POLITECNICO SETUBAL

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EMERGING TRENDS IN ENGINEERING EDUCATION: ADAPTING TO A CHANGING WORLD

BOOK OF ABSTRACTS OF THE 6TH INTERNATIONAL CONFERENCE OF THE PORTUGUESE SOCIETY FOR ENGINEERING EDUCATION

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TITLE

Emerging Trends in Engineering Education: Adapting to a Changing World
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PREFACE

Dear All,

It is with great pleasure that we welcome you to the 6th International Conference of the Portuguese Society for Engineering Education (CISPEE 2025), jointly hosted by the Setúbal School of Technology and the Barreiro School of Technology of the Polytechnic University of Setúbal.

In an increasingly complex and unpredictable world, engineering education must not merely keep pace — it must lead. CISPEE 2025 embraces this imperative by placing at the centre of its agenda the theme "Emerging Trends in Engineering Education: Adapting to a Changing World". This theme reflects our shared understanding that the education of future engineers must be continuously reimagined in light of new scientific, technological, societal, and environmental contexts.

Reflecting this vision, CISPEE 2025 brings together diverse yet interconnected fields of inquiry, spanning innovative teaching methodologies, curriculum development, lifelong learning strategies, and the application of artificial intelligence and computational tools in engineering education. Key focus areas include emerging trends in STEM education, equity, diversity and inclusion, research-driven pedagogical practices, and the cultivation of transversal skills for tomorrow's engineers.

This conference provides a platform for critical reflection, open dialogue, and collaborative inquiry — fostering multifaceted discussions on the ethical responsibilities of engineers, the integration of digital technologies, and the continuous evolution of engineering education. CISPEE 2025 invites participants to challenge assumptions, explore new directions, and reaffirm the transformative role of engineering education in society.

We invite you to take an active part in this scientific dialogue, contributing rigorous research and advancing evidence-based insights into the evolving landscape of engineering education. We trust that CISPEE 2025 will be both intellectually rewarding and a meaningful contribution to the advancement of knowledge in this vital field.

The organizing committee of CISPEE2025

PROGRAM

Location: Setúbal

Time	16 de julho
08:00	Registration & Info Desk
09:00	Opening Session
09:30	Plenary Session I
10:30-11:00	*Coffee break*
11:00	Parallel Session I
12:00	Round table I
13:00	Lunch
14:30	Parallel Session II
15:30	Plenary Session II
16:30-17:00	*Coffee break*
17:00	Parallel Workshop I
18:30-19:30	Social event /Networking Welcome Cocktail

Location: Barreiro

Time	17 de julho
08:00	Registration & Info Desk
09:30	Parallel Session III
10:30-11:00	*Coffeee break*
11:00	Parallel Session IV
12:00	Round table II
13:00	Lunch
14:30-16:30	Parallel Workshop II
17:00	*Coffee break*
17:30 - 18:00	Plenary Session III
18:30-19:30	Social event /Networking/SPEE Meeting
20:00-23:00	Conference Dinner

Location: Setúbal

Time	18 de julho
08:00	Registration & Info Desk
09:00	Parallel Session V
10:00-10:30	*Coffee break*
10:30-12:30	Paralel Workshop III
13:00	**Closing Session** Best Paper Next CISPEE2027

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1. PLENARY SESSIONS

Plenary Session I

July 16th: 9h30 – 10h30
Chair: *Pedro Neto*

LEARNING AS A DRIVER FOR DEVELOPMENT

Guilherme d'Oliveira Martins

Bio: Born in 1952. Master Degree in Juridical and Economic Science (University of Lisbon). Honoris Causa by University Lusíada (June 2016), University Aberta (September 2016), and Institute of Social and Political Sciences (October 2016).
Present Positions: Trustee of the Calouste Gulbenkian Foundation. President of the Grand Council of the CNC – Centro Nacional de Cultura (National Centre for Culture). University Professor at the University Lusíada and the Technical University of Lisbon. Correspondent member of the Portuguese Academy of Sciences. Member of the Portuguese Naval Academy. Member of merit of the Portuguese Academy of History. Corresponding Member of the Brazilian Academy of Letters – Chair 20. Chairman of the General Assembly of the World Monuments Fund (since 1 June 2023). Chairman of the Advisory Board of Banco Português do Fomento (2024).
Previous Positions: Chairman of the Fiscal Council of Caixa Geral de Depósitos. President of the Tribunal de Contas (Portuguese Court of Auditors). National Coordinator of the European Year of Cultural Heritage 2018. President of the Council for the Prevention of Corruption. President of EUROSAI. President of the Contact Committee of the Heads of the Supreme Audit Institutions of the European Union. General-Auditor of the Assembly of the West European Union. First Vice President of EUROSAI. Minister of Presidency. Minister of Finance. Minister of Education. Secretary of State for Educative Administration. Member of the Portuguese Parliament. Vice-Chairman of the Parliamentary Group of the Socialist Party. President of SEDES (Association for Economic and Social Studies). Vice-President of the Portuguese National Commission for UNESCO. Political Adviser of the President of the Republic. Secretary General of the Portuguese Committee of the European Cultural Foundation. Head of Cabinet of the Minister of Finance. Member of the European Convention on the Future of Europe. President of the Steering Committee of the Council of Europe, which adopted the Framework Convention on the Value of Heritage for Society (in Faro, Portugal).

Abstract: There is no better investment than the learning and empowerment of people. We must, therefore, understand the pillars outlined by Edgar Morin: the safeguarding of knowledge against error and illusion; the teaching of methods that allow us to see context and the whole, rather than fragmented knowledge; the recognition of the inseparable link between unity and diversity in the human condition; the learning of a planetary identity, considering humanity as a community of destiny; the need to take the unexpected and the uncertain as hallmarks of our time; education for mutual understanding between people of different backgrounds and cultures; and the development of an ethics of humankind, in line with an inclusive form of citizenship. Ultimately, this is about fully embracing the priorities of learning to know, learning to do, learning to live together and with others, and learning to be. Education is not a commodity. It requires that freedom and autonomy be bound to a genuine sharing of responsibility within society, and to the safeguarding of singularity and the common good. We must realise that a cultured, civilised, and peaceful society—respectful of citizenship and democracy—can only be achieved through an education where information leads to knowledge and knowledge to wisdom. More than concerns directly linked to curricular matters—which should not be confused with the options related to the work I had the honour of coordinating—what I find relevant in these concerns relates to the following: (a) a society such as the Portuguese one must place education and training as its highest priority; (b) it is learning and its quality that must be brought to the forefront, as essential factors of human development;(c) the student must not be seen merely as a future professional or technician, but

as a person and citizen, able to respond to the challenges of uncertainty and complexity; (d) defining a learner profile must not be mistaken for creating a mould, but should be viewed as an essential framework capable of serving as a constant reference for improving education and schooling;(e) in the various fields of education and training, there should be no uncertainty or instability dictated by political or electoral cycles; (f) the progress achieved in the medium and long term in our country resulted from the convergence of several factors – the extension of compulsory schooling, pre-school education, improvements in assessment across relevant domains, the enhancement of the school network, the recognition of prior learning, vocational and artistic education, teacher training, progress in higher education, etc.; (g) there must be no temptation to regard standardisation as an appropriate method for creating an efficient, fair, high-quality public education network for all. This is why a humanist perspective seeks to focus on aspects such as human dignity, active and responsible citizenship, the ability to read and understand the contemporary world, and the appropriate response to the challenges of human development.

Plenary Session II

July 16th: 15h30 – 16h30
Chair: *Rosa Vasconcelos*

ENGINEERING EDUCATION AND THE WILD WORLD OF GENERATIVA AI

Diana Andone

Politehnica University of Timisoara

Bio: Dr. Diana Andone is the Director of the Digital and Distance Education of Politehnica University of Timisoara, Romania, responsible for planning and implementing digital education and associate professor in multimedia, interactive and web technologies. EDEN Senior Fellow, IEEE Education Society 2021 Distinguished Chapter Leadership Award winner, IEEE Education Society Vice-President (2024-2025), with extensive research experience and intense publication and more than 30 research and educational international projects, she teaches course modules in universities from UK, France, USA, Finland, Italy, Greece.

Abstract: The transformation brought by Generative AI into engineering education has driven educators to rethink and adjust methods of teaching and learning, as well as to acquire new skills and adapt to an evolving digital ecosystem. In the context of engineering, where practical problem-solving and innovation are paramount, what competencies will be crucial for educators to impart, and for students to develop? How can Generative AI enhance the creativity and critical thinking of both students and educators or to be included into engineering curriculum? How open education and science practices are changed by GAI? Is academic assessment changing because of the incidents of GAI? Several experiments which showcase the integration of the use of GAI into project development and assessment be presented from both educators and students' perspectives.

Plenary Session III

July 17th: 17h00 – 18h00
Chair: *Rita Pereira*

PROFESSIONAL ROLES FOR FUTURE ENGINEERS, A DRIVER OF DIVERSITY

Greet Langie

Faculty of Engineering Technology, KU Leuven, Belgium

Bio: Greet Langie is a professor at the Faculty of Engineering Technology, KU Leuven. She's a physicist by training and focuses on Engineering Education Research, more specifically on the issues surrounding the transitions from secondary education to higher education and from higher education to professional life. She was the vice dean of education of the Faculty of Engineering Technology at KU Leuven from 2012 until 2020 and is now the vice chair of education of Campus De Nayer (one of the campuses of KU Leuven). She founded the KU Leuven Engineering and Science Education Center (LESEC) in 2009 and was the chair until 2012. She's active in several international networks: She's the vice-president of SEFI (European Society for Engineering Education), a member of the SEFI Special Interest Groups 'Physics', 'Capacity building' and 'Engineering Education Research', a consulting expert in the National Talent-Introduction Base for Interdisciplinary Innovation in Engineering Education at Tsinghua University, the co-organizer of the yearly IIDEA-summer course in Tsinghua University, a member of the Advisory Board of BEST (Board of European Students of Technology) and she received the title 'ING.PAED.IGIP h.c.' from IGIP. In 2022 she launched the first SEFI summer school for PhD students in Engineering Education Research. The second edition was in London in May in 2024.

Abstract: Engineering graduates have diverse roles within the working field. Unfortunately, students do not have a realistic picture of this. At the Faculty of Engineering Technology (KU Leuven, Belgium), we have therefore developed the PREFER framework and tools to help engineering students shape their professional identity. Currently, we are also exploring the potential benefits of implementing this framework in Secondary Education. We want to get more students, especially girls, excited about engineering by making them aware of the wide variety of career options available to engineers. Promoting diversity in engineering not only benefits society but also enhances industry.

2. ROUND TABLES

Round Table IA

July 16th: 12h00 – 13h00

Cybersecurity and Engineering Education

Moderator: *Anikó Costa*

(NOVA School of Science and Technology, Universidade Nova de Lisboa, Lisbon, Portugal)

Bio: Anikó Costa received her engineer degree in Electrical Engineering from Czech Technical University in Prague in 1992, her Master's degree in Informatics, and Ph.D. degree in Electrical Engineering from the Nova University of Lisbon in 2003 and 2010 respectively. She is currently an Assistant Professor at NOVA School of Science and Technology. Her main research interests include model-based development of embedded systems using Petri nets, and statecharts, digital system design, and hardware-software co-design. Her interests also include engineering education.

She is member of IEEE and she is the chair of the Education Chapter of the Portugal Section.

Panelist *Eda Marchetti*
Nelson Escravana
Nuno Cruz
José Amador
José Barata

Abstract: Engineers' works are more and more connected. In the past not even computers were networked, but now cars are networked, buildings are networked, and all kinds of devices are also networked. This evolution demands a strong knowledge of cybersecurity from all kinds of engineers. The issue with security is that security cannot be added to a system. It needs to be designed into a system from the beginning. In order to do that, we need to reformulate engineering education so all engineers have a solid foundation of cybersecurity. This round table aims to discuss how to include cybersecurity in engineering curricula, to face future cybersecurity threats.

This roundtable is expected to have the contributions of highly relevant people in the fields of cybersecurity, both from a law enforcement side and from the industry side, to ensure the best possible discussion is fostered.

Round Table IB

July 16th: 12h00 – 13h00

Philosophy of Engineering in High Quality Higher Education

Moderator: *Jorge Manuel Martins Barata*

(*Civil Engineering Department, University of Porto, Porto, Portugal)*

Bio: Full Professor at the University of Beira Interior and Director of AEROG – Aeronautics and Astronautics Research Center of LAETA, a top R&D unit in energy, transport, and aeronautics. With over 42 years of university teaching experience, he has lectured in propulsion, aerodynamics, heat and mass transfer, and combustion. He has supervised 73 academic works, including 11 PhD theses, 14 master's dissertations, and several postdoctoral and undergraduate projects. He is a Fellow of the Royal Aeronautical Society, Associate Fellow of the American Institute of Aeronautics and Astronautics (AIAA), Senior Member and Aeronautical Engineering Specialist of the Ordem dos Engenheiros, and recipient of a Certificate of Appreciation from SAE Aerospace. He has authored over 300 scientific publications, including more than 60 journal articles, 200 conference papers, 8 books, 14 monographs, and various educational materials. He has held over 20 academic or scientific service roles and participated in 44 funding applications, of which 23 were approved. His affiliations include RAeS, AIAA, SAE, 3AF, VFS, IAF, ASTFE, ISOABE, APMTAC, and SPEE (as founder). He has served as editor or editorial board member of 8 journals and held 11 government or public service positions.

