

SEFI Annual Conference

SEFI 2022

EBOOK ABSTRACTS

**19 - 22 September 2022
Barcelona, Spain**

PREFACE

Welcome to the SEFI Annual Conference 2022 hosted by the Universitat Politècnica de Catalunya-BarcelonaTech!

This book contains the programme, information and technical programme of the contributions accepted for presentation at the 50th SEFI 2022 Annual Conference, to be held in Barcelona on 19-22 September 2022. This conference will allow us to share our vision for the future and the new possibilities that European alliances of tech universities open up for the future of engineering education.

We are moving fast towards new scenarios in engineering education. Not only is technology strongly influencing education, human and social factors are also at the core of essential ways of shaping a new future for universities. "

How can the future of learning and teaching be shaped?

We can have a say, by our comprehensive experience in all relevant elements that influence learning. We share our passion for education and have the will to accompany teachers and new academics on the road to engineering education. For this reason, we have all the SEFI Special Interest Groups working hard on key topics.

Let us share our vision for the future and the new scenarios that open up and bring together the transformative capacity of universities and teachers.

Furthermore, we are delighted to announce that in addition to ISBN, we will include a **Digital Object Identifier (DOI)** for each accepted paper at this year's conference. We hope that you appreciate this important step forward, we believe having a DOI is an excellent advantage for researchers

We would like to thank all people who contributed to the success of the conference as committee members, as reviewers, authors, presenters, session chairs, organizational and administrative staff for their help in making SEFI 2022 possible.

Special thanks to the team of the Institute of Education Sciences (ICE) of the UPC, and to members of the Local Organizing committee who took the largest load share of preparing and running the conference.

The UPC and its Institute of Education Sciences have just celebrated 50 years in teaching and education. Therefore, at this 50th SEFI annual conference, the SEFI and the UPC are pleased to invite everyone to participate.

President of the Conference: Imma Ribas
Chair: Santiago Silvestre
Chair: Ariadna Llorens

Universitat Politècnica de Catalunya

ORGANITATION



**UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH**

Institut de Ciències de l'Educació



European Society for Engineering Education
Europäische Gesellschaft für Ingenieur-Ausbildung
Société Européenne pour la Formation des Ingénieurs

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PAPERS:**ID:**

1101

Topic:

Industry and Companies liaison. Regional Involvement and Innovation
Sustainability. Sustainable Development Goals

Title:

Wheel of Competencies. Industry Demands of Competencies for Research and Innovation

Authors:

Johannsen, Thies

Abstract:

On the basis of the current state of research, the study identifies future-oriented competencies. Using quantitative social research methods, it then investigated demands in industry. This involved, first, a literature analysis and the identification of competencies for research and innovation (R&I) activities. Next, from clusters of the identified competencies I derived 14 different types. On this basis, generated competency profiles that informed the development of a tool for R&I, the Wheel of Competencies. With this newly developed tool specific competency profiles can be generated and analyzed.

Secondly, I operationalized and implemented the competence components in a questionnaire. On this basis, 200 CEOs and heads of R&D departments of medium-sized and large enterprises in Germany were surveyed in November and December 2021 using computer-assisted telephone interviews (CATI). All companies have at least 50 employees and an in-house R&D department. In addition, the companies have to belong to one of the following industry sectors: automotive, chemical, electrical or mechanical engineering.

The results show that certain competencies are in very high demand across all industries, while others are more specific to an industry sector. Overall, the results indicate that the competencies in demand address the dynamic complexity in collaborative R&I processes. The results presented here make an important evidence-based contribution to curriculum development in engineering education based on future-oriented competencies and illustrates which transfer activities and collaborative formats are increasingly relevant.

Keywords:

Competence, Skills, Employability, Curriculum Development, Survey

PAPERS:

ID:

1104

Topic:

Entrepreneurship Education
Fostering Engineering Education Research
Curriculum Development

Title:

Educating Entrepreneurial Engineers - to be context-aware or generic?

Authors:

Saukkonen, Juha

Abstract:

Entrepreneurship education (EE) is high on the agenda of governments and universities globally. With the new forms of entrepreneurship, there has been a surge of specific training programs and materials, e.g. ones dedicated to social entrepreneurship as well as for science & technology-based entrepreneurship.

Parallel to this division of EE into subsegments, tools and methods such as the Business Model Canvas (BMC), Lean Start-Up and Customer Development methods or Disciplined Entrepreneurship by MIT have spread to be used by EE practitioners globally.

With the increasing globalization, virtualization and mobility of learners, EE courses have learners differing in 1) their cultural context that reflects in their value and beliefs, 2) their educational and professional background, and 3) in the area - market and industry - where they aim to start their business. E.g., the process of entrepreneurship is likely to differ in dynamics when going into medical technology vs. mobile gaming, yet some aspects may be mutual to both businesses.

Thus, EE education is facing a dilemma: How unified and non-context specific should the approach of the educator be to deliver EE in scale and keep the EE program manageable vs. how much to focus on the individuals or teams and their specific context.

The paper draws its conclusions based on the views of seven educators of EE diverse in the context they come from and the type of entrepreneurs they have trained. The takeaway to participants is a set of proposed EE designs that deal with the contradicting forces

Keywords:

entrepreneurship, context, culture, program design, entrepreneurial engineers

PAPERS:

ID:

1105

Topic:

Fostering Engineering Education Research
Cooperation for Development
Curriculum Development
Lifelong Learning

Title:

Developing future engineers with broad views and deep skills - emergence of a new T2-capability profile

Authors:

Saukkonen, Juha

Abstract:

Companies are increasingly stressing their need for recruits and employees who can understand the company strategy and operations in a wider scale and with an integrative mindset, opposed to siloed departments, jobs and people possessing those jobs. With new digital technologies, new organizational forms such as team-based organizations and virtual teams as well as Human Resource Management practices like job rotations, there are increasing opportunities of cooperation and integration of people with differing backgrounds and skill sets, like the interplay between marketing (business function) and R&D (engineering function).

However, having the company practices and infrastructure "right" for holistic and cross-disciplinary work does not suffice. The professional preparedness of the practitioners has to support this new paradigm as well. Solution has been proposed to be T-shaped capabilities, where the vertical line represents the deep expertise in one area, and the horizontal line an overview expertises to better understand processes outside one's own domain. This is an improvement to I-shaped capabilities, where the connecting horizontal integration is missing.

The paper propagates for a prospective upgrade to T-shaped capability model, T2 capability profile. The core idea - derived from interviews with industry managers - is that there are two horizontal lines that differ in scope. The societal/business megatrends demand a set of non-contextual understanding of issues such as sustainability, quality as well as of basic technical and financial literacy and the other horizontal line is made of company- and industry-specific processes. To conclude, the opportunities to foster T2-capabilities in (engineering) education gets discussed.

Keywords:

capabilities, professions, expertise, integration

PAPERS:

ID:

1107

Topic:

Virtual and Remote Labs
Challenges of new European Universities

Title:

Remote Energy Lab – Experience and Improvements of European Cooperation in Remote Labs

Authors:

Klüh, Daniel (1);
Baqain, Mais (2);
Lyons Ceron, Alejandro (2);
Novak, Ondrej (3);
Bily, Tomas (3);
Konist, Alar (2);
Gaderer, Matthias (1)

Abstract:

Due to the COVID-19 pandemic, online teaching methods have gained more interest. Most formats of teaching can be easily transferred into an online format from a technical point of view. However, this is more difficult for practical courses in a laboratory. Together with partners from three European universities, we tackled the issue of providing a practical online course for higher education levels in the framework of the EuroTeQ university. In this work, we present our concept of the course and discuss the course goals and further improvements. We tested the remote lab setting in order to offer the course on a yearly basis in future.

The remote lab was focused on energy engineering and was open to students from different engineering disciplines and countries. The course was comprised of three blocks, each consisting of one lecture on the broader context of the topic and one experimental laboratory session. The experimental session was streamed via a video broadcasting service.

The learning outcome of the course was that students on the one hand learn about the technologies discussed in the course and on the other hand learn about intercultural communication skills. The goal was to show the diversity of technologies and to the significance of each technology for a specific country. The experimental sessions proved to deliver a clear explanation of the topic for the students when provided with sufficient course material adapted to online formats. Contrary, keeping a high level of interaction with students during remote experiments was found most challenging.

Keywords:

European University, Remote Lab, Online Teaching

PAPERS:**ID:**

1108

Topic:

Sustainability. Sustainable Development Goals

Title:

The Powerless Engineer: Questioning Approaches to Teaching Social Responsibility

Authors:

Wint, Natalie

Abstract:

In recent years there has been growing emphasis on the requirement for engineers to contribute toward the complex socio-technological challenges confronted by society. The need for a more holistic understanding of the societal impact of engineering has been highlighted by government, professional institutions, industry, and has strengthened calls for a widening of engineering curricula.

Despite this, there is evidence to suggest that the higher education (HE) sector is not producing socially responsible engineering graduates.

This study explores potential barriers to the development of socially responsible, culturally aware engineers. In so doing, it draws upon student feedback and reflections from a UK based engineering design course which makes use of the Engineers Without Borders UK Design for People Design Challenge, and which focuses on human centered, sustainable design. The findings are discussed in the context of theories of reasoned action and planned behaviour.

It is argued that engineering culture and curriculum act to discourage alternative modes of thought which leave students powerless in their ability to enact meaningful change.

Alternative modes of teaching and learning are discussed.

Keywords:

Sustainability, social, society

PAPERS:**ID:**

1109

Topic:Engineering Skills
Assessment**Title:**A SITUATIONAL JUDGEMENT TEST FOR ENGINEERS TO EVALUATE THEIR
PROFESSIONAL STRENGTHS & WEAKNESSES**Authors:**Carthy, Darren (1);
Craps, Sofie (2);
Langie, Greet (2);
Gaughan, Kevin (3);
Bowe, Brian (3)**Abstract:**

This paper reports on the development and evaluation of a 23 item Situational Judgement Test (SJT) with scenarios tailored to the engineering profession. The SJT was developed around the PREFER model, with the support of professional engineers and academics in 11 panel discussions. In total 53 engineering professionals and academics were consulted during the development of both the item-stems and the item responses of the SJT. Subsequently, the SJT was rolled out to 334 final year and masters students enrolled in engineering programmes at TU Dublin and KU Leuven respectively. After taking part in the test, students were send automated reports on their performance on the test, which highlighted how their response compared to a response gathered from a professional engineer, with feedback on how they might improve their competence in a particular area, while also commending their performance in other areas. The results of this study highlight that 8 SJT items had significantly lower mean scores when compared with the test-mean. These items, which were related to perseverance, client focus, vision, planning and organising, solution orientation, team player, work organisation, clear communication and networking all represent potential competence deficits in the population of final year and master students that were tested. This work adds to engineering education scholarship by providing an engineering-specific SJT that enables educators to identify areas of relative strength and weakness in students' professional judgements in order to better prepare them for their future careers.

Keywords:

Skills, Competences, Graduate, Assessment

PAPERS:

ID:

1110

Topic:

Student Engagement
Mentorship and Tutorship

Title:

How to help students to be more efficient?

Authors:

Amante García, Beatriz;
Sánchez, Montse;
Macarulla, Marcel;
Roca, Xavier;
Macanas, Jorge;
Amer, Rafael;
Haro, jaume;
Hernández, Francisco;
Cañadas, Juan Carlos;
Vela, Patricia;
Sunye, Marta

Abstract:

Many papers describe some problems in the first years of university studies, them affect directly to the efficiency of this students. The universities system invests big efforts to analyze what happens.

In this paper we will try to analyze the different factors that affect the students' efficiency from the first-year of the university. A list of these variables will be made and actions to improve them will be presented.

On the other hand, the effort and work of the teachers to organize all the autonomous work tasks of the semester, will be presented. Also support material prepared will be described.

Keywords:

first year of university, efficiency

PAPERS:**ID:**

1111

Topic:

Student Engagement
Gender and Diversity

Title:

The Effect of Teaching in A Second Language in Undergraduate Electrical Engineering

Authors:

Gur, Eran

Abstract:

In many academic colleges and universities, the classes are taught in a language which is not the native tongue of many of the students. One such case exists in Israel as at the beginning of 2021 for 21.1% of the population Arabic was the native language although (almost) all academic studies were conducted in Hebrew (those that weren't were in English, not Arabic). This may pose an obstacle for those talented students who must struggle not only with the material taught but also with the language. The situation is even worse in the case of East Jerusalem students who study only Arabic in school and have a different matriculation than those in Israel. In this paper, the author inspects the differences between students' achievements in Undergraduate Electrical Engineering studies in the past 10 years and tries to find where the language barrier is most restricting and where and when it is a lesser problem. The work compares the years 2012 to 2016 before the pre-studying program for Arabic speaking students was established in the spoken college, to 2017-2021 where a pre-studying program existed and the acceptance conditions for foreign matriculation where changed. The paper compares the more linguistic courses to the more graphic/ mathematic courses and the introductory courses to the more advanced courses to find where the language posed a bigger problem if any.

Keywords:

Foreign languages, Engineering Education, Equity

PAPERS:

ID:

1114

Topic:

Student Engagement
Building Communities and Coordination

Title:

The experiences of students transitioning back to in-person learning post-Covid-19

Authors:

Pick, Louise Therese;
McCartan, Charles;
Fee, Kathryn;
Hermon, John Paul

Abstract:

This paper reports on a preliminary study that was carried out to understand the experiences of engineering students transitioning to on-campus learning following the Covid-19 pandemic. Two cohorts were considered: year 1 students joining the university for the first time after having experienced considerable disruption for the final two years of their schooling and year 2 students who experienced their first year at university almost entirely online. Data was gathered from student surveys which found that the greatest areas of difficulty for students were the academic level of the programme and the workload. A limited comparison was drawn between this finding and some pre-pandemic data which suggests that the difficulty that students had in this area was higher than for students before the pandemic, indicating that two years of disrupted education may have had a negative impact on students' preparedness for higher education. Qualitative open-ended responses by students showed that there was a clear preference for face-to-face teaching, but that students see clear benefits to online resources and lecture recordings, and value having some flexibility in how they learn. Some reduction in student performance was noted.

