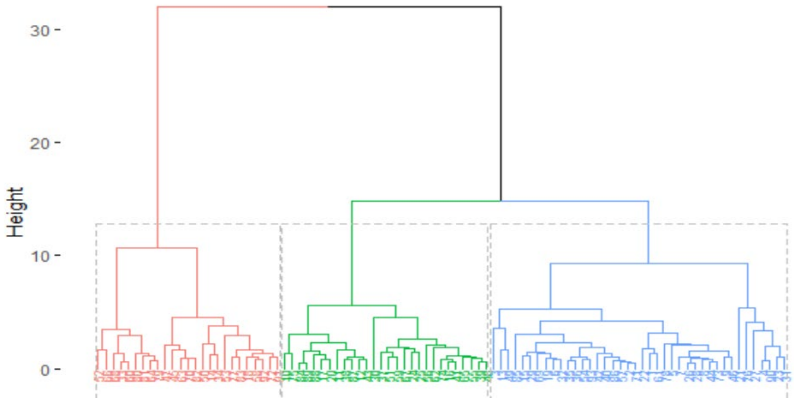


Figure 2. A dendrogram for hierarchical cluster analysis.

Subsequently, we look for the optimal number of clusters from the silhouette method. According to this method, the optimal number of clusters is the one that maximizes the mean of the silhouette coefficient of all observations. Figure 3 shows that the maximum values for the silhouette coefficient are reached at k=2 and k=3.

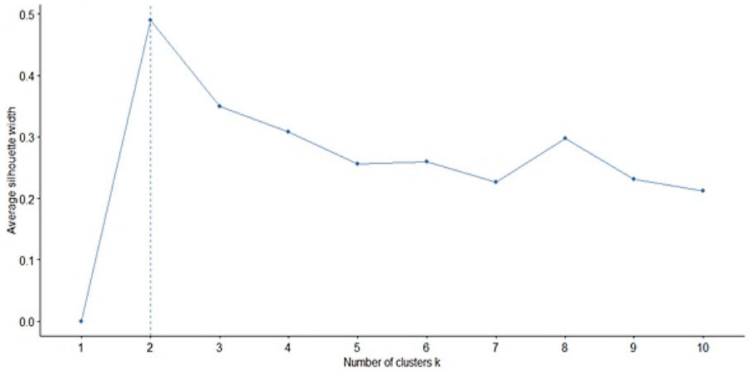


Figure 3. Optimal number of clusters according to the silhouette method.

The analysis uses the PAM (Partition Around Medoids) algorithm, where a medoid corresponds to the object of a group that minimizes the mean difference to all the elements in the group. Initially, we work with three groups, obtain the universities that belong to each group and make the representation in two dimensions as shown in Figure 4.

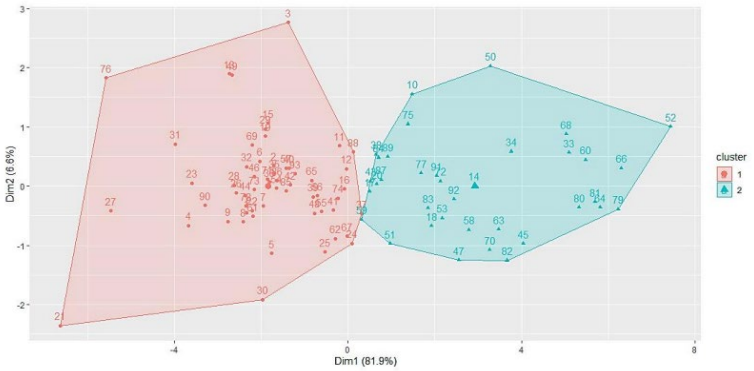


Figure 4. Cluster Analysis visualization

Cluster 1 groups the universities with unfavourable overall scores and favourable or unfavourable written communication scores from Saber Pro. Cluster 2 groups the universities with high overall scores and high and low written communication scores.

4.5. Data Envelopment Analysis

The conceptual scheme that associates the model's input and output variables must be constructed to apply the DEA. The averages of the competencies evaluated in Saber 11 are taken as the model's input variables, and the model's outputs are the averages obtained in Saber Pro.

Based on the data from the universities studied in this research, their efficiency is calculated using the DEA-CCR model, which assumes constant returns to scale (CRS), and the DEA-BBC model, which assumes variable returns to scale (VRS).

Table 5. Summary of the DEA model

Variable	**Cluster**			
	Group 1		**Group2**	
	(CRS)	(VRS)	(CRS)	(VRS)
Efficient universities	18(31,58%)	23(40,35%)	17(47,22%)	25(69,44%)
Inefficient universities	39 (68,42%)	34(59,65%)	19(52,78%)	11(30,56%)
Minimum level of efficiency	0,74	0,94	0,89	0,96
Medium efficiency	0,94	0,98	0,98	0,99
Standard deviation	0,06	0,02	0,03	0,01
Number of universities (DMUs)	57	57	36	36

The table presents the efficiency values of all the universities according to the group to which they belong and the DEA model used in each case. Institutions with efficiency values equal to one are classified as efficient, and the rest as "non-efficient." Universities with efficiency values close to 1 (efficiency frontier) are considered close to achieving efficiency, that is, with opportunities for improvement to achieve it.

5. Conclusions

The study showed that the value added by higher education institutions in Colombia varies according to the competence being evaluated; significant improvements were detected in mathematics and English, but little progress in critical reading and citizenship skills. The principal component analysis (PCA) revealed that universities with accredited programs tend to obtain better results in Saber Pro, while the cluster analysis identified different institutional performance profiles. Likewise, the data envelopment analysis (DEA) showed little homogeneity in the educational impact among universities, which highlights a need to strengthen strategies in less developed sectors.

References

Alexander, R. J. (2015). Teaching and learning for all? The quality imperative revisited. *International Journal of Educational Development*, 40, 250-258. https://doi.org/10.1016/j.ijedudev.2014.11.012

Delahoz-Dominguez, E. J., Guillen-Ibarra, S., & Fontalvo-Herrera, T. (2020). Analysis of the quality accreditation in industrial engineering programs and the results in the standardized national tests, in Colombia, Análisis de la acreditación de calidad en programas de ingeniería industrial y los resultados en las pruebas nacionales estandarizadas, en Colombia. *Formacion Universitaria*, 13(1), 127-134.

Fernandez, F. J. I., & Martinez-Canton, A. (2019). Ethics and Transversal Citizenship in the Teaching of Science and Engineering. 2019 IEEE Integrated STEM Education Conference (ISEC), 104-110. https://doi.org/10.1109/ISECon.2019.8881965

Instituto Colombiano para la Evaluación de la Educación - ICFES. (2022). Saber 11 [Dataset]. https://icfes.gov.co/guest/data-icfes

Visbal-Cadavid, D., Martínez-Gómez, M., & Guijarro, F. (2017). Assessing the efficiency of public universities through DEA. A case study. *Sustainability*, 9(8), 1416.

Zuluaga-Ortiz, R., DelaHoz-Dominguez, E., & Camelo-Guarín, A. (2022). Academic efficiency of engineering university degrees and its driving factors. A PLS-DEA approach. *Journal of International Studies*, 15(2).