Abstract: Engineering and Philosophy are typically conceived as two mutually exclusive domains. Some engineers and philosophers ideas are even worse. As a consequence, they do not understand the transforming world they are living. This essay is neither about Philosophy nor Engineering themselves. It is not restricted to Engineering Ethics or Higher Education. It is dedicated to a broader approach to the philosophy of technology, which is concerned with the technology itself and that aims to understand both the practice of designing and creating artefacts (including artificial processes and systems) and the nature of thing so created. This newer reality implies great modifications in the engineering higher education systems to keep them accountable for the future. Institutions, academics, students, and any other partners, need to think proactively to achieve the necessary transformation. Merely reproducing the engineering teaching, which reached a notable position after the WWII, will not be adequate in the XXI century.

Round Table II

July 17th: 12h00 – 13h00

E4E - Open debate about Engineers future

Moderator: Alfredo Soeiro

(*Civil Engineering Department, University of Porto, Porto, Portugal)*

Bio: Academic director in Civil Engineering of University of Porto and vice president of the department (2003/7); Pro-Rector of the University of Porto for Continuing Education (1998/3); vice president of EUCEN (1992/8) and SEFI (2002/3); president of IACEE (2001/4); president of AUPEC (2001/5); president of SEFI (2003/5); member of the editorial board of the journal European Journal of Engineering Education (1998-...); ambassador of ENETOSH in Portugal (2012-...); medal of 800th Anniversary of U. Sorbonne (1998); International Hall of Fame of Adult and Continuing Education title (2006); EDEN Fellow award (2008) and Senior Fellow (2016); IEOM Global Engineering Education Award (2016); IACEE Fellow (2014); vice-president of EMC of FEANI (2014-18); member of the Steering Committee of EUCEN (2012-16); member of EDEN DLE Board (2020-...); member of IACEE Council (1995-18); Secretary General of AECEF (2017-...); Vice-President of ISHCCO (2019-...).

Abstract: The panel discusses a project focused on the future of the engineering profession and the emerging requirements for developing appropriate professional competencies. The aim of the project E4E is to bridge the gap between society's needs for engineering performance and the provision of suitable education and training. It is structured into four chapters. The first chapter outlines the inception of the initiative, the formation of the consortium, and the operational methods during the funding period. The second chapter addresses the assessment phase, evaluating both current and future training needs for graduating and practicing engineers by offering relevant online courses. The third chapter details the design and preparation of the training courses for testing and validation. Finally, the fourth chapter explores potential scenarios and advancements for the engineering profession, considering adaptations to evolving societal needs for development and progress. Conclusions to define the strategy for the future of engineers and diagnostics of engineering training needed will be presented and discussed in an open debate.

3. PARALLEL SESSIONS

PARALLEL SESSION IA

Reimagining Engineering Education Through Artificial Intelligence

July 16th: 11h00 – 12h00

Chair: *Bill Williams*

[17]

Harnessing Artificial Intelligence to Formulate Intuitive Instructions for Students

George Pozek[1], Alessia Tripaldelli[2], Brian Butka[3]

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Abstract: In the past year, ChatGPT has surfaced as a formidable and transformative force, challenging, and reshaping conventional paradigms across diverse tasks. This research investigates the potential of ChatGPT 3.5, a Generative Pre-trained Transformer, as an innovative tool in coding education, focusing on the delivery of accurate instructional content. Previous research has led us to investigate more AI capabilities with application to the production of learning resources, evaluating ChatGPT's proficiency in completing a digital circuit design laboratory, with the notable result being that ChatGPT achieved a score of 73% on the laboratory assignments. Further delving into its tutoring capabilities, ChatGPT was utilized as a tutor in a Java coding class, where students were permitted to employ ChatGPT as a learning aid. The outcome was compelling, as after students were able to use ChatGPT as a tutor, the average score was 93.325%. This success not only demonstrated the model's adaptability but also highlighted its potential as a valuable resource for students seeking academic support. Central to this new step on the research is the assessment of ChatGPT 3.5's proficiency in understanding Verilog, a sophisticated programming language used in digital systems design. This research is conducted within the context of the Digital Systems Design in Aerospace (CEC330) course at Embry-Riddle Aeronautical University and involves the use of ChatGPT to create detailed laboratory manuals for the class. In this exploration, ChatGPT was tasked with synthesizing informative laboratory manuals by utilizing a provided Verilog code solution. The findings demonstrate the capability of ChatGPT to accurately interpret code and transform it into coherent laboratory instructions. The implications of this study extend to educators, providing them with a powerful tool for crafting clear and comprehensive laboratory instructions for multiple programming classes. This innovative approach has the potential to significantly enhance the instructional experience, enabling professors and teachers to deliver precise guidance to students undertaking coding-related laboratory assignments.

Keywords: Artificial Intelligence, ChatGPT, Engineering Education, Digital Systems Design Laboratory, FPGA

PARALLEL SESSION IA

[20]

How Do Engineering Students View and Use Generative AI For Learning? Exploring Their Habits, Beliefs, And Attitudes

Caroline Dominguez[1], Kaline Ligia Pessoa[2], Ana Morais[3] and Gonçalo Cruz[4]

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Abstract. The emergence of Generative Artificial Intelligence (GAI) is reshaping engineering education. This study explores engineering students' perceptions of the use of GAI tools to support their learning, focusing on three dimensions: 1) perceived ease of use and usefulness, 2) personalization, interactivity, and confidence, and 3) perceived intelligence and intention to adopt. A descriptive quantitative design was employed, involving 66 BSc and MSc engineering students from a Portuguese university who responded to a 49-item survey. The survey was designed *ad hoc* by the authors, drawing on recent instruments developed to assess higher education students' perceptions of GAI use and adoption for learning (e.g., TAME-ChatGPT). Overall results show that students find GAI intuitive and beneficial for learning. However, they also recognize the importance of asking good questions and that these tools can dampen creativity and critical thinking. On the one hand, students are optimistic and inclined to adopt them; on the other hand, they voice ethical and reliability concerns (e.g., information credibility, over-reliance, plagiarism). These findings underscore the need for carefully designed, well-founded integration strategies that can both maximize the potential of GAI tools and minimize their pitfalls. Institutional guidelines, faculty professional development, and AI literacy training initiatives for students may play key roles in fostering the responsible and effective adoption of these tools in academic settings.

Keywords: generative artificial intelligence, engineering education, student perceptions, technology adoption

Acknowledgement: We thank the student participants whose time and insights made this study possible. We also acknowledge the use of OpenAI's ChatGPT-4.5 during manuscript revision to enhance clarity and precision.

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Educators' Adoption and Perceptions of Generative AI Tools in Higher Education.

Omiros Iatrellis[1], Ioanna Kosmopoulou[2], Nicholas Samaras[3] and Konstantinos Kokkinos[4]

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Abstract. Since the introduction of ChatGPT in late 2022, the role of artificial intelligence-driven chatbots in higher education has garnered widespread attention. However, the perspectives of faculty and academic staff regarding these tools remain insufficiently examined. This study explores how educators integrate and perceive generative AI in instructional activities, administrative processes, and student support services. A web-based survey incorporating both structured and open-ended questions was conducted among faculty members associated with a European university network. The findings indicate that nearly half of the participants have utilized AI-powered platforms, such as OpenAI's GPT models, for tasks like course planning, assessment grading, and student guidance. Many respondents acknowledged that AI enhances efficiency in routine academic operations, with two-thirds recognizing its role in optimizing administrative workflows. Furthermore, a significant proportion emphasized the need for institutional policies and targeted training programs to facilitate the responsible adoption of AI in academic environments. Nonetheless, the qualitative responses reflected diverse viewpoints, particularly regarding concerns related to data security, the reliability of AI-generated content, and its potential influence on the future landscape of teaching. These insights underscore both the advantages and challenges associated with incorporating large-scale AI chatbots into university settings.

Keywords: Generative AI, Educators' Attitudes, Large Language Models, Chatbot Integration

Acknowledgement: Supported by the INVEST project under the ERASMUS-EDU-2023-EUR-UNIV program (Project No.: 101124598, www.invest- alliance.eu). Special thanks to the other project partners.

PARALLEL SESSION IB

Empowering Engineers with Transferable Skills: From Self-Learning to Communication

July 16th: 11h00 – 12h00

Chair: *João Pêgo*

[3]

Transferable Skills: Modding *Magic Maze* into a Serious Game for Engineering Education Training.

Ana Pinto[1], Soraia Oliveira[2], Micael Sousa[3] and Carla Carvalho[4]

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Abstract. As engineering education evolves, the need to cultivate transferable skills like teamwork and communication has become as crucial as technical expertise. This study explores the potential of the modern board game *Magic Maze* as a game-based learning tool to develop transferable among engineering students, an approach rarely examined in this context. Conducted with 74 students at a Portuguese university, the study assessed the collaborative gameplay on key skills such as leadership, empathy, and attention while exploring gender-based differences in engagement and outcomes. Data from pre- and post-tests revealed that *Magic Maze* effectively enhanced essential transferable skills, with notable increases in motivation, energy, focus, empathy, and professional skills. Gender differences surfaced, with females reporting higher anxiety and focus, while males demonstrated more familiarity with serious games. Correlation analysis underscored the utility of board games for skill development and goal achievement, with qualitative insights capturing a blend of serious and playful elements. While *Magic Maze* offers a cost-effective and engaging way to foster transferable skills, the findings suggest that educators must be adept in facilitation techniques for optimal impact. This study highlights modern board games as powerful yet underutilized tools in engineering education, enriching the learning experience by combining collaboration with practical skill-building.

Keywords: Transferable skills, Engineering students, Board games, Magic Maze, Game-based learning approaches, Engineering Education

Acknowledgement: This work has been funded by national funds through Fundação para a Ciência e a Tecnologia (FCT), I.P., Project UIDB/05037/2020.

[4]

Curricula: A Case Study at a Portuguese University. Transferable Skills in Engineering

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Abstract. In an increasingly competitive labor market, transferable skills are becoming essential, particularly in engineering. Employers place growing importance on these skills, highlighting the need to assess current competency levels among engineering students. This study aims to examine the transferable skills of engineering students, explore potential gender differences, and translate, adapt, and validate the Generic Skills Perception Questionnaire – Competence Level (GSPQ-CL) for the Portuguese context. A cross-sectional study was conducted with 219 engineering students from a Portuguese University, who voluntarily answered the questionnaire. Descriptive statistics, T-test, and confirmatory factor analysis were used to analyze the data. Findings revealed key strengths and gaps in students' transferable skills, with some gender-based differences. The GSPQ-CL was successfully translated, adapted, and validated for use in Portugal, aligning theoretical guidelines. This innovative study in Portugal aligns with international literature, indicating a need for curricular (re)structuring in engineering programs to better foster transferable skills.

Keywords: transferable skills, undergraduate, engineering curriculum, competence

Acknowledgement: This work has been funded by national funds through Fundação para a Ciência e a Tecnologia (FCT), I.P., Project UIDB/05037/2020.

PARALLEL SESSION IB

[46]

Enhancing Self-Directed Learning Skills of Engineering Students through Project Work.

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Abstract. In response to the need for modern engineering education to reflect current pedagogical trends and the evolving requirements of the profession, this study investigates the efficacy of interdisciplinary team projects in cultivating self-directed learning skills among engineering students within a student-centred learning environment.

The article explores student-centred learning principles, emphasizing student autonomy and the development of essential competencies, including critical thinking, problem-solving, and adaptability. It also discusses self-directed learning, highlighting its importance for lifelong learning and its relationship to factors such as student motivation, self-regulation, and the learning environment.

This paper details the "Project Work Technology" course, a multi-semester interdisciplinary program strategically designed to augment the practical, application-oriented dimension of the educational program in Automation, Computer-Integrated Technologies and Robotics through the implementation of project-based learning methodologies. The course promotes teamwork, employs pedagogical strategies such as flipped and cooperative learning, and incorporates real-world projects to foster student engagement, including supporting them in managing their own learning process, and facilitates the practical application of knowledge and skills.

This study presents preliminary findings derived from student surveys that investigated student expectations for teamwork, preferred learning activities, and their perceptions regarding the factors influencing successful course completion. The survey results demonstrate student strong motivation to learn, a positive attitude towards task and time management, while they demonstrate a lack of practical tools and strategies to perform as self-directed learners.

The article concludes by acknowledging the preliminary nature of the findings presented and emphasizing the need for future research to analyze the long-term impact of the implemented approach on the development of specific SDL skills, such as critical thinking and problem-solving, among engineering students.