Keywords:

Covid-19, transition, online learning, in-person teaching, student experience

PAPERS:

ID:

1116

Topic:

Curriculum Development
Digitalisation & Hybrid models

Title:

Transformation of a traditional face-to-face engineering study program into an digital online program - A case study of Global Production Engineering

Authors:

Eingartner, Valentin;
Severengiz, Mustafa;
Muschard, Bernd;
Kohl, Holger

Abstract:

The need for Digital Education (DE) in higher education has been growing for the past years, as the landscape of education became more diverse and global. It has become apparent with the COVID-19 pandemic that, in terms of width, DE had been mostly neglected so far. In the past year, the master program Global Production Engineering (GPE) at Technische Universität Berlin has been enhanced by a complete digital track, called GPE-Digital. In order to design this online study program a student survey was conducted and lecturers have been interviewed. The results were analysed and requirements for both lecturers and students were identified. Chances and challenges have been identified and a “tool box” for teaching and learning was developed. It contains a multimedia studio, a learning platform, a cloud platform et cetera. Lecturers are supported to develop and adapt their lecture-concepts and to choose the tools needed, which led to a variance of teaching-concepts. In this paper, after presenting the findings of both the interviews and the survey, the “tool box” is presented and its various possibilities for implementation are shown by the example of four different courses offered at GPE-Digital. These examples contain both synchronous and asynchronous teaching and different approaches of preparing joint sessions and lectures. Finally, based on the courses the benefits and challenges are discussed and rough approaches for exploiting the benefits and tackling the challenges are given.

Keywords:

Digital Transformation, Engineering Education, Multimedia Studio, Global Production Engineering

PAPERS:

ID:

1117

Topic:

Mathematics at the heart of Engineering
Digitalisation & Hybrid models

Title:

A Mathematics Peer Assessment Process for Flexible Modes of Delivery

Authors:

Pick, Louise Therese;
Manda, Krishnagoud;
Cole, Jonathan;
McCartan, Charles;
Hermon, John Paul

Abstract:

Educators have experienced significant challenges managing assessment processes over the last two years, particularly when converting in-person interactive and group-based activities to an online format. This was of immediate concern during the initial stage of the Covid-19 pandemic, when interim measures for online assessment were introduced rapidly without the benefit of prior planning and design. As we emerge from the emergency phase of the pandemic, it appears there will be lasting changes to delivery and assessment in higher education, involving more hybrid and blended solutions. This paper discusses how an on-campus peer feedback assessment process for mathematics has been converted to a digital format to facilitate flexible modes of delivery either on-campus or online. A weekly paper-based peer-feedback process had been previously established in our large (150+) first-year engineering mathematics class. The new process involves weekly submission of work through the university Learning Management System (LMS), Canvas, which is peer marked by students using model video solutions for selected questions. Students complete a rubric and provide comments. After each session, students complete a reflective journal, considering their work over the week and the comments they have received. Engagement with the new flexible process has been shown to be comparable to the old system, while the quality of feedback given to peers in the online process is superior to those provided in the paper-based system. The system has been shown to be robust when rapid changes in delivery modes occur.

Keywords:

peer assessment, reflective learning, mathematics, continuous assessment, rubri

PAPERS:**ID:**

1121

Topic:

Physics and Engineering Education

Title:

Introduction to molecular modeling of materials in an undergraduate engineering degree

Authors:

Torras, Juan;
Zanuy, David

Abstract:

Molecular modeling is a chemistry tool that has been widely used in the last decades to mainly support the basic concepts of general chemistry and organic chemistry, in both undergraduate programs of basic sciences and some technological careers. Despite its use, except in some very specific cases, it has been extensively employed as illustrative examples of the chemical concepts that were being demonstrated. Despite the numerous existing applications to comprehend the phenomena behind the development of new materials and biomedicine, it is difficult to find a conceptual introduction of the molecular modeling applied to specific problems on the modern engineering within the undergraduate programs. In the present work, it will be shown the introduction and adaptation of molecular modeling concepts within a new optional course for students coming from materials engineering, chemical engineering and biomedicine engineering. Different approaches to problem-based and small project-based learning are presented to encourage the scientific spirit of students using techniques of molecular modelling that had not been visited throughout their studies and, thus, to discover their potential application in a more specialized context.

Keywords:

exercise & project-based learning; computer laboratory; chemistry; physics; practical courses

PAPERS:

ID:

1122

Topic:

Curriculum Development
Engineering Skills

Title:

Mind the Gap – Students' Perspective on Relevant Competencies Needed and Gained in Engineering Education

Authors:

Winkens, Ann-Kristin;
Lemke, Clara;
Leicht-Scholten, Carmen

Abstract:

There are numerous discourses about competencies of future engineers as well as the challenge to learn, teach and assess them. In particular, this applies for the question of which competencies – besides technical knowledge and understanding – are relevant for future engineers in order to responsibly address the needs of society. This paper contains the initial results of an ongoing research project which aims to investigate engineering students' competencies and their perception thereof. In the context of a recurring engineering master's seminar at RWTH Aachen University the participants conducted interviews with a total of 41 students from outside the course. The interview subjects were themselves master's students from diverse engineering programs. In the interviews, the subjects were asked by their peers, among other things, which competencies they consider relevant for engineers and to what extent they have acquired these in their studies. The answers to those questions are evaluated and discussed in this work. The results show gaps in the acquisition of competencies – from the students' point of view – and in particular a discrepancy between the perceived relevance of competencies and the acquisition of these in the study programs. Besides problem solving, and technical knowledge and understanding, students pointed out that social competencies, such as communication and teamwork are particularly relevant. At the same time, they saw a lack of acquisition of these competencies in their study. The same applies for missing integration of knowledge into practical application.

Keywords:

Engineering Education, Future Skills, Competencies, Problem Solving, RRI

PAPERS:**ID:**

1124

Topic:

Fostering Engineering Education Research
Ethics in Engineering Education

Title:

EMOTIONAL EMPATHY AND ENGINEERING STUDENTS' MORAL REASONING

Authors:

Kotluk, Nihat;
Tormey, Roland

Abstract:

Although engineering education is often characterized as a principally rational activity, research suggests that emotions are vital for learning at all levels of education. In ethics education in particular, there is evidence that including mild emotional information in case studies can enhance learning. Evidence also suggests that specific emotions such as guilt and shame can impact on motivation to act in ethical scenarios. The place of emotions in ethics education remains controversial, however, since emotion can be perceived as a source of bias rather than as a valuable factor in learning and in motivating action. While some specific emotions have been explored in ethics research, there is a lack of empirical research addressing the relationship between ethical judgement and the emotion of empathic distress. In this research, therefore, we aimed to investigate the impact of mild empathic distress on engineering students' ethical judgements. We conducted this study as an experimental design with 305 participants in two groups. Both groups took a modified version of the Engineering and Sciences Issues Test (ESIT) with an experimental group in which we induced a low level of empathetic distress and an emotionally neutral control group. Results show that a low level of empathetic distress does not impact participants' ethical decisions/judgments. Since the prior research evidence suggest that low level of emotional content improves learning, and given that it does not introduce biases in moral reasoning, we conclude it would make sense to include a low level of emotional content into ethics case studies.

Keywords:

Emotions, Ethical Decision-Making, Engineering Education, Moral Reasoning, Moral Emotions

PAPERS:

ID:

1126

Topic:

Mathematics at the heart of Engineering
Co-creation with students

Title:

🏠 A practical approach to Statistics through SRP

Authors:

Freixanet, Maria-Josep (1);
Alsina, Montserrat (1);
Bosch, Marianna (2)

Abstract:

The paper explains the design and the first part of the implementation of a project within the subject of Statistics with first year students in a Bachelor's degree in ICT Systems Engineering in Manresa School of Engineering, part of the Universitat Politècnica de Catalunya. We use the methodology of study and research paths within the theoretical frame of the Anthropological Theory of the Didactic (ATD) and under the paradigm of "Questioning the world".

The project topic is the effect of technology in water footprint. It is linked to a broader project implemented in the same school with "water" as a main focus, called *AquaeSteam*, a project for the promotion of scientific culture. After narrowing down the issue to a concrete problematic questions, the students will analyse data published in IDESCAT, the Statistical Institute of Catalonia, related to water consumption, both domestic and industrial, factors related to climate change, such as temperature and pluviometry, among others, and will also carry out a survey to link all these studies with the water footprint.

The implementation will shed light on the conditions needed to integrate project-based proposals in the traditional organisation of the subject. It will also provide information about the changes that may take place to facilitate the integration, in both the subject's content and instructional structure (lectures and tutorials). The conditions required will then be compared with other experiences of study of research paths in engineering education carried out these past years in the ATD.

Keywords:

statistics education, project-based teaching, study and research paths, anthropological theory of the didactic, lifelong learning

PAPERS:**ID:**

1128

Topic:Gender and Diversity
Assessment**Title:**LACK OF GENDER DIFFERENCES IN ENGINEERING STUDENTS' ASSESSMENT OF
GROUP-BASED PROJECT EXAMS**Authors:**

Dahl, Bettina

Abstract:

At Aalborg University in Denmark, engineering, science, and mathematics students usually spend half the time each semester working in groups on projects within a problem-based learning (PBL) curriculum. These projects are assessed through group-based exams where students receive individual grades. A previous survey of all engineering, science, and mathematics students showed significant differences in how they, respectively, view various aspects of the group exam. However, students also differ when comparing engineering programmes. This paper focuses on potential gender differences in perception of the group exam. Studies of other exam types showed, e.g., that female students report higher levels of text anxiety, have different reactions to exam pressure, and are less overconfident than male students. The present survey was answered by 915 students (617 males, 298 females) from all semesters and study programmes in engineering, science, and mathematics. The analysis showed that on the majority of questions, there were no significant differences between males and females. However, female students are significantly more in favour of an individual exam, and significantly more often experience they need to speak before having finished thinking. Significantly more male students find that participating with their peers during the group-quizzing phase of the exam gives a sense of security, and they are significantly more tactical about when to speak. The paper discusses the areas of significant differences among males and females and the areas without such differences, and concludes that a group exam might be a more gender neutral type of exam for engineering students.

Keywords:

Assessment, Group exam, Problem-based learning, PBL, Gender differences

PAPERS:

ID:

1131

Topic:

Fostering Engineering Education Research
Digitalisation & Hybrid models

Title:

Learning in a blended learning environment: needs and influencing factors

Authors:

Uukkivi, Anne;
Labanova, Oksana;
Murulaid, Tiia;
Nõuakas, Kati;
Petjärv, Britt;
Retšnoj, Vitali

Abstract:

In blended learning, students have the opportunity to choose either online or classroom lectures. For higher education institutions, blended learning has many advantages, such as accessibility to students and teachers, cost efficiency, alleviation of the teacher shortage, etc. But what does this mean for the students?

The aim of the study is to find out students' further need for blended learning, its reasons and factors influencing it. An online survey was conducted to answer the research questions. The collected data was analyzed by using statistical analysis methods.

The results of the survey revealed that the technical prerequisites for students to participate in blended learning were met. The biggest problems are related to the self-regulation skills of students. Problems with blended learning are stronger among first-year students. However, the respondents were rather positive about blended learning. Blended learning is most strongly supported by distance learning students who live far from university and are over 25 years old. The least supportive of blended learning are full-time students living near of the university and who are under the age of 25. This is due to the fact that full-time students experience blended learning problems on average more often than distance students because of the weaker learning skills.

The results of the survey help to understand students' views on blended learning, to plan and conduct studies in a student-friendly way, and to plan trainings for teachers to improve the blended learning process.

Keywords:

students' preferences, higher education, blended learning, survey

PAPERS:

ID:

1132

Topic:

Navigating Open Learning Environments
Teaching methods

Title:

Self-Directed versus Guided Learning – Searching for the Sweet Spot with Lesson Activities in Moodle

Authors:

Deckert, Carsten;
Mohya, Ahmed

Abstract:

In times of a pandemic many university courses have to be taught in an online learning format to respect the requirements of social distancing. Online learning takes place between the poles of self-direction by the student and guidance by the lecturer. In this paper a first-semester course in industrial economics for engineers, which was taught in the self-directed learning format of flipped classroom, was enhanced with lesson activities in the Learning Management System (LMS) Moodle as a means of guided learning with student-content interaction. The paper describes the design and the evaluation of the lesson activities. For the evaluation a student survey to gather the opinions and self-assessments of the students was conducted, and statistical data from Moodle on the performance of the students were collected. The results of the student survey show an overall positive evaluation of the lesson activities by the students who participated in the lesson activities. Furthermore, the results of the statistical data about the students' performance show a relation between participation in the lesson activities and exam success. As a caveat, however, the results also show that the majority of the students chose not to participate in the lesson activities.

Keywords:

self-directed learning, guided learning, lesson activities, Moodle

PAPERS:**ID:**

1133

Topic:

Ethics in Engineering Education

Title:

Introducing Ethics by Design in engineering education: Covid-19 tracing apps

Authors:

Domingo-Pascual, Jordi

Abstract:

Including ethical concepts and considerations in engineering education has attracted significant interest in recent years, mainly due to the impact of some «so called» AI applications in different areas of our social life. The use of case studies in teaching ethics is a well-known and useful approach. The debate related with a given case study helps students think about the implications, motivations and foreseeable impact of the technologies. This fact is in contrast with the common easy-thinking that all technologies are neutral and that an engineer should not bother about ethics and do not have any responsibility at all. While many basic technologies may be considered neutral, more developed and complex systems are not so neutral; they have a motivation and some foreseeable impact and consequences. Thence, engineers have a responsibility when developing these systems.

This paper presents a case study used in Master and Ph.D. courses in a Technical University to introduce the concept of ethics by design and to stress the idea of responsible conduct in engineering. The case under study is the design and development of tracing applications for fighting against the Covid-19 pandemic in 2020. The analysis of the case requires to understand the basic technologies proposed, the different alternatives considered at that time, the understanding of the basic facts related with the contagion chain and the main factors to be addressed, the consideration of the balance between public health rights and individual privacy rights, and the social aspects mainly related with the acceptability by citizens.

Keywords:

ethics by design, covid-19 tracing apps, responsible design, privacy

PAPERS:

ID:

1134

Topic:

Engineering Skills
Teaching methods

Title:

Profile of the participants in a STEAM Lecturer-Training Program Based on Competencies. Lessons for the future.

Authors:

Perez-Poch, Antoni;
Alcober Segura, Jesús;
Alier, Marc;
Llorens, Ariadna;
López, David

Abstract:

This paper presents the results of a research study on the profile of the participants in a postgraduate lecturer training program (15 ECTS) based on competencies in a STEAM (Science, Technology, Engineering, Arts and Mathematics) University. The study research questions are (1) "in which competences do the participants perceive a personal improvement during the programme?" and (2) "can we identify a profile of the candidates most suited to take better advantage of the training?" The study includes current participants and students who have completed the program in the last five years. A mixed research methodology was used including quantitative and qualitative analysis. Data from the program alumni and current candidates have been quantitatively analyzed to identify common personal and background features among them. Structured interviews and focus groups have been conducted to find out how their initial expectations matched with their perception of what was offered in the program. The qualitative interviews include a discussion about their experiences along the programme and their ambitions for their further professional development, and put in context with their specific background. This research has important implications for the future, such as the need for increased training in digital skills. The majority of the teachers surveyed have a positive impression of the training and are in the middle of their careers. However, because of the pressure to satisfy other Academia requirements, many potential applicants in their early career stages do not complete or even contemplate participating in the program.