Keywords: Engineering Education, Self-Directed Learning, Team Projects, Project-Based Learning

PARALLEL SESSION IIA

Educating Engineers for the 21st Century: Leadership, Skills Taxonomies, and STEAM Integration

July 16th: 14h30 – 15h30

Chair: *Jan Van Maele*

[42]

Letta and Draghi push forward engineering schools to adapt to challenges for the future of Europe

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Abstract. A decade ago, Dr. Struth from Bosch said that Industry 4.0 needs an education offensive because companies are not yet able to fully tap into the potential of Industry 4.0. The skills required in the workforce for this industry are changing faster than traditional curricula can keep up due to the new technologies. The reports commissioned by the European Union to Letta and Draghi indicate that EU must invest in the industry and education. The WEF's prediction about jobs until the year 2030 indicates that there is a need for engineers trained for present and future needs, and their training must be in line with these needs. Also, the WEF in the 2023 edition echoed the PISA report for its effects on the economy, and these results have not been satisfactory to anyone. The training of the engineers is the responsibility of the engineering schools. The dropout in engineering schools in Catalonia is over 40\% in the first year, a problem that has not been solved and is persistent in subsequent years. The students who come to engineering schools are Generation Z and have generated the latest PISA, TIMMS, and ICILS reports. This paper explains internal and external causes that favor the abandonment of engineering studies. Some of the causes are linked to each other even if, a priori, they seem independent. Thus, technological knowledge within TPACK, computational thinking, and the teaching staff's resistance to changing teaching methodologies are related to each other, as are the double penalty in exams, and the persistent lack of cross-curricular knowledge transfer. The importance of the analysis of the results of the test carried out on 417 computer engineering students and 139 nautical students on basic knowledge of calculation tools and knowledge of programming languages, is that for the first time, these respondents had the choice to learn a programming language as an optional subject inside the baccalaureate, and the data obtained show the teaching methodology and the learning system. A brief historical review of how engineering schools were taught can help us see the effects of incorporating AI in both sides, professors, and students, and how schools must evolve.

Keywords: ChatGPT, TPACK, The Charm, Microworld, Computational thinking, Industry 4.0, PISA, WEF

Acknowledgement: We would like to acknowledge professors, Xavier Martorell (UPC-BSC, and UPC-FIB in AI), Xavier Verd´u (UPC-FIB in Data Science and Engineering, and AI), Toni Cort´es (UPCFIB in Informatics Engineering), Montse Vela (UPC-FNB), Josep M. Torrents (UPC-FNB), Joan-C Lario (UPC-FNB), and Marina Ciurans Oset (Lule˚a University of Technology).

PARALLEL SESSION IIA

[45]

Mapping ESCO Skills Taxonomy to Educational Offers Using Natural Language Processing and Large Language Models

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Abstract. The European Skills, Competences, Qualifications, and Occupations (ESCO) taxonomy serves as a standardized multilingual framework designed to categorize and describe skills, competences, qualifications, and occupations. Its primary purpose is to support professional mobility and foster a more integrated labor market across Europe by providing a common language for stakeholders in employment, education, and training. Despite its comprehensiveness, ESCO faces challenges in accurately mapping unstructured text, such as course descriptions or job postings, to its skill taxonomy due to the limitations of existing APIs and the complexity of natural language processing (NLP).

To address these challenges, this research proposes a computational system capable of inferring ESCO skills from textual data by leveraging advanced NLP techniques, sentence embeddings, HDBSCAN-based clustering, and Large Language Models (LLMs). The system evaluates similarity between input queries and ESCO skills using three approaches: (1) NLP only, (2) LLM-only recommendations via the official Deepseek API, and (3) a hybrid approach combining NLP and LLM outputs.

HDBSCAN-based clustering is applied to group similar skills into coherent clusters, improving interpretability while addressing the limitations of spherical clustering methods like K-Means. Deepseek-V3, a state-of-the-art LLM developed by DeepSeek AI, is integrated via the official API to refine and validate skill mappings. Preliminary results demonstrate the system's potential to automate skill inference with high accuracy, benefiting universities, students, and employers. User testing indicates that the hybrid approach consistently outperforms standalone methods, with participants rating its results as much more relevant. Notably, while the ESCO API performs comparably to the LLM-only approach for English inputs, it underperforms significantly for Portuguese inputs, highlighting the need for improved multilingual support. Challenges remain, particularly with ambiguous input texts and mappings involving non-English languages, such as Portuguese. Future work will focus on refining the system for multilingual support and addressing edge cases, such as mixed-domain skills.

Keywords: ESCO Taxonomy, Educational Offers, Skill Inference, Natural Language Processing, Large Language Models

Acknowledgement: This study was made possible through funding from the PRR - Recovery and Resilience Plan and the NextGenerationEU initiative at the University of Aveiro. The research was conducted under the scope of the Agenda for Business Innovation "NEXUS: Pacto de Inovação e Transição Verde e Digital para Transportes, Logística e Mobilidade" (Project no.53, Application C645112083-00000059).

The authors extend their heartfelt thanks to the professor from the University of Aveiro who generously participated in user testing. Their valuable feedback and insights were instrumental in refining the system and addressing key challenges.

[11]

STEBAM: Expanding STEAM Education with Biomedical Engineering.

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Abstract. The efficacy of STEAM interventions in reducing education inequalities and enhancing student outcomes has been recently highlighted, as they cultivate both technical and soft skills. However, the incorporation of the biomedical engineering thematic remains significantly uncharted. With this work, we contribute to bridge this gap by combining low-cost hardware with low-code biosignal data acquisition and processing. Didactic materials were also developed to be used during initiatives such as workshops for high school students. They include a DIY solderable electronic kit and two pedagogical experiments where students can interact with the kit's biomedical sensors in a fun and captivating way, namely by computing their heart-rate from a PPG sensor and controlling a dart-shooter using EMG signals. This work demonstrates that engaging, hands-on initiatives can effectively enhance students' understanding of biomedical concepts, and foster interest in STEAM fields among high school students.

Keywords: STEAM Education, Biomedical Engineering, Physiological signals, Data acquisition and processing, Feature extraction

Acknowledgement: This work was developed at Instituto Superior Técnico and in collaboration with Ciência Viva and the Scientist Team of IT- Instituto de Telecomunicações. The project was partially supported by FCT/MECI through national funds and when applicable co-funded EU funds under UID/50008: Instituto de Telecomunicações.

PARALLEL SESSION IIA

[47]

Empowering STEM Educators with Long-Term Forecasting Skills: Results from the FIT4FUTURE Project.

Fırat Sarsar[1], Özge Andiç Çakır[2], Bahadir Namdar[3], Manon van Leeuwen[4], Christoph Kunz[5], Patricia Wolf[6], Jonas Toftgaard[7] and Nuno Pombo[8]

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Abstract. The FIT4FUTURE project is an innovative initiative aimed at empowering STEM educators by enhancing their strategic long-term planning skills through the integration of Long-Term Future Scenarios (LTFS) into higher education curricula.

This study presents the results of the piloting phase of the FIT4FUTURE project, which was conducted across four European countries: Denmark, Germany, Portugal, and Türkiye. The pilot involved extensive collaboration with higher education institutions in these regions, where the training programme and platform were tested in real-world educational settings. Educators were provided with access to LTFS tools, methodologies, and creative approaches such as science fiction prototyping, flash fiction writing, and trend analysis, all aimed at promoting forward-thinking in STEM education.

The findings from the pilot reveal high levels of satisfaction among participants, with educators reporting significant improvements in their ability to incorporate long-term forecasting into their teaching practices. The programme was also found to have a positive impact on student engagement, with educators observing increased motivation, attention, and knowledge retention among their students. Additionally, the flexibility of the training programme allowed educators to tailor the content to their specific educational contexts, further enhancing its relevance and applicability.

Keywords: Futuristic Thinking, Long-Term Future Scenarios (LTFS), STEM Education

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PARALLEL SESSION IIB

Transforming Engineering Education: Pedagogical Innovation and Virtual Technologies

July 16th: 14h30 – 15h30

Chair: *Kathy Meyer-Ross*

[73]

Scholarship of Teaching and Learning in Undergraduate Courses in Engineering: 18 Years of Experience on Soil Mechanics.

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Abstract. The implementation of the Bologna Process in European universities triggered a paradigm shift in higher education. Traditional teaching and learning methods that rely solely on lecturing, in which instructors orally deliver course content with the aid of multimedia tools, tend to foster a passive approach among students, as they primarily assume the role of passive listeners. This type of attitude is not adequate to prepare students for the challenges that they will face during their professional life, where soft skills like communication capacities, ability to work effectively as part of a team, problem-solving, critical thinking, creativity, among others, are essential. Therefore, it is crucial to encourage the adoption of active learning strategies that enable the simultaneous development of technical skills associated with the different formal content in the study programmes and the enhancement of soft skills. During the last 18 years the authors have implemented strategies to promote active learning on undergraduate courses on Soil Mechanics (3rd year of Civil Engineering bachelor programmes). Since 2007/2008, when the first experience using project-based learning occurred, strategies such as guided exercises, immediate feedback, flipped learning, hands-on learning and team-based learning were used to enable a personalized experience to students. The successes and limitations identified have been addressed, by adjusting the teaching and learning models, and by adding new strategies. These strategies can be adapted to be implemented in other engineering courses. The authors are profoundly engaged in these transformations and vouch for their success in promoting deep learning and the development of sound technical and soft skills. The key for success is engaging students in the transformation process, becoming key actors in that process, rather than just players. All the approaches and strategies adopted by the authors in the past 18 years have resulted in a significant workload. However, the adoption of a scientific approach to the teaching and learning activities has also allowed the development of work in this scientific area of Engineering Education, by engaging in the scholarship of teaching and learning (SoTL).

Keywords: active learning, project-based learning, flipped-learning, hands-on learning, team-based learning, soil mechanics, scholarship of teaching and learning

Acknowledgement: This work was supported by: Pedagogical Innovation Projects, University of Aveiro; Foundation for Science and Technology (FCT) through Aveiro Research Centre for Risks and Sustainability in Construction (RISCO), Universidade de Aveiro, Portugal [FCT/UIDB/ECI/04450/2020] and through the project UIDB/04625/2025 of the research unit CERIS.

[15]

Pedagogical Outcomes of the Transnational Pilot Training BUILD2050

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Abstract. This paper presents the pedagogical outcomes of BUILD2050, a transnational pilot training composed of eight training courses addressing building decarbonization.

Challenges in defining and implementing active learning in cooperation with five different academic institutions are discussed. Also, the students' performance and perceptions over the training courses, as well as the teachers' feedback on the application of active learning techniques are presented.

Keywords: transnational training, engineering education, interdisciplinary knowledge

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PARALLEL SESSION IIB

[36]

Fostering Transversal Skills: A Pedagogical Experience in Higher Educational Programs of Technology

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Abstract. The short-cycle higher educational programs called CTeSP, with a strong practical and technological focus, designed to meet labour market demands, were introduced in Portugal by 2014. This paper explores the challenges faced both by the Smart Grids and Domotics CTeSP and by the Electric Vehicles CTeSP taught at Instituto Politécnico de Setúbal. The reorganization strategy applied, tailored to the characteristics of Generation Z, who prefer dynamic and engaging learning approaches, is presented. This strategy consisted of restructuring the organizational and pedagogical framework of the programs to motivate students and address the high dropout and failure rates of these CTeSP by incorporating active methodologies while fostering transversal skills like focus, adaptability, and critical thinking. These skills are essential for employability, contributing to improve the students' academic performance. The results achieved by the implementation of this pedagogical experience are also presented and analyzed.

Keywords: learning strategies, soft skills development, Gen Z

Acknowledgement: This paper is financed by the Research Center in Mathematics and Applications (CIMA).

PARALLEL SESSION IIB

[61]

Creating digital literacy competences based on virtual technologies

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Abstract. Virtual technologies part of Industry 4.0 like virtual, augmented and mixed reality can be part of the curriculum not only to contribute to the implementation of industry 4.0 but also integrated as a teaching and learning medium. In the process of integrating those technologies into engineering education, it was necessary to develop a digital pedagogy. That development also highlighted the need to identify digital skills and competences in educators and learners. Digital literacy competences must, in some cases be created when existing competences are not easily transferable. The integration of Extended Reality (VR/AR/MR) and virtual commissioning into an engineering program leads to propose a roadmap for integration of technologies in teaching focusing on creating digital literacy competences.

Keywords: Digital Pedagogy, Digital Strategy, Digital Literacy, Extended Reality

Acknowledgement: The authors would like to thank the lecturers and students who participated in the study. The authors thank the City of Vienna MA23 for funding of the project.

PARALLEL SESSION IIIA

Human-Centered Engineering Education: Inclusion, Emotion, Reflection and Sustainability

July 17th: 9h30 – 10h30

Chair: *Vitor Viegas*

[60]

Gender biases in AI: building inclusive future in engineering education.

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Abstract. This paper explores gender bias in artificial intelligence (AI) and how AI systems may preserve or intensify existing societal gender biases. A literature review is conducted, in order to identify sources of bias, and two research questions were defined: a research question addressing impacts of gender bias in AI; and the role of engineering education in mitigating such bias during AI development. From the findings four themes emerged: Gender Bias, Inclusiveness, and AI Policy; Workplace Assessment, Decision-Making, and Social Impacts of AI Bias; Ethical Considerations and Strategies for AI Bias Mitigation; and, Algorithmic Fairness and Technical Debiasing Approaches. The study showed that existing literature regarding the engineering students training for gender bias mitigation in AI is in early consolidation stages. Based on literature review the authors present some proposals to mitigate gender bias in engineering education.