Keywords:

STEAM education, teacher training, digital competence; soft skills, higher education

PAPERS:**ID:**

1135

Topic:

Teaching methods

Title:

A Case Study of Engineering Instructor Adaptability Through Evidence of Course Complexity Changes

Authors:

Diefes-Dux, Heidi;
Panther, Grace

Abstract:

Use of a wide array of teaching practices and strategies has been shown to improve students' conceptual understanding, appeal to a diverse set of students, and preparation for engineering work. Adaptability theory provides a lens for understanding changes instructors make and can be useful for conceptualizing faculty development going forward. How an instructor's adaptability plays out in the face of new demands lies in the complexity of the courses they teach. Course complexity refers to both the extent of the array of teaching practices/strategies used in a course and the challenge to implement those practices/strategies. The purpose of this paper is to begin to examine what information is embedded in syllabi that may be used to quantify complexity via a Course Complexity Typology. This work is a case study of a single instructor-course pairing and their course syllabi from multiple semesters.

Keywords:

Instructors, Change, Adaptability

PAPERS:**ID:**

1137

Topic:

Student Engagement
Attractiveness of Engineering

Title:

THE IMPACT OF A STEM PARTNERSHIP ON TRANSFORMATIVE TEACHING AND LEARNING

Authors:

Muñoz-Escalona, Patricia (1);
Rigmand, David (2);
Pinder, Christopher David (3);
Miles, Emma (4);
Cox, Jo (5)

Abstract:

As educators committed to a transformative teaching and learning we need to actively engage with our new generation, promote critical thinking, and share knowledge and skills to promote sustainable developments in order to build that much needed Science Capital. At this moment the UK engineering industry is experiencing two main issues: i) a shortfall of 20,000 graduate engineers per year and ii) lack of female engineers. These two issues are a key challenge that must be addressed to guarantee a sustainable economy. To pursue these goals a STEM partnership between Glasgow Caledonian University (GCU), the Royal Navy and six Primary Schools was funded by the Royal Society Partnership Grants scheme. In this project GCU's students worked collaboratively with 250 primary pupils from age 8 to 11 on the design and manufacturing of a Luge start ramp. Different workshops related to design, manufacturing, mechanical properties, welding and beyond were delivered by the STEM partners, while the pupils provided ideas to enhance the ramp's design and teachers reinforced the topics prior and after each workshop. The project enables to evaluate aspects related to the impact of actively involving young pupils in an engineering real life problem, making them act as engineers, and their change in perception towards engineering. Other aspects that will be analysed are the impact of positive role models not only on the pupils but on pupils' influencers (teachers and parents), as well as the inclusivity and diversity as part of the commitment to a transformative education.

Keywords:

STEM Partnership, Role Model, Engineering, Collaborative and Creativity

PAPERS:

ID:

1138

Topic:

Physics and Engineering Education
Engineering Skills

Title:

PROJECT-BASED LEARNING USING SCIENTIFIC POSTER AS A TOOL FOR LEARNING AND ACQUISITION OF SKILLS IN PHYSICS SUBJECTS OF ENGINEERING BACHELOR'S DEGREES.

Authors:

Cuenca-Gotor, Vanesa Paula;
Salinas Marín, Isabel;
Giménez Valentín, Marcos H.;
Castro Palacio, Juan Carlos;
Sans Tresserras, Juan Ángel;
Ferrando Martín, Vicente;
Sánchez-Ruíz, Luis Manuel;
Monsoriu-Serra, Juan Antonio

Abstract:

This article shows the experience of working on project-based learning using scientific posters, on the study of the mass geometry of matter, with students of various Physics subjects of Degrees in Engineering of the School of Design Engineering of the Polytechnic University of Valencia. The development of this work has been carried out with a dual purpose: on the one hand, to improve the teaching-learning process of mass geometry; and, on the other hand, to improve the acquisition of skills by students. This matter, which is studied in the Physics subjects of the first year of the degree, forms part of the basis of the studies of resistance of materials and theory of mechanisms of subsequent courses. The inclusion of two sessions of laboratory practices, as an extension of the work carried out in the theory and classroom practice sessions, has allowed us to study more deeply the theoretical concepts of mass geometry and their application to a real project, improving the learning by the students. In addition, the presentation of the project through the scientific poster has facilitated the acquisition of cross-curricular competencies such as application and practical thinking, teamwork, effective communication, and critical thinking.

Keywords:

poster, physics project, skills.

PAPERS:**ID:**

1139

Topic:

Fostering Engineering Education Research
Curriculum Development

Title:

Engineers' perceptions of their role in society: the South African case

Authors:

Kloot, Bruce Charles;
Shaw, Corrinne Bonita

Abstract:

Being sparked by interactions with students in the context of a course called 'Engineer in Society', this work-in-progress study explores how engineers conceived of their role during the period of apartheid in South Africa. The literature suggests that engineers consider their contribution to society in solely technical terms rather than in social or political terms. Using interviews with engineering academics, this paper examines how respondents' navigated engineering practice and academic work. The findings indicate significant complexity in terms of how engineers conceived of their role in relation to society, a relationship that was mediated by politicised academic institutions and differentiated cultural norms. This also has an impact on the notion of the culpability of engineers and the question of whether they resisted or complied with the pervasive and brutal regime of apartheid. Although the study revealed a variety of positions and dispositions taken on by engineers, an interesting stance was that of 'technical activism' which involved engineers resisting apartheid by exploiting the liberal spaces that were made available in the context of their engineering work.

Keywords:

Complementary studies, Curriculum, Socio-technical, Qualitative research

PAPERS:

ID:

1140

Topic:

Challenges of new European Universities
Curriculum Development

Title:

ON THE CONNECTIONS BETWEEN CHALLENGE-BASED LEARNING AND THE CDIO FRAMEWORK

Authors:

Gunnarsson, Svante;
Swartz, Maria

Abstract:

Challenge-based learning (CBL) has received increased attention during the last years, and numerous papers have been published, including excellent literature surveys. In some of the publications about CBL the connections to the CDIO (conceive-design-implement-operate) framework are discussed, and it is sometimes claimed that CBL can be seen as an evolution of the CDIO framework. The purposes of this paper are to discuss these connections and to argue that, even though there are several connections, the CDIO framework has a much wider perspective than CBL, and that one key aspect is that CDIO has a program perspective.

There are different interpretations of CBL, and a strict characterization of CBL seems to be lacking. Some of the common features of CBL include open ended tasks, multidisciplinary and team-based learning activities, interaction with external stakeholders, and emphasis on challenges related to sustainability. CBL is also seen as a suitable approach to enable for the students to develop various skills.

The CDIO framework originates from the engineering field, and the fundamental aim of the framework is to educate students who are "ready to engineer". The framework is based on the two documents the CDIO Syllabus and the CDIO Standards respectively, where the first document is a structured set of desired knowledge and skills of an engineer, and the second document contains a collection of the desired properties of an engineering education program.

In the paper, the connections and differences between CBL and CDIO will be discussed based on the items of the CDIO Standards.

Keywords:

challenge-based learning, CDIO framework

PAPERS:**ID:**

1141

Topic:

Mathematics at the heart of Engineering

Title:

SEFI umbrella for teaching mathematics in engineering

Authors:

Velichová, Daniela

Abstract:

Cooperation of mathematics teachers under the umbrella of SEFI MSIG brought many benefits and improvements of strategies adopted at various European TU teaching mathematics courses. Many successful international research teams were formed during conferences benefitting on European grants that supported international programmes aimed to improvements in teaching/learning scenarios. Outcomes and impacts of these programmes are shared in the community, making these benefits available to a large pool of maths practitioners facing similar problems in their everyday life, as weak knowledge from the secondary education, lack of interest in mathematics, low motivation, disinterest to use maths methods in professional fields. Such circumstances undermine the role of mathematics as symbolic language of technical disciplines with consequences in the inadequate position of mathematics in the education of future engineers. Solution of some of the mentioned problems was the subject and goal of many international projects initiated in the SEFI MSIG community. Information summarizing results and findings of 8 European projects funded in different EU programme schemes (Socrates, Leonardo da Vinci, Erasmus) will be presented. Impact of these projects will be analysed in the view of joint efforts to improve the ideas, ways and methods applied in teaching mathematics for engineers. Paper will address several didactical problems revealed from students' answers in didactical questionnaires as feedback and reactions from the "other side". The attitude of students as partners in didactic situations encouraged to cooperate actively with teachers is often neglected when introducing various innovative teaching/learning methods, which are generally considered to be active.

Keywords:

SEFI MSIG, EU programmes, cooperation, mathematics in engineering, students' feedback

PAPERS:

ID:

1143

Topic:

Artificial Intelligence in Education
Engineering Skills

Title:

Understanding and utilizing students' attitudes toward participation in discussions by using emotion analysis

Authors:

Tanaka, Mikiko Sode (1);
Ito, Takao (2);
Miyazaki, Keisuke (2)

Abstract:

We propose a method that uses emotion analysis for PBL education. Emotion analysis is a method of analyzing a person's emotions from the person's remarks or facial expressions. In this method, teachers understand the situation of students from the results of emotion analysis and give accurate advice.

PBL education often involves group activities. The students conducted groups discuss, propose ideas, select ideas, and make the products. However, not all students are able to participate in discussions and express their opinions. It is the teacher's duty to provide guidance to such students. Therefore, we propose the use of emotion analysis techniques to identify and guide students who have problems, such as those who cannot participate in discussions. The method possible do for one teacher to grasp multiple groups at the same time and to develop the students' ability to learn.

Under COVID-19, face-to-face lessons were restricted. Online lessons using Zoom etc. have also been introduced in PBL education. In online classes, it is difficult to grasp the situation of students. This was a big difference from face-to-face lessons. So we looked at ways to keep track of the situation for all students. This is because the gap between students who are willing to take lessons and those who are reluctant to take lessons has widened due to the shift to online lessons. As a result of the adaption to the lessons, the number of students who actively participate in the lessons has increased. The effectiveness of the proposed method was confirmed.

Keywords:

AI emotion analysis discussion PBL

PAPERS:**ID:**

1144

Topic:

Mathematics at the heart of Engineering

Title:

Mathematics education in engineering: a triple discontinuity?

Authors:

Florensa, Ignasi;

Fraga, Iria;

Martínez-Junza, Víctor

Abstract:

Klein announced in 1908 the famous “double discontinuity” experienced by pre-service mathematics teachers when moving from high school to university (first discontinuity) and when they were going back to school institutions (second discontinuity).

Taking this work as an inspiration, we hypothesize that the mathematical education in engineering schools can be characterised by a “triple discontinuity”. The first discontinuity is experienced by engineering students when transitioning between high schools and the first mathematics courses. This discontinuity has been addressed widely both researchers (see for example, Gueudet (2008) or Holmegaard (2014)). The third discontinuity is related with the transition between engineering schools and the workplace and has also been studied in diverse research works such as the often-cited report by Kent and Noss (2003). However, much less attention has been paid to what we call the second discontinuity, characterised by a significant different mathematical activity between first-year mathematical courses and the mathematics in engineering courses in upper courses. Our work characterises the second discontinuity in an Engineering School in Barcelona (Spain) as a first step to identify similar phenomena in other institutions. We have conducted interviews to teachers to find the similarities and differences on the mathematical activity existing in their classes. The results show that the teachers have difficulties to describe the type of mathematical activity further from labelled contents such as “integrals” or “functions” and that the aspects considered as crucial in their courses are very different, preliminary confirming our hypothesis.

Keywords:

Mathematics, Modelling, Engineering

PAPERS:

ID:

1145

Topic:

Sustainability. Sustainable Development Goals

Title:

 PROMOTING SUSTAINABILITY IN EDUCATION THROUGH THE IMPLEMENTATION OF GREEN WALLS FOR GREYWATER TREATMENT

Authors:

Uggetti, Enrica (1);

Biosca, Alex (2);

Pagans, Estel·la (3);

Díez-Montero, Rubén (4)

Abstract:

This study describes the methodology followed to design, build and operate a pilot green wall treating greywater from a vocational training center. The study was carried out in the framework of a master thesis in Environmental Engineering carried out in collaboration with the vocational training center where the pilot system was built. The system consisted of several pots arranged in rows planted with different species of macrophytes. Results showed a successful removal efficiency of the main pollutants (total solids and organic matter), while further post-treatment would be needed to reduce turbidity and pathogens in order to fulfill water reuse standards. This work shows how teaching in certain engineering studies can focus on sustainability and perform a practical work involving younger students from a vocational training center.

Keywords:

Sustainability, green wall, grey water treatment, civil engineering, environmental engineering, active learning methodology

PAPERS:

ID:

1146

Topic:

Student Engagement
Physics and Engineering Education

Title:

RECOMMENDATIONS FOR A MULTICAMPUS COURSE DEVELOPED THROUGH A
"STUDENTS AS PARTNERS" PROJECT

Authors:

Korpås, Guri Sivertsen;
Abel, Roger;
Gunvaldsen, Lina Mathea;
Hansen, Catharina;
Nordahl, Johan Olav;
Åsen, Kristin;
Andersen, Trine Højberg

Abstract:

Evaluations represent a source for information and quality assurance in course development. It is not only the ratings that are essential but the discussions they cause and the improvements of the teaching and learning activities that follow (Roxå et al., 2022). In this process, student and teacher involvement is important to ensure sustainable development. A way to include students in course development is through a Students as Partners approach. This framework challenges the traditional roles and responsibilities of students and teachers (Matthews, 2017), by introducing collaborative, reciprocal processes where everybody has equal opportunities to contribute, following the principles for partnerships by Cook-Sather et al. (2014).

This paper presents recommendations for a Multicampus course in physics and chemistry, developed through a Student as Partners project. In this pilot-project, a resource group consisting of six students, a teacher, and an educational developer was formed and the principles of Students as Partners were followed. The students were selected through a recruitment process, and they received a salary. In this partnership, previous course evaluations were analysed, presented and discussed. This thorough process led to various suggestions for improvements. The main recommendations are that the lectures and learning activities should be diverse and adapted to the students' different needs. These recommendations are not groundbreaking in themselves, however, the grounding in a common understanding through the use of the Student as Partners framework is novel and gives new perspectives to course development and educational development in general.

Keywords:

Educational development, Students as Partners, Multicampus courses, Physics.

PAPERS:

ID:

1148

Topic:

Teaching methods

Assessment

Title:

Effect of a practice-intensive course on doctoral teaching assistants teaching self-efficacy and priorities

Authors:

Isaac, Siara;

de Lima, Joelyn

Abstract:

Doctoral teaching assistants (TAs) provide key support for learning in STEM fields because they are present during exercises, labs and projects when students are actively engaging with course material. While some institutions provide training for TAs, their effect on teaching activities is rarely assessed. We use the lens of Social Cognitive Theory (SCT) to analyse data on the pre and post course teaching priorities of 20 doctoral TAs who followed a 5 day practice-intensive course on STEM HE. Course time was split between instructors modelling interactive teaching strategies to engage TAs in a data-driven reevaluation of their beliefs about teaching and having each TA teach a lesson everyday using a structured feedback loop to promote reflection. TAs reported self efficacy gains for designing instruction, addressing disruptive behaviour and managing student attention spans after the course. Their priorities also appear to shift away from 'teaching' and towards 'learning'. TAs' affective reactions and utility judgements after the course indicated that they thought the course was useful and they intended to use the strategies that they had learnt. This practice and reflection intensive course model, able to accommodate up to 40 TAs, is relevant for institutions seeking to improve the quality of undergraduate education or doctoral candidates' preparation for academic roles.

Keywords:

Doctoral teaching assistants, self-efficacy, pedagogical training, practise-intensive course, academic career preparation

PAPERS:

ID:

1149

Topic:

Building Communities and Coordination
Digitalisation & Hybrid models

Title:

Teachers' and students' perceptions and practices in promoting a sense of community for blended education

Authors:

Pei, Linlin;
Poortman, Cindy;
Schildkamp, Kim;
Benes, Nieck E.

Abstract:

Blended learning (BL) has attracted renewed interest among universities in preparing for education post-COVID-19. While it is not a new concept, higher education intuitions (HEIs) are in a new situation in which most teachers have gained extensive experience teaching online, which was never the case prior to the pandemic. Despite teachers' sincere intentions to further advance BL post-pandemic, maintaining social engagement with students while motivating them to actively participate in learning are significant challenges for teachers working in a BL environment (Pei, 2020). Poor social interactions between students and teachers establish barriers against the quality of BL (4TU. Centre for Engineering Education, 2021; Boelens, De Wever, & Voet, 2017), culminating in students' feelings of loneliness, isolation, and motivation loss (Arslan, 2021; Hehir, Zeller, Luckhurst, & Chandler, 2021; Pei, 2020).

In this situation, a sense of community (SoC) is essential. SoC conducive to learning is crucial, but it can pose certain challenges. Hence, this study aims to enhance the understanding of students' and teachers' recognition of SoC based on their perceptions and practices. A qualitative methodology is used to include non-participant observation, document analysis, and interviews for data collection and analysis. The findings of this study will enhance our understanding of teachers' perceptions, practices, and challenges for cultivating SoC for students. Second, the outcome of this study will help future professional development for teachers working on blended education. Finally, we hope this study can support HEIs in preparing and reshaping universities for the post-pandemic era.

Keywords:

Blended learning, sense of community, social engagement, perceptions and practices

PAPERS:

ID:

1150

Topic:

Student Engagement
Teaching methods

Title:

DESIGN AND EVALUATION OF A CHEMISTRY SUBJECT IN AN ENGINEERING DEGREE

Authors:

Almajano, MaríaPilar;
Darbra, Rosa Mari;
Lalueza, Joana

Abstract:

The impartation of a new Degree at the Universitat Politècnica de Catalunya provided the opportunity to design a Chemistry subject from the beginning. This was designed focusing on the process of student learning, following the indications of the last meeting of the European Higher Education Area in Rome (November 2020).

The objective 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 studied chemistry in high school (between 20 and 30% of the total).

To this end, the flipped classroom methodology has been used. For this purpose, different materials such as videos with embedded questions and tests have been created to promote the students self-learning. In addition, tuition in new skills have also been 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 continuously work.

This method has been put into practice during the last 4 academic courses (3 normal and one in confinement). After each course, the students have assessed, both the methodology and the material. In all cases, they have highlighted the fact that continuous work and immediate feedback is one of the points that have helped them the most in their learning process. Comments on improvement opportunities have also been gathered and implemented together with the students.

Keywords:

Flipped classroom; continuous assessment; leadership; self-study

PAPERS:

ID:

1151

Topic:

Engineering Skills
Assessment

Title:

THE UTILITY OF A PEER REVIEW APPLICATION IN INTERDISCIPLINARY TEAMWORK ARRANGEMENTS

Authors:

Johnson, Coralie;
Macleod, Miles;
Visscher, Klaasjan

Abstract:

Project and challenge-based learning typically require students to navigate personal and professional relationships within a team, in order to collaboratively solve authentic problems. These collaborations are often interdisciplinary in nature – an arrangement that adds increased complexity to the team’s functioning. This is due to distinctions in approaches, epistemologies, ethos or jargon. The ability to provide (and receive) appropriate and constructive feedback to peers, within the team, is a key skill that can enhance team functioning and ultimately, output. Furthermore, it is a competence that aids in lubricating social and work impediments that may be causing bottlenecks to creativity, or the manifestation of ideas. The aim of this study, set within three different interdisciplinary bachelor modules, is to determine to what extent the use of the ‘Buddycheck’ application for peer review, is appreciated by students and teachers. The application, hosted within the learning management system of the university, allows students to rank their peers’ performance according to teacher-set criteria, as well as through flexible open-format feedback; in order to facilitate opportunities for enhanced communication and expectation alignment. We wish to ascertain to what degree team functioning is enhanced through the scaffolded communication opportunities, by highlighting and creating openings to discuss undesirable behaviours, through the feedback application. Preliminary results appear to favour this mode of feedback facilitation, albeit with certain caveats, detailed later. Since teamwork is universal in tertiary education, these insights may be helpful for educators attempting to further improve the evaluation of the process of their projects or challenges.

Keywords:

Peer Review, Interdisciplinarity, Project-based Learning, Challenge-based Learning, Engineering Education.

PAPERS:

ID:

1152

Topic:

Engineering Skills
Teaching methods

Title:

Skills for learning across disciplines in project-based learning

Authors:

van Harmelen, Erwin;
van Otten, Leonie;
Visscher-Voerman, Irene

Abstract:

Education focusing on developing interdisciplinary skills is gaining traction in Higher Education. Often this type of education takes shape through project-based learning. Prior research shows that the focus of such interdisciplinary learning should lie on attaining synthesis and that the end result of an interdisciplinary project should be more than the sum of its disciplinary parts and be truly synergetic. Two important prerequisites of successful interdisciplinary (project)work are reaching a common goal in which each discipline is of added value towards synthesis and attaining a common ground of methods, concepts and views.

In this research project, the focus was on mapping if students were able to reach a common ground and synthesis during working on an interdisciplinary project. The context is the Smart Solutions Semester of Saxion University of Applied Sciences, where third- and fourth-year students from three or more (engineering) disciplines work together in project teams on large (25 ECTS) projects, provided by research groups and the business community. A learning activity was developed for and conducted with four student teams after which semi-structured interviews were held with the students and corresponding tutor. Results confirm the importance of a common goal and common ground. Additionally, results show the importance of fostering interdisciplinary exchange and the crucial role of the tutor in guiding students toward synthesis.

Keywords:

Interdisciplinary skills, project-based learning, interdisciplinary teamwork, interprofessional collaboration, teacher as coach.

PAPERS:

ID:

1153

Topic:

Engineering Skills

Lifelong Learning

Title:

Reflection in action: a critical reflection tool to help students deal with uncertainties in designing solutions for complex problems

Authors:

Wehrmann, Caroline;

Smits, Casper

Abstract:

At Delft University of Technology (DUT) in the Netherlands, students collaborate in multi-disciplinary teams with professionals in living labs to design solutions for real-life complex problems. Students are guided by a lecturer through the four phases of design (Double Diamond, British Design Council) to “cut through” the complexity of the problem. However, in these 'ill-defined wicked problems' nobody has an overall picture of the problem and students face many uncertainties. These uncertainties are often perceived as a barrier for decision-making within the design process.

A reflection tool, based on theoretical insights in transformative and triple-loop learning, is developed to help students critically reflect in action, providing them with options to deal with their uncertainties. We distinguish between task, social, and individual uncertainty (Daalhuizen et al. 2009). In this study, the central question is: How can the reflection tool help students deal with their uncertainties in solving complex problems in DUT living labs. By means of surveys, interviews and observations we monitored two living labs in this year's first semester, one with bachelor and one with master students. We focused on how students used the reflection tool, what kind of uncertainties they encountered, and how they dealt with them.

Analysis of the data shows that students perceived all types of uncertainty in the various phases of the design process. By means of the reflection tool students gradually became aware of the many options they have in dealing with uncertainties, and particularly how these pertain to their decision-making in the design process.

Keywords:

Living labs, critical reflection, uncertainty, complex problems, design methodology

PAPERS:

ID:

1155

Topic:

Mathematics at the heart of Engineering

Title:

🏠 STUDENTS' UNDERSTANDING OF DOUBLE INTEGRALS – IMPLICATIONS FOR THE ENGINEERING CURRICULUM

Authors:

Khemane, Thabiso;

Padayachee, Pragashni;

Shaw, Corrinne

Abstract:

Mathematics plays a significant role in engineering students' education. To undergraduate engineering students, calculus concepts are foundational to their engineering courses. One such concept is the double integral. It is thus important to ensure that students not only learn this concept but also engage to understand it and are able to apply this knowledge in relevant engineering courses. This research paper focuses on the following two components: Firstly, the relevance of double integrals to the engineering curriculum. And secondly, students' understanding of the double integral concept. We present the relevance of double integrals in the engineering curriculum by looking at the use of this concept in different engineering fields. We explored students' understanding of double integrals and administered a test to 35 second year engineering students enrolled in an undergraduate Calculus III course. In a qualitative study, the performance of students was used to analyse the type of misconceptions they have in double integration. The findings reveal that the students encounter difficulties with graphical representation of surfaces and region of integration. In addition, students struggle with changing the order of integration and performing the integration process. While some of these errors are conceptual, others are really due to carelessness in the procedure. Further analysis indicate that some misconceptions are a result of misunderstandings in prerequisite courses. The results will be useful to Mathematics educators who are keen in finding sources of misconceptions. The research may be used in designing functional teaching and learning instruments to rectify misconceptions in double integrals.

Keywords:

Engineering curriculum, mathematics, double integrals, misconceptions

PAPERS:**ID:**

1156

Topic:

Engineering Skills
Teaching methods

Title:

Work in Progress: Fostering Engineering Students Collaboration in Distance and Blended Learning Environments

Authors:

Lutsenko, Galyna V.

Abstract:

The COVID-19 pandemic has caused serious challenges in the organization and supporting communication and collaboration between engineering students and execution of the team projects in online mode. Academic staff had faced the necessity to adapt the actual face-to-face instructional methods to the requirements of online or blended learning settings. For first-year engineering students, this situation is complicated by weak ties with classmates, the growing role of self-directed learning skills, including the planning of time for learning in synchronous and asynchronous modes. At the same time, students also must adapt to the demands of higher education, improve digital skills and master professional content.

The purpose of this study is to present the ongoing experience in adaptation of three semester course "Project Work Technology" to online/blended learning settings by using a combination of the variety of instructional methods and digital technologies. The work in this integrated course begins in the second semester of the first year of studies and includes both basics of project management and practical engineering tasks. The changes were introduced into all elements of the curriculum including learning outcomes, course content, types and duration of students' projects etc. The main attention was paid to the effective using of digital tools and related learning activities. The research question was to evaluate the impact of course on communication and collaboration students' skills and readiness to future teamwork. Also, the survey was carried out which includes the question related to tools, which students use during the lessons, and learning activities.

Keywords:

engineering education, online/blended learning setting, teaching methods

PAPERS:

ID:

1157

Topic:

Ethics in Engineering Education
Engineering Skills

Title:

What works (and what does not) to incorporate ethics as a cross curricular competence?

Authors:

Giménez Carbó, Esther;
Gómez-Martín, María Esther;
Andrés-Doménech, Ignacio

Abstract:

In 2013, an ambitious plan was implemented at Universitat Politècnica de València aiming at ensuring that all graduates achieved a set of 13 transversal competences which would make them excellent graduates not only from a technical point of view, but also beyond. One of these competences in which we want to train and assess our students is "ethical, environmental and professional responsibility". This paper presents the study carried out to check whether it can be proven that all graduates from six different degrees taught at UPV have achieved this objective.

To this end, activities developed within each Bachelor degree curriculum are analysed, studying the suitability of each activity to the level of knowledge required in each course. We will also analyse the perception of students and lecturers in charge of incorporating this transversal content within their subjects.

In view of the results obtained, "good practices" will be proposed, indicating the activities carried out which have succeeded in increasing the students' training and knowledge related to this topic. Activities, which, despite being carried out for a certain purpose, do not manage to work on and assess this cross curricular competence, will also be discussed.

Keywords:

cross curricular competence, engineering ethics, professional responsibility

PAPERS:

ID:

1158

Topic:

Physics and Engineering Education
Teaching methods

Title:

APLICACION OF A GAMIFICATION LEARNING SYSTEM IN MECHANICAL ENGINEERING STUDIES.

Authors:

Pàmies-Vilà, Rosa (1);
Fabregat-Sanjuan, Albert (2);
Puig-Ortiz, Joan (1);
Jordi Nebot, Lluïsa (1);
Hernández Fernández, Antoni (1)

Abstract:

The purpose of this study is to examine the effects of using a gamification tool as a new teaching strategy. Specifically, Kahoot! is evaluated as a tool for enhancing student learning. We test the tool empirically in a university class setting in an engineering degree, namely as part of the laboratory sessions of the subject Mechanism and Machine Theory during two consecutive academic years. The students were randomly divided into three different groups (control group, gamification group and writing group) and their results were evaluated depending on the learning method applied during the class. In terms of gamification, this project introduces real-time feedback to stimulate the interest of students and help them use the typical tools and methodologies of game-based learning. The analysis of their performance in the laboratory exam shows significant differences between the group that used gamification and the groups that did not. It can be seen that gamification improves student learning performance. The study concludes that game-based elements and competitive activities enhanced student performance and recommend their use in educational environments to support the learning process.

Keywords:

Gamification; game-based learning; improving classroom teaching; mechanical engineering; Interactive learning environments

PAPERS:

ID:

1159

Topic:

Mentorship and Tutorship
Engineering Skills

Title:

Professionalising teachers in guiding reflection of students

Authors:

Mittendorff, Kariene;
Eshuis, Elise;
van der Heijden, Karin;
Daggenvoorde-Baarslag, Heleen

Abstract:

The contemporary knowledge society of the 21st century requires students, among other things, to have the ability to think analytically and reflectively. Research into the disappearance of technical employees from the technical labor market also shows it is important to guide students in their professional identity development, in which reflection of students is crucial. Various studies show however that educational programs and teachers experience difficulty with the effective use of reflection in education. In the project 'Strengthening reflection in technical higher education programs', six technical higher professional education programs of two Dutch higher education institutes are working on the improvement of reflection in their programs. Teachers from these teams are also trained in guiding and assessing reflection activities of students. In this current research, the following research questions will be answered:

1. How do teachers guide students during reflection activities or conversations?
2. How do teachers assess students' reflection activities?
3. Does the offered training contribute to an increase in guidance or assessment skills of teachers concerning reflection activities of students?