Keywords: gender bias, artificial intelligence, engineering education, STEM education, mitigation

PARALLEL SESSION IIIA

[67]

Grand challenges and a (brief) why, what and how to 'embrace' emotions in engineering education.

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Abstract. Recognizing the pivotal role of emotions in learning is essential for fostering students' professional competences and overall well-being. This conceptual paper advocates for socio-emotional responsive education as a fundamental component in engineering education. Drawing on existing literature, the paper explores the importance of addressing emotions to tackle three major engineering challenges, the transformative potential of emotional responsive pedagogies, and practical strategies for implementing these approaches in engineering curricula with PBL and CBL. The paper concludes with an overview of two ongoing projects that aim to introduce new perspectives in sustainable engineering education, emphasizing empathy and emotions as key to education for sustainable development.

Keywords: Grand societal and professional challenges, Social and Emotional Learning, Problem Based Learning (PBL), Challenge Based Learning (CBL), Engineering Education, Emotions

PARALLEL SESSION IIIA

[35]

Reflective Diary as a Tool for Enhancing Young Researcher Autonomy.

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Abstract. In the changing educational and research environment, developing independent research competencies among young researchers in STEAM – science, technology, engineering, the arts and mathematics – is crucial at the level of PhD students, masters, and early postdoctoral. The tool offered to achieve this goal is the Reflective Diary, which will complement the existing Research and Professional Development Planning policies and enable participants to structure and reflect on their research activities more effectively. The Reflective Diary promotes the development of self-assessment, critical thinking, planning skills, and independent project management. It will also help develop a research plan, document resources and means of achievement, and divide activities into key stages. Keeping the Reflective Diary is organized in such a way that young researchers can record their achievements, difficulties, problem-solving, and ``insight moments" and receive feedback from academic supervisors. Such a structure contributes to the active involvement in self-analysis and the development of responsibility for their own progress and encourages individual scientific discoveries. The proposed tool will stimulate lifelong learning, allowing participants to realize the importance of an interdisciplinary approach, critically evaluate selected research practices, and plan further stages of work. Ultimately, this tool will create an environment where young researchers not only work toward completing their projects but also develop the reflective and knowledge management skills necessary for long-term careers in the STEAM fields.

Keywords: reflective diary, research planning, engineering education, analysis of achievements, self-assessment, professional development, research autonomy, reflective journal

PARALLEL SESSION IIIA

[70]

Enhancing Sustainability Education through Life Cycle Assessment.

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Abstract. Given the pressing environmental challenges we face today, integrating sustainability concepts into higher education programs is essential for cultivating environmentally conscious attitudes. This article explores how Life Cycle Assessment (LCA) can be effectively incorporated into Chemical engineering courses, exemplified by a case study on acetaldehyde production via ethanol dehydrogenation using OpenLCA software for different scenarios. These scenarios included (I) the normal process, (II) energy recovery, (III) ethanol recycling, and (IV) combined ethanol recycling and energy recovery. Aspen Plus was used to model the synthesis process, while OpenLCA assessed environmental impacts, focusing on climate change, ozone formation, resource use, and human health effects.This research highlights the importance of teaching these methodologies to master's students of chemical engineering to foster environmentally responsible engineers for a sustainable future.

Keywords: life cycle analysis, AspenPlus, OpenLCA, environmental impacts, higher education

Acknowledgement: The authors of this work are grateful for the Fundação para a Ciência e a Tecnologia, I.P/; MCTES through national funds PIDDAC - CQE UIDB/ 00100/2020 and UIDP/00100/2020 (DOI 10.54499/UIDP/00100/2020). And IMS the Associated Laboratory funded by Project LA/P/0056/2020 (DOI 10.54499 /LA/P/0056/2020). We are also grateful for the Fundação para a Ciência e a Tecnologia PhD grant PRT/BD/154409/2023, under which this work was developed.

PARALLEL SESSION IIIB

Learning by Doing: Active Pedagogies in Chemistry and Biotechnology

July 17th: 9h30 – 10h30

Chair: *Susana Piçarra*

[59]

Experiential Learning in Chemistry Education: The Case of REDOX Reactions

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Abstract. This study investigates the impact of gamification and experiential learning on chemistry education, specifically in teaching chemical kinetics and oxidation-reduction (REDOX) reactions to engineering students. The primary objective is to assess whether these methodologies enhance conceptual understanding and student engagement compared to traditional teaching approaches. The research involved 48 first-year engineering students, divided into two groups of 24. A gamified learning experience was designed, where students built and competed with electrochemical mini-cars powered by a clock reaction functioning as an ON/OFF system. Pre- and post-assessments were conducted to evaluate improvements in conceptual comprehension, while engagement was measured using a structured rubric addressing teamwork, problem-solving, and active participation. The findings indicate a 22% improvement in students' understanding of reaction rate calculations and the relationship between chemistry and electrochemical applications. Additionally, students demonstrated enhanced problem-solving skills in the STEM (Science, Technology, Engineering, and Mathematics) area and collaborative competencies, reinforcing the effectiveness of gamification and experiential learning.

These results underscore the potential of integrating interactive and competitive methodologies to provide more meaningful learning by bridging theoretical concepts with hands-on applications, preparing students for interdisciplinary challenges in engineering and applied sciences.

Keywords: Educational innovation, Professional education, Gamification, Experiential learning, Chemical kinetics, REDOX reactions.

Acknowledgement: The authors would like to thank the Writing Lab, Institute for the Future of Education, Tecnológico de Monterrey, Mexico, for the financial and technical support they received in producing this work.

PARALLEL SESSION IIIB

[65]

Unlocking Knowledge Through Competition: Trivia for Functional Groups and Nomenclature in Organic Chemistry

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Abstract. Gamification has emerged as an innovative pedagogical strategy that enhances engagement and learning outcomes by integrating game elements into educational contexts. In organic chemistry education, where students often struggle with functional groups and systematic nomenclature, gamification offers a promising approach to reinforcing conceptual understanding. This study examines the effectiveness of the "Nomenclature Naming Game", a trivia-based competition designed to improve students' proficiency in recognizing functional groups and applying nomenclature rules. Participants, second-year undergraduate engineering students, first attended a traditional lecture on the subject, followed by the trivia competition, where teams competed to answer nomenclature-related questions. To incentivize participation, teams earned extra points toward their final course grades based on correct responses, fostering a competitive yet collaborative learning environment. Pre- and post-activity evaluations were conducted to assess the impact of this approach. Results revealed a 15.2% improvement in students' understanding of functional groups and nomenclature, demonstrating the game's effectiveness in enhancing content retention and application. Moreover, students reported increased motivation, engagement, and teamwork skills, highlighting the trivia format's role in developing critical thinking and problem-solving competencies. These findings underscore the potential scalability of gamified learning in chemistry education. By making abstract concepts more accessible and engaging, this approach provides a replicable model for integrating gamification in STEM (Science, Technology, Engineering, and Mathematics) disciplines, encouraging a more interactive and effective learning experience.

Keywords: Educational innovation, Professional education, Organic chemistry nomenclature, Experiential learning.

Acknowledgement: The authors would like to thank the financial and technical support of Writing Lab, Institute for the Future of Education, Tecnológico de Monterrey, Mexico, in the production of this work.

PARALLEL SESSION IIIB

[71]

Advancing Biotechnology Education with Active Learning and Sustainability

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Abstract. This study explores the application of active learning methodologies in the Biotechnology curriculum at Escola Superior de Tecnologia do Barreiro, with a particular emphasis on the valorization of winery effluents. The study was conducted over two academic years (2023–2024 and 2024–2025), with students engaged in collaborative data sharing through Microsoft Teams and the implementation of the Jigsaw strategy to foster teamwork, communication, and critical thinking. The factorial design (FD) method was employed in the first year to analyze the effects of nutrient supplementation, whereas, in the second year, students worked with the most promising conditions identified. Results from informal surveys indicated that students valued these methodologies, recognizing their effectiveness in enhancing both technical skills and collaborative abilities. The integration of real-world applications related to sustainability and carbon capture using microorganisms strongly resonated with students, reinforcing the practical relevance of the work and its connection to future career opportunities. However, challenges associated with group dynamics and student engagement were identified, highlighting the need for effective collaboration management within active learning settings. This study underscores the importance of incorporating sustainability principles and collaborative approaches in higher education to address contemporary challenges.

Keywords: Active Learning, Biotechnology Education, Collaborative Learning, Jigsaw, Sustainable Practices

Acknowledgement: The authors would like to express their sincere gratitude to all the Biotechnology students who attended the Laboratórios VB curricular unit in the years 2023-2024 and 2024-2025. We deeply appreciate your openness to participating in these methodologies, your responsibility in data collection and sharing, and the valuable feedback you provided.

PARALLEL SESSION IIIB

[72]

Flipped classroom design of a chemistry subject in a new engineering degree.

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Abstract. For the past 7 years, the Universitat Politècnica de Catalunya (UPC) has been offering a Bachelor's Degree in Industrial Technologies and Economic Analysis, entirely taught in English. One of its subjects is Chemistry. This subject was designed around the process of student learning, following the results of the last meeting of the European Higher Education Area in Rome (November 2020). The goal of the design was to comply with the regulatory requirements and incorporate the learning outcomes that were already defined in other engineering areas, as well as to facilitate the learning of students who had not taken chemistry in high school (between 20 and 40% of the total). The flipped classroom methodology was used to this end. In this regard, different materials such as videos with embedded questions and tests were created to promote the students' self-learning. In addition, tuition in new skills was provided, like cooperative work methodologies or criteria to prepare successful summaries. Every week, the students have to complete online homework (10% of the subject's grade), committing themselves to continuous work. This method has been put into practice during several academic courses (including one in semi-confinement). After each course, the students have to assess both the methodology and the material. Comments on improvement opportunities have been gathered and implemented in the subject. In all cases, they have highlighted the fact that continuous work and immediate feedback are two of the aspects that have helped them the most in their learning process. This paper presents the result on the evolution in a non-conventional field, such as industrial engineering.

Keywords: flipped classroom, continuous assessment, leadership, self-study, chemistry

Acknowledgement: To all the students who have made this experience possible.

PARALLEL SESSION IVA

Transforming Engineering Education: From Narrative Learning to Digital Immersion

July 17th: 11h00 – 12h00

Chair: *Inês Direito*

[31]

Innovative teaching and learning methods in engineering education: Presentation and Moderation Skills for Civil Engineers

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Abstract. The Moderation and Presentation Skills module addresses the critical need for civil engineers to develop strong presentation and moderation skills alongside their technical expertise. These competencies enable engineers to communicate complex ideas effectively, facilitate collaboration among diverse stakeholders, and lead solution-oriented discussions in infrastructure projects. The module also emphasizes the integration of social responsibility into higher education, preparing students to address societal challenges such as climate change, urbanization, and sustainable resource management with accountability and equity. Through a combination of theoretical instruction, group activities, and a realistic political simulation, students enhance their reflection, discussion, and negotiation skills. Evaluation results highlight significant improvements in students' confidence, critical thinking, and ability to balance competing interests in professional scenarios. This innovative educational approach bridges technical knowledge with essential soft skills, equipping students for leadership roles in academia, industry, and society. The module serves as a transformative model for fostering both professional and ethical competencies in higher education.

Keywords: Civil Engineering Education, Social Responsibility, Ethical Awareness, Communication, Leadership Skills

Acknowledgement: We would like to express our heartfelt gratitude to the students who actively contributed to the development of the simulation and its evaluations. Your dedication, creativity, and critical insights have been invaluable in shaping this project. By investing your time and expertise, you have enriched the outcomes and demonstrated the profound impact of collaborative effort. Your contributions have not only advanced the simulation but also provided essential feedback that will guide its future iterations. Thank you for your commitment and hard work; your efforts are deeply appreciated.

PARALLEL SESSION IVA

[32]

Implementation of learning strategies: Prosumage in Civil Engineering

Andreas Franze[1] *and Kathy Meyer-Ross*[2]

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Abstract. The Prosumage Approach redefines higher education by transforming students into active contributors who create and sustain educational resources while completing their academic theses. By integrating Bloom's Taxonomy and Biggs' Constructive Alignment, this innovative framework aligns learning objectives, teaching methods, and assessments. Students utilize the OPAL platform to design self-study courses and modules, combining theoretical knowledge with practical application. Bachelor's students develop individual course units, while Master's students create comprehensive modules, fostering collaboration across cohorts. Feedback indicates high levels of engagement and satisfaction, with students valuing the meaningful, lasting impact of their work. By promoting sustainability, collaboration, and reflective learning, the Prosumage Approach enriches the academic experience and establishes a dynamic, reusable repository of educational content.

Keywords: Prosumage Approach, Higher Education Pyramid, OPAL, Educational Content Creation, Sustainability in Education, Collaborative Learning, Bloom's Taxonomy, Constructive Alignment

Acknowledgement: We extend our heartfelt gratitude to the students who have actively contributed to the development and implementation of the Prosumage Approach.

Special thanks go to the Bachelor's and Master's students who, through their hard work, have not only created engaging and innovative educational resources but also deepened their academic understanding by reflecting on their processes through their theses. Your contributions have not only enriched the learning experience for your peers but also established a foundation of sustainability in education by ensuring these resources remain accessible to future cohorts.

[18]

Integrating Digital Immersive Technologies to Improve Engineering Teaching and Learning for Sustainability Goals

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Abstract. The integration of virtual reality (VR) in higher education offers transformative potential in wide technological fields, especially in achieving the sustainable development goals (SDGs), notably Goal 7 and Goal 9, which represent clean and cost-effective energy, industry, innovation, and infrastructure, respectively. This paper explores the role of VR in advancing these goals through immersive learning experiences that promote sustainable practices and innovative solutions in engineering education. By looking at and examining the cognitive-affective model of immersive learning and the challenge-based learning approach, the study highlights the effectiveness of VR in enhancing student engagement, understanding, and retention of complex technical subjects. The methodology involves designing and implementing VR-based training sessions for undergraduate engineering students, followed by an analysis of the outcomes through qualitative and quantitative assessments. The findings suggest that VR can significantly contribute to sustainable development by fostering a deeper understanding of clean energy technologies and innovative industrial practices as used by future engineers.

This paper will investigate the IEEE standard for digital intelligence (DQ) as outlined in the IEEE's DQ Framework. This framework encompasses eight fundamental elements of digital existence, ranging from personal and social identities to technology usage, including tools and media items. Online collaboration and communication for work and leisure contexts, basic operational and technical skills needed for daily digital activities and job opportunities, possible safety and security concerns with technology, emotional and relational aspects, and human rights in the digital age are also covered [1]. The results show that students can benefit from these experiences and be better prepared for various potential career fields.

Keywords: New technologies in Eng education, Emerging and future areas of Eng education, Immersive Technologies

Acknowledgement: This work is associated with the Strategic Alignment of Teaching and Learning Enhancement (SATLE) Fund 2024, provided through the National Forum for the Enhancement of Teaching and Learning. The author acknowledges the support of the members of the Teaching and Learning Centre (SETU-Carlow) who coordinated this fund at a local level.

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PARALLEL SESSION IVA

[64]

Integrating narrative learning and AI for collaborative problem solving in engineering education

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Abstract. The ANECAI methodology (Narrative Learning and Collaborative AI-Assisted Assessment) integrates narrative-based instruction, cognitive scaffolding, and artificial intelligence (AI) tools to enhance learning outcomes in higher education. Grounded in problem-based learning, Bloom's taxonomy, and self-regulated learning theory, ANECAI unfolds in several phases: an initial phase of real-life contextualization, followed by theoretical development through storytelling, then scaffolded questioning, an AI-assisted synthesis phase, and finally, a collaborative peer assessment. Applied in the courses "Chemical Experimentation and Fundamental Statistical Thinking" and "Chemical Experimentation and Intermediate Statistical Thinking", this study employs a mixed-methods approach to assess its impact on engineering and chemistry students. Results indicate that students exposed to ANECAI achieved a 15% improvement in conceptual retention, with 94.1% reporting high levels of engagement and learning satisfaction, compared to 75% and 83.3%, respectively, in the traditional learning group. Additionally, students using ANECAI showed an 88.2% increase in self-regulated learning strategies, reinforcing its effectiveness in fostering autonomy and critical thinking. However, findings also highlight the need for additional instructional strategies to encourage deeper academic exploration and the use of complementary learning resources. These results underscore the potential of AI-driven pedagogical models in STEM education, fostering a more immersive and student-centered learning experience.

Keywords: Educational Innovation, Professional Education, Statistical, Chemistry, Educative Storytelling

Acknowledgement: The authors would like to thank the financial and technical support of Writing Lab, Institute for the Future of Education, Tecnológico de Monterrey, Mexico, in the production of this work.

PARALLEL SESSION IVB

Innovating Mathematics, Adaptive and Intelligent Approaches in Engineering Education

July 17th: 11h00 – 12h00

Chair: *Ana Freitas*

[10]

Exploring the Experiences of First-Year Engineering and IT Students with the LIM Digital Mathematical Card Game

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Abstract. Card games, especially educational card games, have been effectively utilized for decades to support mathematics teaching. The Institute of Mathematics at the University of Miskolc began developing didactic card games for game-based learning workshops in 2018. The LimStorm deck is designed to adapt to the globally known rules of the UNO and SOLO card games. LimStorm focuses on practicing the limits of sequences of real numbers and learning about notable limits. Using a non-digital version of the LimStorm game, gameplay sessions with students commenced in 2020. For four academic years, only the non-digital version was employed in workshops. In response to the increasing demand for digital adaptations, the online version, dubbed LIM, was developed in the spring of 2024. The first live testing with 88 engineering and IT students during the autumn semester of the 2024/2025 academic year was provided. Our quantitative study used a Likert-scale questionnaire to collect data on the impact of the LIM didactic game. Questionnaire results indicate significant cognitive benefits, as well as enhanced emotional and motivational engagement fostered by game-based learning. The findings of this study advocate for the integration of game-based learning strategies within mathematics education, as these approaches not only promote cognitive understanding but also foster a positive emotional connection to the subject. The data collected by the software during the LIM game complement the questionnaire results, thus enriching the analysis.

Keywords: game-based learning, digital games, card games, engineering mathematics, limits of sequences

[28]

Adaptive learning in a calculus course for engineering students

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Abstract. The recent increase in applications exploiting artificial intelligence has provided a wide range of new possibilities in most aspects of human life. Within the educational field, one of the goals that seems plausible nowadays is providing students with a personalized learning experience by creating algorithms that tailor themselves to meet individual needs. This approach is called adaptive learning, and it provides several advantages for learners, such as learning-time optimization, knowledge and skills reinforcement, and delivery of up-to-date content. On their end, the teacher gets detailed analytics about the progress, struggles, and achievements of students, which allows for specific reinforcement and reshaping of lesson plans. In this paper, the learning experience from an adaptive learning implementation of a first-year Calculus course for engineering students is analyzed based on quantitative and qualitative results. The former is performed by contrasting the outcome of traditional written evaluations and overall grades for the course, while the latter uses a sentiment analysis obtained from student's comments. The comparison takes place between groups that used the adaptive platform Realizeit® and control groups with a traditional teaching methodology.

Keywords: Educational Innovation, Higher Education, Adaptive Learning, Sentiment Analysis, Implementation of learning strategies

Acknowledgement: The authors would like to acknowledge the financial and the technical support of Writing Lab, Institute for the Future of the Education, Tecnologico de Monterrey, Mexico, in the production of this work.

[50]

Revealing and Addressing Semantic Discontinuities in Engineering Mathematics Education

Matheus de Andrade[1], *Jan Van Maele*[2], *Ashley Clayton*[3] *and Ruth Reynolds*[4]

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Abstract. Mathematics is a pillar of engineering, yet students often struggle to bridge the gap between mathematical concepts and engineering applications. This paper explores this issue through the concept of *semantic discontinuities* and how they can affect the teaching and learning of engineering mathematics. We use the Semantics Domain of Legitimation Code Theory to describe how differences in context-dependence and complexity can create obstacles for students in applying mathematics to engineering problems. As an illustrative case, we examine a well-known mathematical joke about topology. This analysis is extended through two simulated explanatory artefacts, designed to model how a mathematician and an engineer might explain the same concept differently. By mapping these artefacts onto the Semantic Plane, we exemplify distinct organisations of mathematical meaning through textual explanations. We discuss implications for curriculum design, instructional strategies, and interdisciplinary collaboration. This work-in-progress offers practical insights for educators interested in analysing pedagogical resources from a semantic lens.

Keywords: engineering mathematics, conceptual understanding, legitimation code theory, interdisciplinary education

[40]

A Holistic Approach to Academic Advising through Fuzzy Logic, Semantic Web Technologies, and Expert Reasoning in Engineering Education

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Abstract. Higher Education Institutions (HEIs) face increasing demands for efficient, scalable, and personalized academic advising solutions. Traditional advising methods, often resource-intensive and inconsistent, struggle to accommodate diverse student needs. This paper introduces EDUC8EU, a knowledge-driven AI-powered academic advising system, leveraging a fuzzy expert system to provide adaptive and context-aware recommendations. The system integrates expert systems, fuzzy logic, and semantic web technologies to provide dynamic, personalized recommendations that align with students' academic interests, skill sets, and career aspirations. By leveraging external validated sources such as ESCO and O*NET, EDUC8EU performs real-time analysis to ensure alignment between academic pathways and industry requirements. Built on a modular, scalable architecture, EDUC8EU enables continuous adaptation through a self-evolving feedback loop, dynamically refining recommendations based on user interactions and emerging labor market trends. The system is grounded in well-established educational principles, incorporating methodologies that emphasize career alignment, personality-based reasoning, and self-exploration. An empirical evaluation within an engineering education setting demonstrated high levels of student satisfaction, increased decision-making confidence, and enhanced career alignment. This research contributes to the growing field of AI-powered academic advising, demonstrating its potential to support students in making well-informed, career-aligned decisions.

Keywords: Academic advising, Expert systems, Semantic Web, Engineering Education, Intelligent Components, Fuzzy Logic

Acknowledgement: Supported by the INVEST project under the ERASMUS-EDU-2023-EUR-UNIV program (Project No.: 101124598, www.invest- alliance.eu). Special thanks to the other project partners.

PARALLEL SESSION VA

Innovative Lab-Based Learning in Engineering: Structures, Machines, and Design

July 18th: 9h00 – 10h00

Chair: *Margarida Pinho-Lopes*

[19]

Learning Static Equilibrium Using a Small Structure

Alejandro Guajardo-Cuéllar[1], *Armando Roman-Flores*[2] *and Salvador Romo-Torres*[3]

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Abstract. Statics is a fundamental basic course relevant in various engineering programs. Teaching the calculation of static equilibrium and the involved concepts of a structure, frame, or machine is a challenge for instructors teaching the course. The main challenge for the teacher is to apply the learning contents in a real case that the student can validate with measurements of the calculations. This work presents an intervention in a statics course using a method that employs a scaled real structure designed and built by the students. The goal of this project is to provide students a tool to visualize, measure, and understand abstract concepts such as reaction forces and couple through a tangible structure. The proposed intervention is flexible, as the prototype can be built with simple, low-cost materials. Its construction and assembly do not require complex manufacturing processes or assembly operations, and the dimensions of the prototype are easy to handle manually. The students calculate the reaction forces and moments acting on this structure in static equilibrium and validate their calculations through experimental measurements on the prototype. The students develop the measurement method by identifying measuring points and characterization of the measurement instrument. This experiential tool can assist in understanding fundamental concepts studied during the course. The students' motivation is measured using the Intrinsic Motivation Inventory, a validated survey finding overall a positive perception. The findings reveal that throughout the intervention, students remain interested, motivated, and involved, even while acknowledging the difficulty of the task. The presented methodology allows the development of the competencies declared in the course related to the analysis and modeling of systems in equilibrium. The intervention also enables the lecturer to observe the development of the declared competences during the design, analysis and construction of the prototype, and to assess it through a final deliverable, which includes both the prototype and the accompanying analysis. The intervention tackles the difficulty of offering a hands-on activity that enables students to grasp and apply essential and theoretical concepts in statics.

Keywords: Statics, Competence Development, Educational Innovation, Higher Education

Acknowledgement: The authors would like to acknowledge the financial support of Writing Lab, Institute for the Future of Education, Tecnologico de Monterrey, Mexico, in the production of this work.

PARALLEL SESSION VA

[33]

Enhancing Learning Through Activities: Student Perceptions in Design of Experiments

Isabel M. João[1] and João M. Silva

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Abstract. Understanding students' perceptions of Design of Experiments (DOE) methods offers insights into their engagement and active learning can enhance participation and information retention. These perceptions reveal the effectiveness of active learning techniques and highlight areas needing improvement. Instructors can better adapt teaching methods to suit diverse student needs and learning styles. This research evaluates students' engagement and perceptions of active learning in a DOE project within the Advanced Techniques for Quality course of the Quality and Environmental Engineering Master Course. It explores students' views on the effectiveness of active learning in the DOE project, challenges faced by students with active learning, the impact of feedback from peers and instructors on project improvement, and satisfaction levels with the active learning DOE project. The findings help to understand active learning effectiveness, student challenges, feedback relevance, and satisfaction. The research is an opportunity to learn, reflect, and improve teaching efforts and project outcomes.

Keywords: Active Learning, Design of Experiments, Student Perceptions, Satisfaction

PARALLEL SESSION VA

[51]

Experimental Model of a Switched Reluctance Machine for Engineering Education

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Abstract. This paper presents a physical didactic model of a switched reluctance machine that allows students to modify the number of poles in the rotor and stator. This hands-on approach improves understanding of magnetization, torque behavior, control, and power circuits. Built with simple ferrous materials for low cost and accessibility, the model integrates experimental and active learning techniques. The benefits for learning and its integration with simulation tools for analyzing magnetic fields are also discussed.

Keywords: Machine models, Simulation, Engineering teaching

Acknowledgement: This paper is financed by Sociedade Portuguesa para a Educação em Engenharia (SPEE).