A selection of teachers of the participating teams will be interviewed before and after the training. To assess teachers pedagogical and didactical knowledge and skills, video vignette interviews are used. Vignettes were designed to provide teachers with multiple authentic situations that are prototypical in their teaching context and which are depicted in video captions. Interview protocols were used to elicit teaching interventions and teachers' rationales and thoughts behind these interventions in the depicted situations.

Keywords:

reflection, guidance, teacher skills, professionalisation

PAPERS:**ID:**

1160

Topic:

Mathematics at the heart of Engineering

Teaching methods

Title:

Teaching advanced quantitative techniques through a competitive project

Authors:

Domenech, Bruno;

García-Villoria, Alberto;

Maquirriain, Javier;

Pastor, Rafael

Abstract:

Heuristics, metaheuristics and matheuristics are quantitative techniques that can be used to solve complex combinatorial optimisation problems for many engineering applications (industry, logistics, supply chain, scheduling, services, etc.). The course Quantitative Methods of Industrial Process Management II from the Master's Degree in Industrial Engineering of the Technical University of Catalonia addresses such topic. The course is organised into 3 session typologies: (1) master classes, where lecturers provide students the theoretical concepts; (2) practical classes, where students solve small-size problems based on real cases; and (3) competitive project, which is the core of the evaluation. On this regard, a real-based combinatorial optimisation problem is provided and, in 3-member groups, students have to develop an ad hoc (meta/math/hiper)heuristic, based on the theory concepts, and code it with standard language (Python, Java, C++, etc.). For the evaluation, each group solves 10 exam-instances of the problem. The qualification is based on the result achieved by each group for each instance in comparison with a minimum quality threshold, defined by the lecturers, and the results of the other groups. In this manner, students learn very complex concepts in a friendly but competitive environment, which invites them to work hard on the application of theory concepts into a problem close to those they will find in their professional career. Students' assessments show an increase in their performance and interest regarding the course.

Keywords:

quantitative techniques, heuristics, engineering, competitive project

PAPERS:

ID:

1161

Topic:

Lifelong Learning
Teaching methods

Title:

DEVELOPING PROFESSIONAL INFLUENCING SKILLS OF YOUNG ACADEMIC ENGINEERS – CASE: YOUNG PROFESSIONALS' FORUM (YPF)

Authors:

Ylitalo, Jari;
Kostamo, Tuukka

Abstract:

Professional working life skills have become an essential part of the engineering skillset in recent years. However, it seems that basic engineering education does not sufficiently provide the students with these skills. The Finnish Association of Academic Engineers and Architects (TEK) established a new kind of peer forum to develop these skills of its younger members. The forum consists of workshops, assignments, and peer dialogues over a four-month time period. The forum's approach leans on a dialogic, experiential and reflective way of learning enabling the participants to further build their personal influencing practices; investigate their professional relationships; experiment changes in their self-management practices; and share their experiences in peer groups. Since 2017, over 900 young TEK members have participated. The aim of this study in progress is to make an overview to the experienced impacts of the forum and scrutinize the forum's influence mechanisms in a more detailed way. The data was collected through an inquiry to all participants. The study indicates that the forum has been most influential in supporting the participants to become more aware of their professional influence, to build capabilities to change their personal and social practices, and to enhance their professional networks. The most significant impact element has been various peer discussions and dialogues. As a conclusion the study highlights the needs and interests of young professionals to develop the essential working life skills.

Keywords:

professional influencing skills, leadership skills, self-management practices, peer networking, continuous learning

PAPERS:**ID:**

1162

Topic:

Sustainability. Sustainable Development Goals

Title:

INTEGRATING SUSTAINABILITY AND SOCIAL COMMITMENT (S&SC) COMPETENCES IN THE CURRICULUM AT THE BARCELONA SCHOOL OF CIVIL ENGINEERING

Authors:

Roca Bosch, Elisabet;

Real, Esther;

Ferrer, Ivet

Abstract:

The importance of integrating the Sustainable Development Goals (SDG) in the curriculum of all the bachelor and master degrees at UPC has been legally and institutionally recognised. At the Barcelona School of Civil Engineering, issues such as professional ethics, environmental impacts of infrastructures, respect for cultural diversity and gender perspective are currently cross-cutting competences highlighted and stated in the study plans as Sustainability and Social Commitment (S&SC). However, its effective implementation requires significant teaching efforts in order to adapt academic curricula, so far limited to individual non-coordinated initiatives.

The launch of the "ODS-Camins Toolkit" project (Toolkit for the Promotion of SDG in the Civil and Environmental Engineering Fields) seeks to encourage the implementation of teaching innovation practices that contribute to the deployment and assessment of S&CS competences. The spirit of the project is to collaborate and exchange experiences, develop new practices, and draft a common pathway for the promotion of the SDG in the field of civil and environmental engineering studies.

The paper will explain the experience of this one-year project, highlighting barriers, challenges, and sharing the lessons learned with the final purpose of involving all the community in the years to come. It will also present the Toolkit for the Promotion of SDG in the Civil and Environmental Engineering Fields

Keywords:

SDG, Civil and Environmental Engineering, Sustainability

PAPERS:

ID:

1163

Topic:

Niche & Novel
Gender and Diversity

Title:

Triggering and internalising teamworking skills in neuro-typical and neuro-atypical students with a computer orchestrated group learning environment: A multi case study

Authors:

Malik, Manish (1);
Sime, Julie-Ann (2)

Abstract:

Project-based learning and flipped classroom approaches are often used for developing team working skills in graduates. However, many engineering schools face efficiency and effectiveness challenges when it comes to facilitating students in these settings. For neuro-atypical (NAT) students, such as those with Attention Deficit Hyperactivity Disorder (ADHD) or Autism, support for developing teamworking skills can be limited. Even neuro-typical (NT) students find teamwork challenging and can benefit from an intervention that supports development of such skills. Self, Co and Shared regulation skills are considered important for effective team working. Regulation is a multi-staged process, which includes goal setting, planning, doing, monitoring and evaluating own and a team's work. Research on use of computer scripts to successfully orchestrate the multiple stages at a shared level shows only partial success. Many Computer Supported and Collaborative Learning studies cite over-scripting as a common criticism related to orchestration of shared regulation and team work. This work investigates "How computer orchestration scripts affect the triggering and internalisation of Self, Co and Social regulation skills in NT and NAT students when using a Computer Orchestrated Group Learning Environment (COGLE)?". COGLE was used with first year neurotypical and neuro-atypical engineering students to study its impact on triggering existing and/or internalising new regulation scripts in team working. Qualitative data from two literal replication cases were analysed. This work shows how different types of scripts in COGLE helped trigger, develop and internalise regulation skills and highlights areas where more work is needed.

Keywords:

Neurologically atypical, ASD, ADHD, Collaborative learning, Computer supported collaboration (CSCL) at computer

PAPERS:**ID:**

1164

Topic:

Engineering Skills

Digitalisation & Hybrid models

Title:

A landscape review of the literature focussing upon the use of technology to support Problem, Case and Project based learning in Higher Education STEM disciplines.

Authors:

Wood, Ruth (1);

Malik, Manish (2)

Abstract:

A systematic approach was undertaken to locate and analyse empirical research examining the use of technology to support constructivist approaches to learning. In particular, this paper focuses upon Problem, Project and Case Based Learning and consults publications which have employed technology in Science, Technology, Engineering and Mathematics within on campus higher education settings. Four databases were searched and after applying relevant inclusion and exclusion criteria, 56 publications published during 2007–2021 were included in this review. In addition to systematically documenting the landscape of literature associated with this area of research, this paper offers an analysis of the contributions of the research in understanding the way in which technology affects efficiency, team effectiveness and inclusivity as part of the learning process.

Keywords:

Problem, Case, Project based learning, technology enhance learning

PAPERS:

ID:

1167

Topic:

Student Engagement
Physics and Engineering Education

Title:

 Promoting lab engagement in experimental compressible flow modelling

Authors:

Armengol, Sílvia;
Gamez-Montero, Pedro J;
Raush, Gustavo

Abstract:

The present work depicts the development of an experimental equipment that reveals compressible fluid dynamics, while collecting data from an incompressible flow like water in an open-channel. It consists of an extensive theoretical framework followed by a practical analysis, the aim of which was to trigger the hydraulic jump, both normal and oblique, in order to illustrate its hydro-gasdynamic analogy with a shock wave, occurring in supersonic compressible flows.

The assembly, called “water table”, arises from the necessity of economical alternatives to expensive supersonic wind tunnels in the experimental study of compressible flows. Thus, a canal based on a Laval nozzle was constructed where water flow could experiment a hydraulic jump. Through its visual and experimental perception, fellow interested could more easily understand the physics and engineering behind this phenomenon.

Multiple design alternatives were evaluated considering environmental, economic, functional and aesthetic factors. A low-cost implementation was critical in the design process. The measurements revealed that the geometry of the nozzle and the wedges designed as obstacles to cause obliquity were the most influential elements in the formation of a hydraulic jump in the set-up. Regarding the experimental variables, the upstream and downstream heights had the highest relevance. Therefore, their manipulation and analysis could lead to further educational investigations.

This research is a step forward to support students in the understanding of compressible flow principles by providing an in-house experimental set-up. The equipment is an opportunity of carrying out lab measurements, which certainly guides to a major commitment in the field.

Keywords:

STEM education, undergraduate research, compressible flow, fluid mechanics, water table

PAPERS:

ID:

1168

Topic:

Entrepreneurship Education

Engineering Skills

Title:

Correlation study between the access mark and the performance in project-based and standard subjects.

Authors:

Bragós, Ramon (1);

Aoun, Louay (1);

Charosky, Guido (2);

Bermejo, Sandra (1);

Rey, Francesc (1);

Pegueroles, Josep (1)

Abstract:

The access mark to engineering studies is often used as an a priori success estimator. In our institution, we have observed that the correlation of the access mark with the grades obtained in project-based courses ($R=0.52$) is slightly lower than the one obtained with the average of the other non-project-based courses ($R=0.58$), and is especially low in capstone projects ($R=0.31$). Project-based courses are one of the most acknowledged ways of promoting the learning of transversal skills, specifically innovation and entrepreneurship skills. In our institution, ICT engineering bachelor students perform a project-courses path, with three subjects of growing complexity in the 2nd, 3d and 4th year. While the first two are partially guided and with challenges proposed by the faculty members, the 3d one is a 12 ECTS capstone project with challenges proposed by industry or external institutions. In this study, we have analyzed the performance of the students along 10 academic years (2011-2012 to 2020-2021). Not only the correlation with the access mark in these courses is lower but the prediction interval is also different. While it is almost impossible that a student with a low access mark gets an outstanding average mark in the bachelor and vice-versa, there are students with a low access mark which have an outstanding performance in the capstone project and students with a very high access mark and with high results in analytical courses but with a poor performance in capstone projects. Therefore, a different kind of skills are promoted in these courses.

Keywords:

Innovation skills, Capstone Project, Access grades, Project-based learning

PAPERS:

ID:

1169

Topic:

Gender and Diversity

Title:

📖 The phantom menace: spatial abilities and STEM outreach to fight underrepresentation in STEM

Authors:

Velho, Mariana;

Dorran, David;

Duffy, Gavin

Abstract:

Spatial abilities are an important, and often overlooked, component of Science, Technology, Engineering and Mathematics (STEM) education with skills like spatial visualisation and mental rotation being important for technical professions such as engineering. Individual differences in spatial abilities have been reported throughout the years. Factors such as being female or having a low-socioeconomic status are linked with lower spatial abilities level. Spatial abilities training interventions have proven to be effective, with some showing improvements, not only in spatial abilities level, but also in the success and retention of students enrolled on STEM degree programmes, especially for women. In today's technological society, STEM outreach activities are a common method to promote STEM for children, showing them role models in the area, and improving their self-efficacy, sense of belonging and motivation to follow careers in STEM. At the same time, the underrepresentation seen in the area (e.g., women; LGBTQ+ community; ethnic minorities; and other marginalised groups) needs to be addressed in order to enhance the inclusive environment of these fields. This concept paper discusses review work in relation to underrepresented groups and how future spatial abilities studies should consider integrating the knowledge from past spatial abilities studies into STEM outreach activities. This integration can make spatial training available to more people, revealing itself to be a useful tool in helping diminish underrepresentation in STEM.

Keywords:

spatial abilities, STEM education, intersectionality, STEM outreach, inclusive

PAPERS:**ID:**

1170

Topic:

Student Engagement

Title:

Strengthening Students' Learning Outcomes through Quiz Work

Authors:

Posselt, Charlotte;

Stisen Flyger, Charlotte;

Kjaersgaard, Niels

Abstract:

Most instructors of Engineering students will be familiar with students who – instead of engaging actively with a given field of knowledge – merely reproduce the curriculum at the exam. This study hypothesizes that students will achieve a higher taxonomic level by using a didactic tool – with a higher degree of understanding, application, and reflection as a result. We have developed such a didactic tool and method to create engaging teaching sessions through a special learning process: that is students preparing quizzes.

Our starting point is the French researcher Guy Brousseau's theory of didactical situations in mathematics and his five phases. In the first phase the didactic contract was established between the students and the instructor, that is the assignment of preparing quizzes was handed over. During phases 2-4 the students worked with the concrete quizzes (a-didactic parts). In phase 5, cohesion of the learning and transfer was established.

We examined the relationship between quizzes and student learning outcomes through the lens of the American professor Vincent Tinto's influential three-fold model of motivation: Self-efficacy, sense of belonging and perception of curriculum. The students' self-efficacy and perception of curriculum are strengthened by working with the topic several times (repetition: the more students learn, the more they come to believe they can learn).

The study showed among other things that out of 37 answers, 79% of the respondents reported that preparing quizzes for other students improved their learning outcome compared to traditional learning.

Keywords:

Strengthening learning outcome, engaging students, quizzes

PAPERS:**ID:**

1171

Topic:

Industry and Companies liaison. Regional Involvement and Innovation

Title:

Perceptions and Experiences of Online Internship

Authors:

Tepsa, Tauno;
Mielikäinen, Maisa;
Angelva, Juhani

Abstract:

Remote working enables organisations to have location- and time-independent business processes. Working life practices should also be applied in higher education. Lapland University of Applied Sciences' ICT education in Finland met the challenge by developing an online internship concept that improves cooperation between the university and industry and promotes the content and quality of education. This paper describes the experiences of the research project of online internship models. Oral feedback from students (N = 12) and companies (N = 6) were analysed along with the online internship concept during 2021. The concept includes three types of process models. Based on the idea that business and industry representatives are active players in the process. The supervising teachers and technical support staff of Lapland University of Applied Sciences (UAS) acted as a support network. Results confirmed the notion of the usefulness and suitability of the concept for the purpose. The marketing of the concept was supported by a process website. The challenges found focused on, for example equipment resources and the pedagogical skills of industry representatives. The concept can be generalised regardless of the field.