PARALLEL SESSION VA

[53]

Upgrading the Naval Architecture Laboratory at the Portuguese Naval Academy

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Abstract. The article describes the modernization of a laboratory to teach Naval Architecture classes at the Portuguese Naval Academy. The laboratory consists of a towing water tank where tests are conducted to study the hydrodynamics of ship hulls built to scale. The paper focuses on the instrumentation and automation of the tank, from the design phase to the validation phase, including the practical implementation. Experimental evidence is presented showing that the proposed solution works and is an asset for students and researchers. This work offers valuable guidance for those planning to construct a new tank or upgrade an existing one.

Keywords: naval architecture, hydrodynamics, laboratory, teaching, instrumentation, automation

PARALLEL SESSION VB

Engineering Assessment: From Practice-Based Evaluation to AI-Enhanced Tutoring

July 18th: 9h00 – 10h00

Chair: *Anabela Alves*

[39]

An Evaluation System (Assessment Center) for disciplinary and transversal competencies of engineers in scenarios linked to the professional practice

Elena Gabriela Cabral Velázquez[1], *Luis Alberto Mejía-Manzano*[2] *and Alondra Yuliana Ramírez-Suaste*[3]

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Abstract. Any change in the educational sector under the context of competencies-based education requires a consistent evaluation process that contributes to the solid and comprehensive development of competencies in higher education students, accentuating their constant updating, which undoubtedly leads to the competencies redefinition and curriculum development process. Thus, the evaluation in a validated process is of great relevance for confirming the knowledge, skills and values acquired and developed by the undergraduate students at the end of their study programs. The present work integrates an implemented methodology in undergraduate students through unconventional experiential environments focusing on the measurement and ensuring of the development degree of disciplinary and transversal competencies before undergraduates´ graduation. The Assessment Center (AC) was established in the context of the methodologies Challenge-Based Learning (CBL) paradigm and case method technique for solving real problems. The guidelines were established under a collaborative environment connected to work real situations, promoting the participation and the interaction through reflection, critical analysis, group discussion, and decision-making. This initiative allowed the students to apply theoretical knowledge in practical situations. A survey was designed and applied to the performance observation and analysis process with input from academics, employers, consultants, and human resources experts. The deployment of this exercise was carried out at the end of the Chemical Engineering (CE) curricula at Tecnologico de Monterrey during the fall semester in 2020. Under this evaluation system, the students located their level of competence development, a comparative of his/her individual performance with the team and cohort performance, opportunity areas and complete feedback through a report. The present work establishes the basis for a curriculum evaluation, future improvement, and update using an integral evaluation exercise linked to the professional practice in an engineering program.

Keywords: Higher education, Curriculum development, Disciplinary and transversal competencies, System evaluation, Assessment center, Challenge-based learning

Acknowledgement: The authors would like to acknowledge the technical support of Writing Lab, TecLabs, Tecnologico de Monterrey

[58]

Beyond Assessment: Measuring and Developing Graduate Attributes for the Engineering Technologist in Higher Education

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Abstract. The evolving landscape of engineering practice necessitates robust frameworks that define, measure, and foster professional competence holistically. While the International Engineering Alliance (IEA) Graduate Attributes and Professional Competencies (GAPC) framework sets a global standard for engineering qualification outcomes, challenges persist in assessing these attributes holistically. Competence extends beyond discrete skills and requires integrated, context-sensitive evaluation. This paper explores a competence measurement strategy by aligning the IEA GAPC framework with the Competence Measurement (COMET) model, a three-dimensional framework originally developed in vocational education. The IEA GAPC framework (2021) reflects contemporary imperatives, including sustainable development, diversity, ethics, and emerging technologies. It establishes individually assessable graduate attributes that indicate potential for professional practice. However, true competence encompasses the ability to perform professional activities to the expected standards in independent practice, requiring a more holistic approach. The COMET model, rooted in educational psychology, enables structured, multi-dimensional assessment of professional competence. By integrating the COMET model with the IEA framework, this study proposes an enhanced evaluation approach that captures the interconnected nature of engineering competencies. This integration facilitates a more nuanced understanding of competence development in engineering education, ensuring assessments reflect real-world professional performance. By bridging the IEA GAPC framework with the COMET model, this paper presents a novel approach to measuring and fostering engineering competence in higher education. This synthesis offers an improved strategy for evaluating engineering graduates, ensuring their readiness for professional practice in a rapidly evolving field. This paper is therefore presented as a conceptual approach to engage in its relevance before a formal pilot project is implemented.

Keywords: Engineering Competence, Graduate Attributes, Competence Assessment, IEA GAPC Framework, COMET Model

[68]

Application of the Software Sparkplus to assess group work in Laboratory Classes: An Overview and Perspectives

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Abstract. This work is included in a research line started in 2018, using the Software SparkPlus, focused on Biotechnology students (Laboratory Classes) of Escola Superior de Tecnologia do Barreiro. In this work, it was possible to make a detailed study of the working in group perception of students in the academic years 2023/2024 and 2024/2025 and their results were compared with their colleagues of Bioinformatics during the same period. The answer rate to the survey observed in the Bioinformatics course was significantly lower than the one observed for Biotechnology. In what concerns RPF (Relative Performance Factor) and SA/PA (Self-Assessment/Peer Assessment) factors, as expected, many of the students presented "Good and Fair contributions" to the group work. The methodology hereby presented can be a useful tool to identify "atypical students" which present RPF and SA/PA outside the limits defined as "Good and Fair contribution" and need further attention from the teacher. Finally, an attempt to use RPF factor to adjust the final assessment of students was applied to the Bioinformatics Students (Molecular Spectroscopy Curricular Unit- Laboratory Work component).

Keywords: Teamwork, Collaborative skills, Laboratory Classes, Sparkplus.

Acknowledgement: The authors acknowledge Professor Bill Willams and Professor Pedro Neto for bringing SparkPlus to Escola Superior de Tecnologia do Barreiro, Instituto Politécnico de Setúbal

[69]

AI in Measurement-Based Learning: A Challenge for Assessment, an Opportunity for Tutoring

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Abstract. The rapid advancement of artificial intelligence (AI) has introduced significant challenges to traditional assessment methods in engineering education. While AI-powered tools, such as ChatGPT, can enhance learning by assisting with data analysis and problem-solving, they also raise concerns regarding academic integrity and students' conceptual understanding. This study explores how AI interacts with measurement-based physics assignments, focusing on whether AI can solve these tasks independently and how it can be effectively integrated as a learning tool rather than a substitute for student effort. Five measurement assignments, covering topics such as acceleration analysis, friction coefficients, specific heat capacity, discharge coefficients, and muzzle velocity estimation, were given to ChatGPT under the same conditions as human students. The AI's performance was evaluated based on accuracy, problem-solving methodology, and ability to visualize results. Findings indicate that ChatGPT can successfully apply theoretical models and provide structured solutions and even exemplary data and graphs to many measurement assignments. Sometimes it fails to identify key experimental limitations, such as real-world heat loss and sensor calibration issues. Nevertheless, it clearly outperforms many bachelor's level engineering students. The results highlight the need for AI-resilient assessment and grading methods, where students engage in hands-on data collection, critical thinking, and peer discussions to ensure deeper learning.

Keywords: Engineering Physics, Measurement assignments, Artificial intelligence in education, ChatGPT

PARALLEL SESSION VC

Educating Engineers for Impact: Integrating Skills, Doctoral Innovation, and AI-Driven Learning

July 18th: 9h00 – 10h00

Chair: *Filomena Soares*

[49]

Mapping Inner Development Goals in Transversal Skills Engineering Courses: An Exploratory Study

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Abstract. This exploratory study maps the offering of courses in transversal skills within engineering programs at two Portuguese engineering higher education institutions against the Inner Development Goals (IDGs). By analyzing information from institutional websites, this study pilots a methodology for broader inclusion of other engineering higher education institutions and identifies the extent to which current offerings incorporate skills across the five IDG pillars: being, thinking, relating, collaborating, and acting. The findings reveal gaps and opportunities for integrating IDGs into engineering education, particularly in the relating and acting pillars, providing valuable insights for educators and stakeholders to enhance the holistic development of future engineers.

Keywords: engineering education, engineering curricula, transversal skills, Inner Development Goals (IDG)

Acknowledgement: This study was supported by UID 00481 Centre for Mechanical Technology and Automation (TEMA).

[43]

Shaping engineering doctoral education for the 21st-century knowledge production

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Abstract. The purpose of doctoral education has shifted its focus to incorporate economic and societal demands. European transnational policies and funding initiatives have stressed the need to prepare doctoral candidates for diverse career paths, including those beyond academia.

This is a relevant issue in science, technology, engineering and mathematics (STEM) doctoral education, as STEM doctoral graduates tend to pursue careers outside academia. Their preparation fuels industrial innovation while contributing to Europe's competitiveness. Consequently, higher education institutions are under pressure to develop doctoral education strategies addressing the alleged skills-mismatch or culture shock experienced by STEM doctoral graduates transitioning into non-academic sectors.

The research strategy is based on an exploratory case-study, convening a mix-method research, to investigate a public Portuguese STEM higher education institution with 18 doctoral programs.

This paper aims, firstly, to identify the extent to which there is an institutional doctoral education strategy to address skills-mismatches by developing transversal competencies at the doctoral level. Secondly, the paper aims to identify which of these competencies are prioritized by the institutional doctoral education.

By examining institutional approaches and decision-making processes, this study contributes to the ongoing debate on how to prepare graduates for contemporary doctoral careers (within and beyond academia), while continuing to promote academic integrity and autonomy for curriculum development.

Keywords: STEM, Engineering, Doctoral Education, Transversal competencies, Transferable skills

Acknowledgement: This work was supported by the Fundação para a Ciência e a Tecnologia, IP (FCT) and by the European Social Fund [PhD studentship no. 2024.02139.BD]. It was also supported by the FCT within the multi-year funding awarded to CIIE [grants no. UIDB/00167/2020 and UIDP/00167/2020] and to CIIMAR [grants no. UIDB044232020 and UIDP044232020].

PARALLEL SESSION VC

[66]

Modeling of pollutant particle motion with homemade prototypes and artificial intelligence: an innovative approach in Bioengineering

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Abstract. This study explores the integration of artificial intelligence (AI) in modeling pollutant particle behavior within the Modeling of Motion in Bioengineering and Chemical Processes course for first-semester engineering students at XX. The methodology builds upon principles of kinematics and dynamics to analyze the movement of airborne particles (PM 10 and PM 2.5) emitted from point sources. The project follows a constructivist and project-based learning approach, where students design and build prototypes to simulate these physical phenomena, comparing experimental and control conditions. Two student groups participated in the study: an experimental group, which incorporated AI-assisted predictive modeling tools to enhance analysis, and a control group, which employed traditional methods without AI intervention. The evaluation encompassed both conceptual understanding (measured through pre- and post-tests) and cognitive engagement (assessed via student self-reports and instructor observations). Findings indicate that students in the AI-assisted group demonstrated a deeper comprehension of complex motion dynamics, particularly in predicting emergent particle behavior patterns. However, the study acknowledges that long-term retention and transferability of competencies require further longitudinal assessment. The results contribute to the broader discourse on AI-enhanced learning in engineering education, providing insights into its potential for augmenting analytical skills and problem-solving capabilities. Future research will examine the scalability and adaptability of this approach in different STEM disciplines to refine its pedagogical effectiveness.

Keywords: Educational innovation, Professional education, Tec 21, GPT, Supervised learning, Reinforcement learning

Acknowledgement: The authors express their sincere gratitude for the financial and technical support provided by Writing Lab, Institute for the Future of Education at Tecnologico de Monterrey, Mexico, in the creation of this work.

[26]

Empowering Engineers with Communication Skills for Green Technology Projects

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Abstract. Effective communication in engineering projects is pivotal for empowering the green transition, as it fosters multidisciplinary collaboration, ensures clarity across diverse stakeholders, and bridges technical and cultural gaps, ultimately driving sustainable innovation and project success. The main aim of this study is to give a contribution to overcome these communication limitations. This research explores the critical role of communication in engineering projects related to the green transition, as part of the ECO-GT project in Portugal.

Through focus groups and interviews with different stakeholders, including engineers, product manufacturers and end-users, the research identifies communication challenges and essential skills required during project implementation. The findings show that the importance of multidisciplinary collaboration, adapted language depending on the target audience, and openness to feedback are essential to achieving project goals. Key findings include the need for tailored communication strategies at all project stages to overcome technical and cultural barriers. This research highlights the value of integrating communication training into engineering education to prepare future engineers for the complexities of green transition projects.

Keywords: Green Transition, Communication, Education, Engineering

Acknowledgement: This research is supported by EU Erasmus + programme funding the project Engineers Communicating and Collaborating Internationally for the Green Transition - ECO-GT Project number 2023-1-PL01-KA220-HED-000165199. The authors also would like to thank the participants in the focus groups and interviews.