Keywords:

Internship, Online, Remote work, Industry liaison

PAPERS:

ID:

1173

Topic:

Sustainability. Sustainable Development Goals

Title:

 A Research Program about a short-term PBL approach based on the SDG

Authors:

Braga, Marco (1);
d'Escoffier, Luiz (1,2);
Guerra, Aida (3)

Abstract:

The rapid increase in the world population concentrated in urban areas has created complex problems for cities, namely access to drinking water, sanitation, living, commuter, etc. However, many solutions could be prototyped today aiming to create future cities. It is very important that engineering education face this challenge, mainly in the field of Sustainable Development Goals (SDG), where students develop knowledge and skills in a given engineering field while addressing SDG. Project-based learning (PbL) is not new in educating engineers in general, and for sustainable development in particular. In PbL, different type of problems leads to different type of projects solved and developed by a group of students. For example, some narrow problems demanding low technological solutions could be developed by students in the first stages of engineering courses. The Federal Center for Engineering Education in Rio-Brazil has been developing a short-term project experience (PbL) focusing on the SDG in the cities. During 48h the students are faced with SDG problems from urban communities and are challenged to create low-cost solutions. In the end, they should present a pitch for experts from NGOs, government, and corporations. This paper presents a short-term PBL approach for SDG supported by cases developed by the students and concludes with recommendations about a research program, aiming to understand the process and the ways to transform the projects into concrete social innovation actions of sustainability applied to communities.

Keywords:

PbL, Sustainability, SDG, Short-term PbL, Engineering Education

PAPERS:

ID:

1175

Topic:

Navigating Open Learning Environments

Title:

EngiMath online course. Effective feedback from UPC mathematics teachers.

Authors:

Serrat, Carles;
Estela, M. Rosa;
Bruguera, M. Montserrat;
Pantazi, Chara

Abstract:

EngiMath is a 3 ECTS online course in engineering mathematics, in seven different languages (English, Spanish, Portuguese, Catalan, Polish, Romanian and Estonian), and it is the main and practical output of the ERASMUS+ project entitled "Mathematics on-line learning model in Engineering education" (2018-1-EE01-KA203-047098, Nov 1st, 2018-August 31st, 2021) in which the authors were participating. The course is integrated with Learning Management Systems such as Moodle and it is compatible with other platforms using Learning Tools Interoperability.

Once the EngiMath course has been implemented, authors undertake, with the support of the Institute of Education Sciences at the Universitat Politècnica de Catalunya-BarcelonaTECH (UPC), a unique project, EngiMath@UPC, with these three practical objectives: a) incorporate EngiMath into the teaching activity of the widest as possible range of students, b) gather students and faculty feedback regarding the tracking of materials and their performance in the student training process, and c) statistically analyze the data collected in order to validate and adjust the follow-up of the materials. In connection with the above mentioned objective b) a training course addressed to the math professors has been prepared at UPC.

This paper has two main goals. On the one hand, to introduce the EngiMath course as an online open educational resource for the academic community benefit, and on the other hand, to analyze the valuable feedback given by the training activity participants. Details on the online course implementation as well as main conclusions will be presented and discussed throughout the document.

Keywords:

Online courses, Engineering mathematics, Open Educational Resources, ERASMUS+ projects, Assessment tools

PAPERS:

ID:

1176

Topic:

Engineering Skills
Teaching methods

Title:

Multi-, inter- and transdisciplinarity in challenge-based engineering education

Authors:

Visscher, Klaasjan (1);
Johnson, Coralie (1);
MacLeod, Miles (1);
van der Veen, Jan (2)

Abstract:

Challenge-based learning (CBL) offers students in engineering programmes an opportunity to develop communicative and collaborative skills, apply disciplinary knowledge and develop boundary-crossing competencies. Mono-disciplinary approaches to CBL are generally regarded too limited, but whether multi-disciplinary, interdisciplinary, or transdisciplinary approaches should be used is open to discussion. Often, these concepts are used interchangeably, but there are notable differences. In literature, knowledge integration is mostly mentioned to make a distinction, but because of difficulties in applying this concept to education, we focus on tangible differences in educational practices, related to learning objectives, assessment, and the design of challenges. The different forms of CBL are illustrated by three case-studies carried out at a research university in the Netherlands. We found similarities, but also some subtle differences between multi-, inter- and transdisciplinary approaches to CBL. Multidisciplinary CBL projects are relatively pre-structured, with an indication of the knowledge that is to be applied, deepened, or combined. Interdisciplinary CBL is more open-ended, with students made responsible for connecting their disciplinary backgrounds to the project and for integrating disciplinary perspectives. Transdisciplinary CBL focuses more on impact than on integrating disciplinary contributions. Challenges are open-ended from a content and stakeholder perspective, while structure emerges in the interactions between students, teachers and stakeholders. Which form of CBL can best be employed in a course or programme is dependent on the intended learning objectives. Educators should be aware of trade-offs and of the specific teacher competences required to design and support these different forms of CBL.

Keywords:

Interdisciplinary education, Transdisciplinary education, Challenge-based learning, Problem-solving competences

PAPERS:

ID:

1178

Topic:

Student Engagement
Curriculum Development

Title:

🏠 ENGINEERING STUDENTS' MOTIVATION FOR LEARNING IN CHALLENGE-DRIVEN PROJECT COURSES: A QUALITATIVE PILOT STUDY

Authors:

Pantzos, Panagiotis (1);
Rosén, Anders (1);
Buckley, Jeffrey (1,2);
Gumaelius, Lena (1)

Abstract:

This pilot study explores engineering students' motivation for learning and studying through the lens of Self-Determination Theory (SDT). Five postgraduate students from a research-intensive Swedish university participated in semi-structured qualitative interviews about their study experiences from different Challenge-Driven Education (CDE) courses. It adds to the limited, existing literature on CDE and is the first to study it from a purely motivational perspective. As this is a pilot study, the primary intent of the data analysis concerns the first two phases of Braun and Clarke's (2006) thematic analysis approach - familiarisation and immersion in the data and generating initial codes. A combination of inductive and deductive approaches to analysing the data were used, and preliminary motivational factors emerged from the interviews are illustrated according to the SDT concepts. A variety of motivations for learning and studying, such as innovation, real-world problem solving, contribution to the society, and trial for following master thesis projects, emerged from the data and positioned on the self-determination continuum in which different types of regulations are guiding students' behaviours simultaneously. Furthermore, autonomy in the choice of a project, feedback and assignment deadlines, and relationships within group work, enhanced or/and undermined the three psychological needs defined by SDT; autonomy, competence and relatedness. Preliminary findings are discussed in relation to the SDT literature, and practical applications are suggested for supporting the motivational needs of engineering students. Finally plans for a continuation of the study are discussed in light of this initial phase.

Keywords:

higher engineering education, challenge-driven education, self-determination theory, student learning, motivation

PAPERS:

ID:

1182

Topic:

Niche & Novel
Gender and Diversity

Title:

Hybrid Engineering Education Research: The Challenges & Benefits of an Emergent Methodology.

Authors:

Andrews, Jane;
Knowles, Nicola;
Palmer, India;
Knowles, Graeme;
Clark, Robin

Abstract:

Engaging students of any discipline in meaningful and constructive research about their university experience can be challenging[1]. During the Pandemic maintaining a balanced approach to sampling and data collection when conducting pedagogical research proved to be more than a little problematic, with many students seemingly experiencing 'online fatigue'. Moving slowly out of the Pandemic, the issues have changed, with students now hesitant to participate in face-to-face research. This short concept paper discusses the practical and theoretical challenges encountered in undertaking Engineering Education Research (EER) at a time of unprecedented social and educational change. In focusing very much on methodology this paper does not report on the emergent findings of the study discussed but instead focuses on the methodology itself.

Keywords:

Hybrid Research, Grounded Theory, Applied Scholarship

PAPERS:

ID:

1183

Topic:

Virtual and Remote Labs

Title:

🏠 Evidence-Based Practice to the Forefront: A Case Study of Engineering Team Project-Based Learning in an Online Learning Environment

Authors:

O'Connor, Sean P.;

Power, Jason R.;

Blom, Nicolaas;

Tanner, David A.

Abstract:

Approaches such as problem and project-based learning (PBL) are the cornerstone of modern engineering curricula. With a growing need to move these student-centred active learning curricula to online and blended learning environments due to issues including increasing cohort sizes and limited budgets, it is essential that instructional designers in engineering education understand the impacts that these differing mediums may have on student collaboration. This study is the beginning of a body of work with the aim to develop effective teaching and learning strategies for team project-based learning in online and blended learning environments. This case study was carried out in an Irish university in 2021 in a first-year engineering module during the COVID-19 pandemic. The study followed an explanatory mixed methods design in which a questionnaire and semi-structured interviews were utilised to collect data. The research data was gathered in two phases. Phase 1 included a questionnaire with both closed- and open-ended questions (N=94). Phase 2 was based on semi-structured interviews (N=7). This paper will focus on the qualitative datasets, including the open-ended questions and interviews. After completing a thematic analysis, we identified six themes and eighteen sub-themes that affect students' perceptions of team project-based learning (PBL) in an online environment. Each of these themes are discussed within this paper. The paper concludes with an outline of future research plans for the ongoing project.

Keywords:

Online Learning, Distance Education, Engineering Education Research, Evidenced-Based Practice, PBL, Teamwork

PAPERS:

ID:

1185

Topic:

Sustainability. Sustainable Development Goals

Title:

🏠 What about Sustainability? Investigating Engineering Students' Sustainability Awareness and Attitude

Authors:

Nakad, Mantoura (1);
Kövesi, Klara (2)

Abstract:

Engineers have a growing contribution towards attaining the Sustainable Development Goals (SDGs). Thus, graduate engineering students' awareness and attitude will be crucial for dealing with these complex societal challenges. The purpose of this study is to investigate the sustainability awareness (SA) of engineering students from a developing country in comparison to that of those published from developed European countries. It also aims to explore engineering students' attitudes and willingness to consider sustainability challenges as an important part of their future professional role. We have conducted a quantitative online survey (n=253) with the participation of engineering students from different majors at Bachelors and Masters levels. The data concerning students' awareness and attitude underwent quantitative statistical analysis and was compared to that in the literature. The data was analyzed using SPSS to investigate differences and similarities between majors and validate its quality. The findings show good levels of SA and lower levels of knowledge in SDGs among engineering students compared to that presented by European studies. Thus, a gap in SDGs' awareness exists between students from developed and developing countries. However, students' positive attitudes and willingness to be involved in SDGs' practices were remarkably high in understanding the leading role of engineers toward achieving the SDGs. Our results confirm engineering students' motivation and strong positive attitude for resolving sustainability issues in developing countries despite challenging lifestyles. Our findings could be further used by engineering faculties in developing countries to minimize the gap and enhance future engineers' contribution towards a more sustainable society.

Keywords:

Sustainability awareness, Engineering education, SDG

PAPERS:

ID:

1187

Topic:

Niche & Novel

Building Communities and Coordination

Title:

The Positive Start Project: A Proactive Approach to Promoting Positive Mental Health in the Newer Engineering Academic Community.

Authors:

Knowles, Nicola;

Andrews, Jane;

Knowles, Graeme;

Clark, Robin

Abstract:

The Positive Start Project is a new initiative that is in the process of providing a series of workshops and events focused around academic wellbeing, career development and positive mental health within a large faculty of engineering and applied science in the uk. Aimed at building a scholarly and sustainable research and teaching community of early career academics (ECAs), the project has arisen out of a need to provide high quality professional development activities and frameworks for the ECA community whilst also combatting social and academic isolation left over from the two-year long period of 'lockdown'.

Adopting an Action Research Approach this paper addresses a little considered topic in academic circles, the need to nurture positive wellbeing amongst the Engineering Education academic community. Describing proposed plans for how the Positive Start Project will be developed, disseminated and reviewed, attention is paid to how 'wellbeing' will be benchmarked at the beginning of the project. Following this a brief overview of some of the planned support and development activities is given whilst the conclusion reiterates the need for a positive and proactive approach to academic wellbeing whilst also noting why Early Career Academics are an important demographic group within our Engineering Education community.

Keywords:

Mental health, Newer Academic Communities

PAPERS:**ID:**

1188

Topic:

Teaching methods

Digitalisation & Hybrid models

Title:

Aspects of online educational materials massive development

Authors:

Zeman, Tomáš;

Hrad, Jaromír

Abstract:

We participated in collaborative development of more than six hundred comprehensive online teaching materials for higher professional schools in the Czech Republic. The paper focuses on explaining the procedures and methods that we used to make the development process as efficient as possible, which was necessary with respect to the quantity of the materials and the limited time. Managing the logistics was the key, as several hundred people took part in the project. We are also describing, from the pedagogical point of view, the OER structure, its division into educational blocks, and types of educational objects.

Keywords:

on-line course, learning material, development of educational materials

PAPERS:

ID:

1189

Topic:

Artificial Intelligence in Education
Curriculum Development

Title:

Learning Journeys for Scalable AI Education: An MIT - USAF Collaboration

Authors:

Salazar Gomez, Andres Felipe (1);
Bagiati, Aikaterini (1);
Breazeal, Cynthia (1);
Radovan, John (1,2);
Kennedy, Kathleen D (1)

Abstract:

In 2021 the United States Air Force (USAF) and the Department of Defense (DoD) entered into a collaboration with multiple units within the Massachusetts Institute of Technology (MIT) to develop a new academic program focusing on Artificial Intelligence (AI) training. Given the size and the diversity within the body of USAF employees, the goal of this collaboration is to design and implement an innovative program that will achieve maximum learning outcomes at scale for learners with diverse roles and educational backgrounds. This program is now piloting and evaluating three different learning journeys addressing three different groups of USAF employees (USAF leaders and decision makers; technology developers; and daily frontend technology users). The learning journeys were designed based on each group's specific professional needs and academic backgrounds, and they include combinations of online synchronous and asynchronous courses and face-to-face activities. The program's pilot is currently underway and evaluation research findings are informing the next program iterations. The ultimate goal of this program is to formulate general recommendations on how to serve large numbers of diverse learners at scale in an optimum way. In addition to an evaluation pilot study, MIT experts on AI and the Science of Learning have been asked to review the program and their feedback will be integrated into the next program iteration.

This paper presents the three learning journeys as originally designed to serve the three first diverse cohorts of learners, as well as the plan for future improvement and implementation of the program.

Keywords:

AI curriculum development, training in AI, diverse learners, skills development, scalability

PAPERS:

ID:

1190

Topic:

Challenges of new European Universities
Curriculum Development

Title:

Implementing Agile Continuous Education (ACE) at MIT and beyond: The MIT Refugee Action Hub (ReACT) case

Authors:

Bagiati, Aikaterini;
Salazar Gomez, Andres Felipe;
Masic, Admir;
Cook, Lana;
Sastry, Anjali;
Westerman, George;
Breazeal, Cynthia;
Kumar, Vijay MS;
Kennedy, Kathleen D;
Sarma, Sanjay E

Abstract:

The rapid pace of change in technology, business models, and work practices is causing ever-increasing strain on the global workforce. Companies in every industry need to train professionals with updated skill-sets in a rapid and continuous manner. However, traditional educational models — university classes and in-person degrees— are increasingly incompatible with the needs of professionals, the market, and society as a whole. New models of education require more flexible, granular and affordable alternatives. MIT is currently developing a new educational framework called Agile Continuous Education (ACE). ACE describes workforce level education offered in a flexible, cost-effective and time-efficient manner by combining individual, group, and real-life mentored learning through multiple traditional and emerging learning modalities.

This paper introduces the ACE framework along with its different learning approaches and modalities (e.g. asynchronous and synchronous online courses, virtual synchronous bootcamps, and real-life mentored apprenticeships and internships) and presents the MIT Refugee Action Hub (ReACT) as an illustrative example. MIT ReACT is an institute-wide effort to develop global education programs for underserved communities, including refugees, displaced persons, migrants and economically disadvantaged populations, with the goal of promoting the learner's social integration and formal inclusion into the job market. MIT ReACT's core programs are the Certificate in Computer and Data Science (CDS) and the MicroMasters in Data, Economics and Development Policy, which consist of a combination of online courses, bootcamps, and global apprenticeships. Currently, MIT ReACT has regional presence in the Middle East and North Africa, East Africa, South America, Asia, Europe and North America.

Keywords:

Professional development, agile education, skills development, refugee education, flexible study pathways

PAPERS:**ID:**

1191

Topic:

Architecture Education

Title:

Course clustering based on the phylogenetic tree of students' grades in architectural degree

Authors:

García-Escudero, Daniel;

Bardí-Milà, Berta;

Fayos, Francesc;

Valls, Francesc

Abstract:

A large-scale correlational analysis was conducted on the grades of the students who completed their studies in the 1994 curriculum in the [AFFILIATION]. The study included the passing grades of a total of 3910 students corresponding to all 47 compulsory subjects, as elective courses were excluded. The objective of the research was to explore whether courses with related content were associated with the corresponding grades at an aggregate level, and identify similarities and dissimilarities in their clustering. The correlation between the grades in all courses was computed pairwise, and used as a distance measure to quantify the grade of affinity between them. Using this distance metric, the results were processed using hierarchical cluster analysis producing a tree structure according to this similarity/dissimilarity measure. The clustering results were visualized in a phylogenetic tree, identifying the optimal number of clusters and coloring the results accordingly. The visualization of this tree matched very closely the grouping of courses according to departmental divisions, indicating a strong association between the grades obtained and specific areas of knowledge. The lowest marks were also found to be concentrated in the first years and among the graphic and design subjects. These results reinforce previous studies that have investigated the relationship between academic performance during the degree course and the entry grade. The great discontinuity between them and the fact that PBL is characteristic of the degree course and less common in secondary school could be the reasons for these results.

Keywords:

Architecture Education, Grade Correlation, Academic Results, Educational data mining, Data Visualization

PAPERS:

ID:

1192

Topic:

Entrepreneurship Education

Industry and Companies liaison. Regional Involvement and Innovation

Title:

From creativity to value creation

Authors:

Citraro, Mauro;

Carcano, Cristina;

Carpanzano, Emanuele;

Puiatti, Alessandro;

Sommaruga, Lorenzo;

Vignati, Sara

Abstract:

In today's world, globally interconnected, volatile, and characterized by a sky-rocketing complexity, significant and unprecedented interdisciplinary is required among various stakeholders to create resilient and innovative value chains. Within this compelling context, we focus on the new role that university-industry collaboration plays on a large scale in bridging the gap between ideas generation and value creation to the economy and society. A new way to promote attitude towards entrepreneurial leadership at an early stage among students and teachers is experienced by linking curricular and extra-curricular teaching and contents, as well as supporting voluntary learning "on demand" among students. Intertwined links are indeed possible within a nursing environment, so-called Entrepreneurship, where students are encouraged to express their creativity, both by raising startup ideas and by solving companies' technical/scientific issues. Entrepreneurial students are so supported on their innovative ideas through collaboration with teachers/experts/entrepreneurs. They are also stimulated to engage other students to be part of an interdisciplinary team. It comes up that cooperation in supporting cross-fertilization of creative ideas will be fed by competencies, an open-minded environment, and where diversity integration is playing an important role. Only through different thinking is it possible to develop outstanding achievements. Coordination is guaranteed by a collaborative IT platform, which is also open to SMEs to facilitate them involving entrepreneurial students. Within this new collaborative framework, all stakeholders will profit from reciprocal learning and creativity, increasing the entrepreneurial attitudes of students and teachers and thus accelerating the transfer of academic startup ideas into industrial applications and business opportunities.

Keywords:

Extracurricular teaching, Sharing creativity, Cross-fertilization, Cooperation, Knowledge Transfer

PAPERS:

ID:

1194

Topic:

Student Engagement
Navigating Open Learning Environments

Title:

The technical and pedagogical challenges for implementing feedback strategies in a virtual learning environment

Authors:

Iqbal, Asima;
Masood, Maryam;
Schrock, Lauren;
Makrinov, Ninna

Abstract:

Pedagogical developments in the virtual learning environment (VLE) are constrained by technical expertise which impacts the design and delivery of online learning, including the implementation of varied feedback strategies. In recognising this dilemma, the paper addresses the question, "What are the technical and pedagogical challenges of implementing feedback strategies in a VLE?" This short paper presents an initial critical, reflexive account on the challenges to embed and manage feedback strategies, including automatic feedback, peer feedback, and tutor-led feedback, on the VLE of a blended module provided to over 1,200 engineering and business students at a UK university. As a result, the authors recognise the importance of upskilling engineering educators to technically innovate their VLEs to enhance student learning and connections through feedback. Further investigations to evaluate the impact of the varied feedback strategies on student learning will occur at a later stage in order to advance this work in progress.

Keywords:

Feedback, Virtual learning environments, Professional development, Supporting innovation

PAPERS:

ID:

1195

Topic:

Student Engagement

Co-creation with students

Title:

Making sense of interdisciplinarity in challenge-based learning: A two-step co-creation approach towards educational redesign

Authors:

Ming, Xin (1);

MacLeod, Miles (1);

van der Veen, Jan (2)

Abstract:

Challenge-based learning gains popularity in engineering education for allowing students to transcend academic and disciplinary boundaries and fully engage in real-world problems, but it is largely underexplored how to improve specific designs of such educational practices to promote interdisciplinary learning experiences and competencies. This paper describes two studies that together in two steps make up an evidence-based redesign of a challenged-based course featuring group-work projects in an undergraduate program combining engineering with liberal arts and sciences. A first study based on observation and interviews collects different and varying learning experiences throughout students' learning activities. The results showed that interdisciplinary experiences are constructed in complex dynamics between students' disciplinary identity formation and the interdisciplinary and collaborative course configuration. Such dynamics may result in positive learning experiences (engagement and interdisciplinary enrichment) as well as negative ones (disengagement and frustration). Especially regarding the discrepancy between common experiences across the three phases of tackling the challenge (mapping, mitigating, integrating), representatives of parties important for the course were invited to a roundtable session in a second study to discuss and reflect on the first study's findings and what they can mean for the course design. Understandings achieved in the session are used as input for upcoming course redesign towards a more desirably organized challenge-based learning. The two-step approach towards redesign is an example of involving researchers and students in evidence-based educational redesign, exemplifying the value of naturalistic research and educational co-creation in understanding and optimizing students' learning experience to achieve fruitful challenge-based learning.

Keywords:

challenge-based learning, interdisciplinarity, project-based learning, learning experience, co-creation

PAPERS:

ID:

1197

Topic:

Curriculum Development

Engineering Skills

Title:

Smart Products, Engineering and Services – an example of modern engineering education

Authors:

Schmitt, Florian (1);

Rudolph, Kris (1);

Blat Belmonte, Benjamin (2);

Kappes, Aaron Ben (2);

Kirchner, Eckhard (1);

Rinderknecht, Stephan (2)

Abstract:

As digitization and Industry 4.0 progress, the need for smart products and innovative business models increases. This contribution presents the underlying concept of the collaborative course Smart Products, Engineering and Services of the departments IMS, pmd and TIM of the Technical University of Darmstadt. The objective is to enable students of mechanical engineering to develop and work with smart products, and to derive possible business models for their use. A combination of traditional lectures, flipped classroom exercises, as well as a development project characterizes the unique character of the course. The presented topics range from the basics of sensing machine elements, intelligent mechatronic systems and the use of artificial intelligence in the latter. Further, it comprises product development methods such as agile development, V&V methods and the usage of rapid manufacturing technologies. The flipped classroom exercises serve as preparation for the project work and allow students to gain practical experience with additive manufacturing processes as well as cyber-physical systems. As part of the project work, students develop a smart product which must complete the control task of balancing a body against vertical perturbation. For this purpose, the kinematics, the controller, and the usage of a force-measuring ball bearing as a sensing machine element are predetermined. Missing components must be designed and manufactured in a Makerspace using 3D printing or laser cutting and the developed controller must be implemented. The smart product is finally tested on a specially developed test rig.

Keywords:

Agile development, flipped classroom, smart systems, rapid manufacturing, condition monitoring

PAPERS:

ID:

1199

Topic:

Building Communities and Coordination
Fostering Engineering Education Research

Title:

Software engineering teacher networks in Finland - what motivates teachers to collaborate?

Authors:

Kilamo, Terhi (1);
Knutas, Antti (2);
Korhonen, Ari (3);
Poranen, Timo (1);
Sievi-Korte, Outi (1)

Abstract:

Teaching collaboration between universities is becoming increasingly important. Student intakes are increasing, and students are including MOOC courses from other universities to their studies. In Finland, there has been a long tradition in national teaching collaboration in computing education field. Our main research question is what motivates software engineering teachers to collaborate among universities. In this paper, we first give a short overview of national teaching collaboration from 1990's to the present day. Then, we present findings from a questionnaire that had respondents from active network participants. Main factors and practices that motivated teachers to participate in networking activities were existing project funding, active leaders and enough participants, interesting topics such as new innovations in learning technology, regular meetings and remote participation.

Keywords:

Teaching collaboration, networking activities, software engineering teachers, motivation to collaborate

PAPERS:

ID:

1200

Topic:

Student Engagement
Teaching methods

Title:

Introduction of process in embedded programming supporting student's self-efficacy - case study

Authors:

Schultz, Ole;
Blaszczyk, Tomasz

Abstract:

This work is directed towards the improvement of programming skills for students on the 2nd semester of Electrical Engineering (EE) BEng signed up for the "Digital Electronics and Programming" (DEP) course. The goal is to support students who tend to drop out in the first half of the semester or give up and not show up at oral exams. In our research hypothesis we state: Decreasing and eliminating negative emotional experiences will increase student's self-efficacy thereby lowering dropout. We experiment with a programming process guide in text and video to gain students' capability in solving programming problems and increase metacognitive awareness. Additionally, we measure students' emotional experience of programming by using a special self-assessment vignette inquiry. For comparison purposes we introduced the same measurement methodology in 2021 on the courses where there is no focus on the process guideline. The results show a positive effect on lowering the negative emotional impact when students use a programming process guide. The article describes the theoretical background based on literature studies for both the process and the students' self-assessment, and discusses results achieved in relation to the findings in the literature. The preliminary results are described in [8] and in paper here we present recent outcomes for the autumn 2021 and spring 2022 semester over 9 weeks.

Keywords:

Metacognitive process, Self-efficacy, Problem solving, self-awareness, self-management, Vignette questions

PAPERS:**ID:**

1201

Topic:

Curriculum Development

Engineering Skills

Title:

Challenges for Engineering students working with authentic complex problems

Authors:

Routhe, Henrik Worm;

Winther, Maiken;

Nguyen, Nhung Tuyet;

Holgaard, Jette Egelund;

Kolmos, Anette

Abstract:

Engineers are important participants in solving societal, environmental and technical problems. However, due to an increasing complexity in relation to these problems new interdisciplinary competences are needed in engineering. Instead of students working with monodisciplinary problems, a situation where students work with authentic complex problems in interdisciplinary teams together with a company may scaffold development of new competences. The question is: What are the challenges for students structuring the work on authentic interdisciplinary problems? This study explores a three-day event where 7 students from XXX XXX (XXX) from four different faculties and one student from XXX XXX XXX XXX (XXX), (6th-10th semester), worked in two groups at a large XXX company, solving authentic complex problems. The event was structured as a Hackathon where the students for three days worked with problem identification, problem analysis and finalizing with a pitch competition presenting their findings. During the event the students had workshops to support the work and they had the opportunity to use employees from the company as facilitators. It was an extracurricular activity during the summer holiday season. The methodology used for data collection was qualitative both in terms of observations and participants' reflection reports. The students were observed during the whole event. Findings from the study highlighted, that students experience inability to transfer and transform project competences from their previous disciplinary experiences to an interdisciplinary setting.

Keywords:

Interdisciplinarity, PBL, authentic complex problem solving

PAPERS:

ID:

1202

Topic:

Navigating Open Learning Environments
Joint Programmes

Title:

Student motivation and disciplinary expertise in Challenge-Based Learning

Authors:

MacLeod, Miles;
Johnston, Coralie;
Poortman, Cindy;
Visscher, Klaasjan

Abstract:

Challenge-based learning (CBL) seeks to help students acquire skills necessary for collaborative real-world problem solving. It generally favours self-learning, in which students should seek out their own role in a problem-solving environment and choose their own set of skills to develop which are relevant to the challenge. However students from traditional degree programmes may enter with an expectation that their disciplinary expertise will count and be valued in the context of a project, but face a situation that the problem chosen by a group or the dynamics of a group render their expertise less relevant. In survey-based studies of two CBL modules, we explore the relationship between the roles students play and their levels of motivation. We find no evidence that the lack of a disciplinary role strongly affects student motivation. Rather the data suggests that if a CBL environment is properly framed around self-development and multiple potential learning goals students can relax any commitments or expectations related to their expertise, and take on different roles. This is good news for the CBL aims and goals. That said students do have a tendency to revert to disciplinary roles over the course of projects and are against their disciplinary roles being excluded when they are clearly relevant. Instructors can potentially avoid problems by having students evaluate their role choices against desired project outcomes.