4. PARALLEL WORKSHOPS

PARALLEL WORKSHOP I

July 16th: 17h00 – 18h30

WSI.1

Interdisciplinarity in Engineering Education

Susana Lucas and Cristina Oliveira

Susana Lucas – Bio: PhD in Chemical Engineering and Civil Engineering. Since 2008, she has been an Adjunct Professor at the Polytechnic Institute of Setúbal – Barreiro School of Technology. She is a member of the C-MADE research center. Her current area of specialization/research focuses on sustainable construction, construction that promotes health and well-being, human-centered construction, building in connection with the natural environment, water as a fundamental resource, and efficient ways of using it

Cristina Oliveira – Bio: PhD in Civil Engineering from the University of Lisbon, with a Master's degree in Structures and a five-year undergraduate degree in the same field. She conducted postdoctoral research at the University of Aveiro. She is currently an Adjunct Professor at the Barreiro School of Technology of the Polytechnic Institute. Her research areas include control algorithms, vulnerability assessment, seismic strengthening, and seismic analysis

Overview: In this workshop, participants will explore practical strategies to promote interdisciplinarity in engineering education. In a rapidly changing world, educating future engineers requires approaches that combine knowledge from different areas, connecting traditional disciplines to new emerging fields. This workshop will provide teachers with tools and activities that can be adapted to their own classes to create more connected, relevant and dynamic learning experiences.
Objectives: Present the benefits and challenges of interdisciplinarity in engineering education. Demonstrate practical techniques to integrate knowledge from different areas in the classes. Develop collaborative activities that teachers can replicate with their students. Promote reflection on how to adapt education to current needs.

PARALLEL WORKSHOP I

WSI.2

Combining Experiential Learning and Team-Based Learning

Margarida Pinho Lopes and Joaquim Macedo

Margarida Pinho Lopes – Bio: Margarida Pinho-Lopes is an Assistant Professor at the Department of Civil Engineering at the University of Aveiro, Portugal, and a Visiting Academic at the University of Southampton, United Kingdom. Her area of work is geotechnical engineering. She holds a PhD in Civil Engineering from the Faculty of Engineering of the University of Porto (Portugal).
Her research work is on geotechnical engineering, particularly on the application of geosynthetics in civil engineering. Her current research interests include numerical models for geosynthetics, nature-based solutions for soil reinforcement, sustainable geotechnical solutions, and geotechnical engineering education.
Margarida has experience with student-centred learning models, such as problem- and project-based learning, team-based learning, feedback practices, experiential learning, and outreach activities. She is involved in projects related to pedagogical innovation in higher education and is a member of ISSMGE TC306 Geoengineering Education, a Fellow of AdvanceHE and of SPEE. She is also a council member of the Pedagogical Board of University of Aveiro.
She received the New Frontiers of Engineering – Higher Education Teachers award (2012, 2016, 2023) by the Portuguese Institution of Engineers and the Good Pedagogical Practices Award from the University of Aveiro in 2022, with an Honourable Mention in 2021.

Joaquim Macedo – Bio: Joaquim Macedo is an Assistant Professor in the Department of Civil Engineering, University of Aveiro, where he completed his PhD in 2013 on the topic of road traffic microsimulation. He works in the fields of transportation infrastructures and geotechnics and teaches several courses on those topics.
He is the supervisor of ongoing PhD and master's students and has supervised and co-supervised several master's theses. His main research interests are Traffic Engineering, particularly traffic modeling, didactics in higher education, and geotechnics applied to transportation infrastructures.
Since 2007, Joaquim has been implementing active learning strategies in the courses he teaches, especially project-based learning and team-based learning. He is involved in pedagogical innovation projects in higher education and is a member of SPEE, the UA pedagogical innovation support team, and author of several publications on engineering education.
He received the New Frontiers of Engineering – Higher Education Teachers award (2012, 2016, 2023) by the Portuguese Institution of Engineers and an Honourable Mention in the Good Pedagogical Practices Award from the University of Aveiro in 2021.

Overview: The motto of CISPEE 2025 "Emerging Trends in Engineering Education: Adapting to a Changing World" is the driver for the proposed workshop. The workshop puts participants in the role of students and illustrates, hands-on, how to combine two very different active learning strategies, with the goal of promoting deep learning and critical thinking.
The adoption of active learning strategies in higher education is key for developing well-rounded engineers, with both technical, soft and transferable skills. Engineering graduates need to be able to solve complex problems, which requires a deep understanding of fundamental principles and the ability to relate and apply them. For that they need to possess technical knowledge and competences, soft skills relevant to the profession, and digital literacy. In a context of rapid scientific and technological advances, the ability and openness to lifelong learning are also essential aspects for the success of future engineers.
Active learning strategies, which involve students actively engaging with the content, solving problems, and collaborating with peers, are crucial for attaining a deeper level of understanding. With these

strategies, students are called to participate in different types of activities and are challenged in various ways.

One form of active learning that is privileged by engineering instructors is experiential learning. In this form of learning, students learn by doing, namely by engaging in hands-on activities and reflecting on those experiences. This process facilitates closing the gap between theory, previous knowledge, and real-life situations.

With a focus on small-group work, team-based learning enables applying conceptual knowledge using a structured sequence of activities. Typically, team-based learning includes: 1) individual work; 2) group work; 3) immediate feedback. Team-based learning makes use of problem-solving activities that apply conceptual and procedural knowledge. This approach is versatile as it can be used for small, medium and large size classes, as activities are organised in different numbers of small groups (often, 4 to 7 students).

Combining the benefits of hands-on activities with team-based learning can help engineering students bridge the gap between theory, prior knowledge, and real-world applications, while fostering a structured approach to deep learning and enhancing critical thinking skills.

The presenters have implemented this combined approach in their courses. The pedagogical context in which the combination of experiential and team-based learning was implemented includes a wide range of teaching and learning strategies and resources that scaffold autonomous and self-regulated learning, enabling a transition to personalised learning. In addition, the sessions using this combined approach were implemented in a space specially designed for active teaching and learning.

The presenters will share their experience of combining these two strategies with the participants, using examples from their courses and feedback from their students. This combined approach was implemented using digital tools, to foster digital literacy and induce practices in the context of the ongoing digital transformation.

The participants will experience the approach proposed from a student perspective. The workshop will include: i) experiential learning; ii) team-based learning; iii) overview of the approach adopted, reflections and sharing experiences to enhance student learning and the development of critical thinking in undergraduate engineering programmes.

PARALLEL WORKSHOP I

WSI.3

Capacity Building for Engineering Education Practice and Scholarship in Lusophone Countries

Matheus de Andrade, Inês Direito, Bill Williams and Valquíria Villas-Boas

Matheus de Andrade – Bio: Matheus de Andrade is an Assistant Professor (Teaching) at the UCL Centre for Engineering Education (CEE), with a focus on large-scale mathematics education, and quantitative methods in EE Research. Matheus is Deputy Editor of the European Journal of Engineering Education (EJEE) and a member of the SEFI Ethics and Sustainability SIGs.

Inês Direito – Bio: Inês Direito is a researcher at the University of Aveiro (Centre for Mechanical Technology and Automation) in Portugal, and honorary Senior Research Fellow at the Centre for Engineering Education (University College London, UK). Her research is focused on exploring empathy as a tool to enhance EE and practice**.**

Bill Williams – Bio: Bill Williams originally trained as a chemist at the UCC, National University of Ireland and has work experience in Mozambique and Portugal. He ran international distance courses for the International Labour Organization in various African Lusophone countries. He serves as Senior Associate Editor of JEE and Associate Editor of EJEE. Dr Williams is an active member of SEFI EE Research and DEI SIGs. As a founding member of SPEE he has a good knowledge of EE initiatives in the Lusophone world.

Valquíria Villas-Boas – Bio: Valquíria Villas-Boas was a member of the Research in Engineering Education Network (REEN) from 2017 to 2021 due to her knowledge of the research context in EE in Brazil. She has also been collaborating with Portuguese researchers since 2012, which also gives her a considerable knowledge of EER in Portugal. She is a member of the Steering Committee of the Active Learning in Engineering Education (ALE).

Overview: EE Research (EER) is a growing field, with established roots and traditions mostly in the United States (US). Many universities in the US have dedicated departments of Engineering Education (EE), which co-exist in parallel with other disciplinary engineering departments (e.g. Civil, Mechanical, etc), as well as established PhD programs in EE. EER is an emerging field in Portugal (Van-Hattum, Williams, & Oliveira, 2013) and Brazil (Viana & Villas-Boas, 2022).

Despite the recognition of EE in the Portuguese and Brazilian contexts, and many good practices in EE being published by scholars in both countries, research in these contexts could be more vibrant. The Lusophone Network for EER aims to map out the current landscape of EE capacity-building, scholarship and research in Portugal and Brazil, as well as other Portuguese-speaking countries. The proposed workshop aims to start mapping out this landscape in Portugal.

The intended outcomes of the workshop are: i) Capture different international perspectives on EE capacity building for innovative practices, scholarship & research; ii) To map out the challenges faced by engineering educators in engaging with scholarly research in EE; iii) To identify opportunities for sharing 'know-how' and resources between scholars.

PARALLEL WORKSHOP II

July 17th: 14h30 – 16h30

WSII.1

Applied Gamification in Engineering Education

Fausto Mourato and Martinha Piteira

Fausto Mourato – Bio: Fausto Mourato obtained his PhD in Computer Science from FCT/UNL in 2016 and currently holds an Associate Professor position at the Polytechnic Institute of Setúbal. His research primarily focuses on the development of video games, with complementary interests in Extended Reality, Gamification, Serious Games and Human-Computer Interaction. He teaches courses on game design and game programming, as well as other informatic courses where he usually includes principles from game design into the educational process. He also contributed to interdisciplinary projects, such as the development of smart buildings, promoting environmental awareness, preventing of social alienation, among others, applying game design concepts to address diverse challenges.

Martinha Piteira – Bio: Martinha Piteira obtained her PhD in Information Sciences and Technologies from the University Institute of Lisbon (ISCTE-IUL) and currently holds an Associate Professor position at the Polytechnic Institute of Setúbal. Her research interests include Information Systems, with a particular focus on Online Learning Systems, Gamification, Educational Games, and Human-Computer Interaction. She is also interested in Usability and Accessibility, Ethics in Information Systems and Artificial Intelligence, and student-centered pedagogical approaches. In her research, Martinha explores the potential of gamified learning environments to enhance programming education. She developed a conceptual framework for gamification implementation, which she applied through the creation of a MOOC for programming students.

Overview: This workshop aims to explore the potential of gamification as a powerful tool in engineering education and other fields. By leveraging elements of game design such as competition, rewards, challenges, and storytelling, educators can create engaging and meaningful learning experiences that motivate students and improve outcomes. Gamification offers an innovative way to approach traditional learning challenges, especially within the often-demanding context of engineering education, which can benefit significantly from active, student-centered engagement. Participants in this workshop will gain practical insights into the principles of gamification, learn about the benefits it brings to the educational process, and engage with real examples of its successful implementation. The session will cover both theoretical concepts and hands-on activities to provide participants with a well-rounded understanding of how gamification can be integrated into their own teaching practices to foster active learning and student motivation.

Target Audience: This workshop is designed for educators, particularly those teaching in engineering or technical fields, who are interested in gaining a foundational understanding of how to apply gamification in their courses. It is also suitable for those who have already experimented with basic gamification techniques and are looking to share their experiences, discuss outcomes, and exchange ideas with colleagues on more advanced or effective approaches.

Objectives: To better understand the potential of gamification in education, it is essential to first grasp its core principles and the role it plays in enhancing learning experiences. Gamification, by integrating game elements, offers strategies that boost student engagement and motivation, making learning more dynamic and appealing. Furthermore, by exploring practical examples of gamified activities specifically

within engineering education, it becomes evident how these methods can be tailored to meet the unique demands and challenges of more technical fields. This approach allows educators to learn how to design and implement foundational gamification strategies that foster meaningful engagement and motivation in students, effectively integrating gamified principles into the teaching and learning process.

PARALLEL WORKSHOP II

WSII.2

Curriculum Design for an Expedition Learning Semester on Energy Sovereignty Engineering

Haraldur Audunsson and Siegfried Rouvrais

Haraldur Audunsson - Bio: PhD is an Associate Professor of Physics in the Department of Engineering at Reykjavik University. His educational interests include applied physics, engineering education, and experiential learning.

Siegfried Rouvrais - Bio: He is a Research Scientist at IMT Atlantique and Lab-STICC CNRS, and an Associate Professor in Engineering Education. Since 2000, he has led or participated in European and international R&D projects. His work focuses on modeling and analyzing complex software and higher education systems, contributing to frameworks and tools that enhance engineering education. He has authored around 100 international publications and is a senior IEEE member.

Overview: Decarbonization is a major objective of the EU, which aims to achieve carbon neutrality by 2050. Decarbonization concerns all sectors. The success of a decarbonization strategy requires coordinated action, in particular with higher education institutions through their science and technology curricula when preparing the next generation of engineers.

After 15mins presentation of the context and theoretical background, participants in subgroups of 3-6 design the structure and curriculum of a joint European final Master-2 semester. The context is a 5-month expedition in an imagined cruise ship with T&L workspaces, traveling between several coastal EU cities to visit both universities and large energy companies, e.g. starting from Portugal. The participants draw the itinerary of the low-carbon cruise ship, a real mobile learning lab, visiting at least 5-7 universities and 5-7 companies and inform a canvas of nine components (cf. Figures, hands-on engagement). The components of the curriculum include: main goals and learning outcomes of the program, entry requirements, structure and contents of the program, teaching and learning methods, location of teaching and learning, interpersonal skills, assessment methods, language of instruction, and ethno- and sociographic aspects, including diversity and equity. Some parts are already prefilled.

At the end of the workshop session, participants engage in a semi-structured discussion on current educational practices and potential future directions, a debate free time depending. No prior knowledge is needed for the workshop, even no expertise in energy training, just openness to innovative ideas in curriculum design.

The workshop provides an opportunity for engineering program designers, educational leaders, pedagogists, and teacher, even students and industrials or territorial decision makers, to exchange innovative perspectives on an exciting semester of engineering training.

Acknowledgement: This workshop was designed through the DECART project, co-funded by the Erasmus+ programme of the European Union (www.decartproject.eu, reference 22022-1-FR01-KA220-HED-000087657). The European Commission support for its production does not constitute an endorsement of the contents which reflects the author views only, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

PARALLEL WORKSHOP II

WSII.3

Engineering for All: Redesigning Education for Diversity and Inclusion

María Doval Ruiz, Rita Pereira and Cristina Borges

María Doval Ruiz – Bio: Associate Professor, Faculty of Education and Social Work, Universidade de Vigo, Spain. She holds a BA in Philosophy and Education Sciences from the Universidade de Santiago de Compostela and a PhD in Psycho-pedagogy from the Universidade de Vigo. María Isabel previously served as Vice-Rector of Social Responsibility, Internationalisation, and Cooperation, as well as Vice-Rector for Welfare, Equity, and Diversity, where she led initiatives related to the Diversity Unit and Transparency and Open Government policies. She also held the position of Head of her Academic Department and key roles in public administration, including Deputy Director General of Galician Universities and member of the management team at ACSUG (Agency for the Quality of the Galician Education System). Her areas of expertise include ICT and education, inclusion, participatory research, innovative education, rurality, the European Higher Education Area, comparative pedagogy, and gender and education.

Overview: The 2-hours workshop aims to equip educators and academic leaders with the knowledge and strategies needed to create more inclusive, diverse, and equitable (DEI) environments in engineering education. This session will explore practical approaches to addressing the unique needs of students and faculty from underrepresented and vulnerable groups, including women, neurodivergent individuals, first genertion and those from disadvantaged socioeconomic backgrounds, among others.

Participants will engage in interactive discussions, case studies, and collaborative activities to explore:

1. How to integrate inclusive teaching practices, such as Universal Design for Learning (UDL), to make engineering courses accessible to diverse learners.
2. Strategies for addressing unconscious bias in curriculum design, student assessments, and team projects.
3. Institutional policies that can support neurodivergent faculty and students, and how to implement them effectively.

By the end of the workshop, participants will have:

- A foundational understanding of how DEI principles apply to engineering education.
- Practical tools and examples for fostering inclusivity in their teaching practices and institutional policies.
- A collaborative space for sharing challenges and solutions with peers from diverse contexts.

This workshop aligns with the conference theme by demonstrating how diversity strengthens the engineering profession's ability to solve complex, global challenges.

Keywords: Inclusive Engineering Education, Diversity, Equity, and Inclusion (DEI), Neurodiversity in Higher Education

PARALLEL WORKSHOP II

WSII.4

Embedding Empathy in Engineering Design Courses

Jan Van Maele, Veerle Bloemen, Diana Bairaktarova and Inês Direito

Bio - Jan Van Maele is a professor in the Faculty of Engineering Technology at KU Leuven, Belgium, where he teaches and researches communication with a focus on intercultural learning and community engagement. He has widely collaborated in these fields with partners in Europe, Asia and the Americas.
Bio - Veerle Bloemen is an Associate Professor in the Department of Materials Engineering and affiliated to the Faculty of Engineering Technology at KU Leuven, Belgium. Her research aims at integrating biofabrication technologies in cell-based strategies for various biomedical applications. She teaches biomedical engineering courses focusing on design thinking and stakeholder engagement.
Bio - Diana Bairaktarova is an Associate Professor in the Department of Engineering Education and an affiliate faculty in the Department of Mechanical Engineering and Human-centered Design Program at Virginia Tech. She has received the W. S. 'Pete' White Innovation in Engineering Education and XCaliber Awards for exceptional contributions to technology enriched learning.
Bio - Inês Direito is a researcher at the University of Aveiro (Centre for Mechanical Technology and Automation) in Portugal, and honorary Senior Research Fellow at the Centre for Engineering Education (University College London, UK). Her research is focused on exploring empathy as a tool to enhance engineering education and practice.

Overview: The primary goal of the workshop is to explore and demonstrate effective strategies for embedding empathy into engineering education, particularly in design-based project work. By showcasing successful examples from this innovative approach at a European and a North-American institution, we aim to provide practical tools for educators to integrate empathetic practices into their courses. The intended outcomes include a deeper understanding of the role of empathy in addressing engineering issues, actionable strategies and practical methods for embedding empathy in engineering courses, and joining a growing global community of practice for nurturing empathy in engineering education.

At the beginning of the workshop, the facilitators will offer a brief introduction to the concept and practice of empathy in engineering education. Several tried-out empathic imagination methods are briefly introduced such as developing and voicing personas as a step towards stakeholder engagement; figure storming as an ideation method; and the human face perspective-taking activity. Following this, participants will be invited to engage in hands-on empathy activities in small groups. Participants are also encouraged to bring up ideas of how empathy activities could be embedded in their own contexts.

This workshop closely aligns with the conference theme of innovative teaching and learning methods in engineering education. By focusing on empathy, we address a critical yet often overlooked transferable competency that engineers require when they address wicked problems in the real world. Through the interactive exercises and dialogue, participants will gain practical strategies and skills that they can immediately apply in their teaching.

In conclusion, this workshop aims to equip engineering educators with the knowledge and tools to embed empathy into their courses, ultimately leading to more effective and socially responsible engineers.

PARALLEL WORKSHOP III

July 18th: 10h30 – 12h30

WSIII.1

Teaching and Learning Basic Electronics Through Remote Experiments

Gustavo R. Alves, Unai Hernández-Jayo and Javier García-Zubía

Bio - Gustavo R. Alves obtained his PhD and the Habilitation in Computers and Electrical Engineering, from the University of Porto, Portugal, in 1999 and 2023, respectively. He is affiliated with the Polytechnic of Porto – School of Engineering, since 1994, where he now holds a position as an Associate Professor. He was involved in 21 national and international R&D projects, has authored or co-authored 280+ publications, including book chapters and conference and journal papers with a referee process, and has delivered 70+ invited webinars/keynotes at national and international levels. His research interests include engineering education and remote laboratories. Dr. Alves currently serves as the Head of the Innovation Centre for Engineering and Industrial Technology (CIETI), an R&D unit supported by the Portuguese Governmental Agency for Science & Technology (FCT). ORCID

Bio - Unai Hernández-Jayo is a Telecommunications Engineer and holds a PhD in Computer and Telecommunications Engineering from the University of Deusto. He is currently a lecturer and researcher at the University of Deusto. His publications are mainly in e-Learning, specifically in the design and development of remote laboratories, an activity he carries out within the framework of the DEUSTEK research group. He has participated in more than 50 research projects, being the principal investigator in more than 20 of them. He is an author/co-author of more than 150 research publications, mainly in engineering education and remote laboratories. ORCID

Bio - Javier García-Zubía:is a professor at the University of Deusto since 2015 and is a member of the DEUSTEK research group. He was involved in 50+ national and international R&D projects and has authored or co-authored 260+ publications, including book chapters, conference, and journal papers with a referee process. He was invited as a keynote speaker in 10+ conferences and he was awarded in 10+ events. He edited three books around remote labs and he is the author of the book Remote Laboratories: Empowering STEM Education with Technology recently published by World Scientific Publishing. ORCID

Context: The COVID-19 lockdown triggered a widespread interest in solutions based on non-traditional (remote and virtual) laboratories, derived from the restrictions imposed on the physical presence of teachers and students in traditional (hands-on) laboratories. Spite the repetition of the advantages associated with the complementary use of remote and virtual laboratories, alongside evidence from its regular use in distance education modalities, "the problem had to appear in order to understand the solution". In other words, although remote and virtual laboratories have a history of more than 25 years, only more recently the discussion about its regular use in STEM education became widespread.

Purpose: Given this background, we deliver a workshop where attendees will have the opportunity to use a remote laboratory, named Virtual Instrumentation Systems in Reality (VISIR), which enables doing (real) experiments with electrical and electronic circuits, supported by an enquiry-based pedagogical framework explained in the recently launched VISIR Handbook. The course will be supported by VISIR

nodes installed in Portugal and Brazil, and the newest version of this remote laboratory, named HIVE, which has been developed by LabsLand®, a company devoted to the delivery and support of remote laboratories. HIVE nodes are presently installed in Spain and Germany. The aim of this workshop is to give participants insight into how to design an entire course on a specific engineering field using remote experiments and an enquiry-based teaching and learning approach as the two major instructional strategies. A practical example in the specific area of electric and electronic circuits supports the workshop.

WSIII.2

Critical Minds in Action: AI-Enhanced Service-Learning and CBL in Engineering

Celina Pinto Leão, Anabela C. Alves, Sílvia Araújo and Filomena Soares

Celina Pinto Leão – Bio: Associate Professor at the University of Minho, Celina has been deeply committed to advancing engineering education, particularly in the curricular units of Applied Statistics and Numerical Methods. She has consistently incorporated innovative pedagogical approaches, including active learning methodologies, and recently embraced the potential of Generative AI to enhance learning. She is active in ethics, gender equity, and inclusion, and contributes to the Master's program board, promoting dynamic academic environments.

Anabela C. Alves – Bio: Associate Professor at the Department of Production and Systems, School of Engineering, University of Minho. She holds a PhD in Production and Systems Engineering and is a member of the ALGORITMI/LASI Research Centre. Her research interests include Lean Production, Planning and Control, Project Management, and Engineering Education, especially Project-Based and Problem-Based Learning. She has co-authored over 200 publications, including 4 books.

Sílvia Araújo – Bio: Sílvia Araújo is an Associate Professor at the Department of Romance Studies, University of Minho. Expert in Language Sciences and Digital Humanities, she leads multiple FCT-funded projects. Her work focuses on corpus linguistics, NLP, and AI in education. She coordinates the Master's in Digital Humanities and the related research group at the Center for Humanistic Studies, and promotes technology integration through accredited training at all educational levels.

Filomena Soares – Bio: Filomena Soares holds a degree and PhD in Chemical Engineering, and a MSc in Electrical and Computer Engineering. She is a researcher at the ALGORITMI Centre and teaches at the Industrial Electronics Department at University of Minho. Her interests include automation systems, biomedical process control, and the use of serious games and robotics in rehabilitation. She is active in research and the promotion of active teaching methodologies.

Overview: Engineering education is evolving, demanding innovative methods that promote critical thinking, active learning, and real-world problem-solving. This 2-hour workshop explores the transformative role of Generative AI in advancing Service-Learning (SL) and Challenge-Based Learning (CBL) within engineering education. Generative AI, with its ability to simulate, predict, and create new information, offers unprecedented opportunities to revolutionize how engineering students learn and apply their knowledge. Educators can create immersive, interactive, and personalized learning experiences that promote critical thinking and problem-solving skills by integrating AI-driven tools into challenge-based learning and service-learning frameworks.

Participants will work in small, interactive groups to tackle pre-defined challenges using AI-driven tools and strategies. These hands-on activities will demonstrate how Generative AI can create immersive and personalized learning experiences, fostering collaboration, critical analysis, and creative problem-solving.

The workshop will begin with a brief introduction to theoretical frameworks and practical examples, followed by group-based activities designed to apply AI-enhanced methods in real-world educational scenarios. Attendees will explore challenges curated by the workshop organizers, engaging directly with tools to simulate, predict, and design innovative solutions.

By the end of the session, participants will gain practical insights into integrating Generative AI into their teaching practices, unlocking new possibilities for interactive and transformative learning experiences.

PARALLEL WORKSHOP III

This workshop aims to foster a collaborative environment for educators and researchers to share insights, explore opportunities, and shape the future of engineering education.

WSIII.3

Supporting the Digital Transformation of Engineering Education

Ansys

Overview: The use of computer-aided engineering technologies is gaining increasing attention in conversations about the future of engineering education in the context of curriculum reduction, changes in students' abstraction skills, the shift to PBL models, and industry demands to update the toolbox with which students graduate from universities. In this workshop, we will review how ANSYS technologies can be used in the classroom, from the perspective of concretizing highly abstract and complex content, through the resolution of real-life engineering problems in digital (and secure) environments, to the provision of valuable tools for students' future professional development.

This workshop presents concrete cases and application examples that emerge from ESSS's experience working with more than 1,000 engineering schools worldwide. We will then discuss a practical case using one of our flagship software programs, ANSYS Granta Edupack, which will be used to demonstrate how detailed materials selection and sustainability could be addressed with technology in class.

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