Keywords:

Challenge based learning, motivation, interdisciplinarity, expertise

PAPERS:

ID:

1203

Topic:

Physics and Engineering Education
Challenges of new European Universities

Title:

Teachers' views on collaborating in multi-campus course cluster for engineering students

Authors:

Kahrs, Magnus Strøm;
Korpås, Guri Sivertsen

Abstract:

At a European multi-campus university, parallel study programmes offered at every campus (e.g. engineering studies) and appurtenant courses are coordinated, to ensure similar quality and systematic development. In this paper, we present a case from such a multi-campus course, consisting of a cluster of basic courses in physics and chemistry for first-year engineering students. These courses are coordinated through identical syllabus and assessment practice but are taught locally at each campus.

The authors had noted some frustration among the teachers involved in these courses, and were interested to investigate the reasons for this frustration, and ultimately to inform the development of these multi-campus courses.

This project emerged from a realisation that literature on multi-campus courses is often associated with distance learning, while in this case, the actual teaching is provided locally. Concepts associated with teacher collaboration, such as collaborative culture versus contrived collegiality, collective versus fragmented collaboration, and depth of collaboration seem like a viable way forward in understanding the dynamics between teachers in a context like this.

In this paper, we present early results from this ongoing project, which include interviews of teachers involved in these physics/chemistry courses. Preliminary results from these interviews suggest that the expressed frustrations stem from contrived collegiality. Although the teachers experience sufficient freedom in terms of choosing their own teaching methods, several teachers raise concerns about the lack of common aims for this course cluster, which reduces collaboration to coordination of mere practical tasks.

Keywords:

Course development, Teacher collaboration, Multi-campus course, Physics

PAPERS:

ID:

1204

Topic:

Entrepreneurship Education
Attractiveness of Engineering

Title:

Restoring the prestige of the engineering education through a fourth engineering wave in the development of the fundamental scientific knowledge of economy

Authors:

Stefanov, Stefan Trifonov (1);
Stefanov, Trifon Trifonov (2)

Abstract:

There is no doubt that in the EU and the USA the engineering education has completely lost its previous prestige. The finest youths have shifted from aspiring to become engineers towards aspiring to become professional economists and businessmen. It has been forgotten that the enterprises for machines, which are best understood by engineers, are the backbone of every national economy and without a human capital capable of managing their economy efficiently as well as supporting their internal activities will lead not only to us observing a shift of the finest youths away from engineering, but also a shift away from a sustainable economic future.

This paper presents a new approach that will bring back the previous and well-deserved prestige of the all-important engineering education, a prestige connected to the names of Henry Towne, Frederick Taylor, William Deming and all the engineers responsible for the three engineering waves in the development of the fundamental scientific knowledge of economy. However, we find ourselves at the brink of a fourth engineering wave in the development of the fundamental scientific knowledge of economy, a wave connected to Bulgarian based Institute for Systemic Economic Engineering which has successfully developed a systemic universal model of the enterprise for machines, a model widely thought to be impossible to develop, but if developed successfully, would bring economic changes equal to the combined magnitude of the economic changes brought by all the previous engineering waves and will form a new professional class defined by the term systemic economic engineers.

Keywords:

prestige, engineering wave, engineering knowledge, disruptive innovation

PAPERS:

ID:

1205

Topic:

Attractiveness of Engineering
Gender and Diversity

Title:

The Future of Women Aerospace Engineers in Academia – a numbers game

Authors:

Saunders-Smiths, Gillian

Abstract:

The gender divide for women in the engineering domain in academia is still very large today, even though most institutions are committed to changing this. Although there are slow improvements in the number of women working in academic positions in Engineering, the Netherlands, in particular, is still lagging badly behind the rest of Europe with women making up only 17.6% of all full professors in the engineering domain and for 25.7% in the entire academic domain. This is despite many efforts across the board to improve this situation.

The situation is even worse in the field of Aerospace Engineering and within this field, the lack of progress is not unique to the Netherlands with similar issues being reported in the United States of America and wider afield.

This paper reports on research on the capacity building among women required within the aerospace engineering domain to reach the commonly defined critical mass percentage of 30% of women full professors using metrics on career progress and on as well as labour market data on the career development of Aerospace graduates to show where potential new interventions can be made.

Keywords:

workplace diversity, gender, aerospace engineering, careers

PAPERS:

ID:

1207

Topic:

Ethics in Engineering Education
Teaching methods

Title:

Enhancing student communication skills via debating Engineering Ethics

Authors:

Mackay, Isobel;
Miller, Thomas

Abstract:

In Engineering, the construction of informed, persuasive and convincing arguments is at the very core of everyday practice. However, in taught postgraduate education there is often an excessive focus on assessment of these skills through written arguments or oral presentations that are usually in the form of long uninterrupted monologues, where the construction of the arguments themselves is almost never challenged. To change this status quo, we have successfully pioneered the use of oral debate as a dynamic and engaging mechanism to develop and assess this skill in our Chemical Engineering MSc students.

Debate is an ideal mechanism to assess our students' ability to construct arguments as it actively encourages them to (1) think about both sides of an argument, (2) consider how they can persuade others and (3) express their viewpoint professionally but with conviction. For this reason, the debates were linked to important engineering ethical dilemmas, by discussing topics such as "should developing countries prioritise the shift to clean energy over economic growth".

The development of this debate-based training and assessment has had several positive outcomes on the students' learning experience and vital skills development. Importantly students found the debates to be both an interesting and enjoyable method of assessment and noted that the skills learned would be useful in their future careers. In this concept paper, we present our experiences in delivering debate assessments to engineering students along with recommendations for practitioners wishing to implement similar styles of performative assessments in their own pedagogy.

Keywords:

Debating, Communication Skills, Engineering Ethics, Assessment

PAPERS:

ID:

1208

Topic:

Industry and Companies liaison. Regional Involvement and Innovation
Engineering Skills

Title:

Teaching engineering students how to design a Proof-Of-Concept: A way to experience the value of reflexive practices for engineers?

Authors:

Thomas, Maxime;
Lafkihi, Mariam;
Jobin, Caroline;
Ballot, Eric;
Le Masson, Pascal;
Weil, Benoit

Abstract:

Industrial companies expect engineers to take an external and critical look at their activities through reflexive practices. Recognising the criticality of reflexivity, Project Based Learning approaches include assignments for students to implement reflexive approaches on their projects. However, it remains unclear in the literature whether those assignments help the students experience the value of reflexive practices or if students consider them as academic exercises. In this concept paper, we present a new teaching module that intends to make students experience the value of reflexive practices for engineers. In this module, an industrial partner asks a group of master engineering students to design and implement a Proof-of-Concept (POC) to help the company explore an innovation field. This eight-week project is mainly conducted within the company. Teachers act both as coaches through regular meetings and as experts through lectures focusing on specific engineering reasoning (statistics, modelling, simulation, design of experiments...) that are necessary to design a robust POC. At the end of the module, students present conclusions drawn from their POC to the company which explain to students the next steps envisioned from their contribution.

The module is two years old : so far, the authors supervised twelve students split into four industrial projects. Feedback for both companies and students were collected, as well as the lectures and the final presentations. Based on these, we conducted a preliminary analysis that suggests that students experience the value of reflexive practices for engineering work during the module.

Keywords:

Teaching Proof-Of-Concept Design, Project-Based-Learning, Innovation and Design, Industrial Projects, Engineering Skills

PAPERS:**ID:**

1209

Topic:

Student Engagement
Mentorship and Tutorship

Title:

Actions for Academic Performance Improvement of University Newcomer Students in an Electronics Introductory Subject

Authors:

Gasulla, Manel;
Jordana, Josep;
Robert, Francesc Josep

Abstract:

The subject Electronics for Telecommunications (ET) is taught in the first semester of the Telecommunications degrees at the Castelldefels School of Telecommunications and Aerospace Engineering (EETAC). The academic performance is relatively low compared to the same course taught in a double degree of Aerospace and Telecommunications, in part justified by the large difference in the university access marks of the students between both degrees. Several actions have been implemented in courses 2019/20 and 2020/21 to address this issue, especially in theory classes where student attendance is lower than in laboratory sessions. Implementation difficulties have arisen because of the presence of the COVID pandemic. Even so, performance has greatly increased, especially at the first semester of each academic year. In addition, a student survey shows a good satisfaction with the introduced actions and others in process of introduction or assessment. Some of the actions, particularly those to be applied in the theory sessions, could be easily extrapolated to other first-semester courses of the degrees.

Keywords:

Academic performance, Electronics course, University newcomer students, Student engagement

PAPERS:

ID:

1210

Topic:

Industry and Companies liaison. Regional Involvement and Innovation
Curriculum Development

Title:

Online co-design of a university Work-Based Learning degree programme: lessons learned from comparing cases in United Kingdom and Country X

Authors:

Smith, Christopher (1);
Knowles, Graeme (2);
Jones, Edwina (2);
Martin, Celine (2);
Dlamini, Patience (3);
Mahlalela, John (3)

Abstract:

Greater collaboration is required between universities, industry and society to provide the engineering education that will tackle society's challenges. Work-based learning (WBL) programmes offer an industry-aligned, academically-informed education to support such socio-economic development. Co-design of such programmes is vital with responses to the COVID-19 pandemic innovating alternative ways to design programmes. Knowles et al (2021) outlined an approach to online programme co-design in the UK university context, framed using Signature Pedagogy and through online conferencing and Miro (online whiteboard). Subsequently, the approach has been utilised to co-design a WBL degree programme in Electrical Engineering in Eswatini, supported by Knowles and other UK and Eswatini colleagues.

This paper compares and contrasts cases from UK and Eswatini, and from this address the research question, "What considerations are required to support an effective online process to co-design a work-based learning programme in Engineering?" A collaborative autoethnographic methodology based around field notes, observations and reflections is used to allow exploration across pedagogy, technology, work practices, expectations and challenges.

Many aspects of the approach worked well in both cases (for example, effectiveness of Signature Pedagogy, Miro as shared space), whereas differences arose related to limitations in the synchronous use of technologies, and readiness to adopt an outcome-focused approach. Addressing these differences, along with balancing progress against full participation and having clear expectations of participants, are key considerations in online co-design of WBL programmes. Moreover, the approach of Knowles (ibid) has shown to be adaptable with potential for broader adoption.

Keywords:

work-based learning, programme co-design, curriculum co-design, online collaboration, Signature Pedagogy

PAPERS:**ID:**

1216

Topic:

Mathematics at the heart of Engineering
Virtual and Augmented Reality in Education

Title:

AUGMENTED REALITY FOR LEARNING MATHEMATICS: A PILOT STUDY WITH
WEBXR AS AN ACCESSIBLE TOOL

Authors:

Wong, Jacqueline (1);
Bayoumy, Sharif (2);
Freeke, Arno (2);
Cabo, Annoesjka J (1)

Abstract:

One of the concerns in service mathematics courses, such as calculus for engineering, is students' interest in these studies. Research suggests that engineering undergraduates' lack of awareness about the importance of mathematics for their study success and for their careers contributes to their low motivation for mathematics. An approach to increasing student motivation is to take advantage of technological tools to provide students with more engaging learning experiences. Recent studies showed that augmented reality (AR) enhances student engagement, motivation, and knowledge retention. However, implementing AR can be challenging since it can be quite costly and technically complex. The current paper describes a case study in which an AR application was designed and developed using WebXR, in the context of a service mathematics course for teaching calculus. The AR content involves drawing of level curves and the visualization of a volcano and the flow of lava to support students' learning of directional derivatives. A pilot study was conducted to examine engineering undergraduates' perceptions of using AR for learning mathematics. Results show that students perceived using AR for learning mathematics as enjoyable and motivating. Students reported that AR content adds value to their classes by making the mathematical concepts clearer and helping them apply what they have learned to real life. However, the AR content did not work well on all mobile phones and all versions of web browsers. Lessons learned from the design and development of AR using WebXR as well as recommendations for future studies are discussed in this paper.

Keywords:

service mathematics, augmented reality, student engagement, motivation, technology-enhanced learning

PAPERS:

ID:

1217

Topic:

Sustainability. Sustainable Development Goals
Ethics in Engineering Education

Title:

The Edinsost2-SDG project: Introducing SDGs in Higher Education

Authors:

Sánchez-Carracedo, Fermín;
Segalàs, Jordi;
Tejedor, Gemma

Abstract:

The main objective of the EDINSOST2-SDG project is to introduce sustainability and the Sustainable Development Goals (SDGs) in Higher Education. The project focuses on Engineering degrees, Education Degrees, and the Business Administration and Management degrees of the Spanish university system. The project has four main objectives: (O1) Identify the SDGs in the EDINSOST sustainability competency maps (SCM); (O2) Improve the learning outcomes of sustainability and SDGs in the degrees related to the project; (O3) Faculty training in Education for Sustainability and SDGs; and (O4) Analyse the students' learning in Sustainability and SDGs during their training at the university. The current project began in 2019 and is scheduled to end in December 2022. This paper presents the main results achieved so far in the O1. SDGs have been included in the SCMs previously designed by the EDINSOST project. Each SCM learning outcome is related to a set of UNESCO learning objectives and UN indicators of the SDGs. As EDINSOST2-SDG results, the SCM has been simplified to make it easier for teachers. A pilot project is currently being carried out at the (Hidden for blind review) to analyse ten engineering degrees using this simplified SCM. The results of the pilot project will be presented in June 2022, but the preliminary results show that the reduction in the number of learning outcomes has been a key aspect to motivate those responsible for the different degrees involved in the pilot project to use the SCM as a tool to introduce sustainability in their degrees.

Keywords:

Sustainability, education for sustainable development, sustainable development goals, EDINSOST project, sustainability map

PAPERS:**ID:**

1218

Topic:

Engineering Skills

Title:

Reflection in Technical Higher Education: Student Perceptions

Authors:

Eshuis, Elise;

Mittendorff, Kariene;

Daggenvoorde-Baarslag, Heleen

Abstract:

The project 'Strengthening reflection in technical higher education programs' is a response to the need for well-trained reflective science and engineering professionals and the subsequent question of teachers about how reflection can be designed and embedded in a meaningful way, especially in technical study programs. Within this project, eight technical education teams from two Dutch universities of applied sciences are working on improving the use of reflection in their curriculum. Among other things, teachers are professionalized in their guidance skills, to improve the guidance of reflective activities of their students.

One of the research activities within the project involved a questionnaire to gain insight into: 1) the extent to which engineering students have an inclination and need for self-reflection, 2) the reflection level that engineering students reach according to their own judgement, and 3) how engineering students value (guidance of) current reflection activities in their study program.

In the short (concept) paper we will address some main findings of this questionnaire based on data of 843 first- to fourth-year students from eight technical study programs. Amongst others, results indicate - contrary to some other research findings - that engineering students acknowledge the importance of being able to reflect as a future professional. However, they seem relatively less satisfied with currently provided guidance regarding reflection in their study programs. Also, most often employed reflection activities (i.e., reflection reports) are generally perceived least useful. Results give further direction to optimize activities and teacher guidance regarding reflection within higher (technical) education programs.

Keywords:

reflection skills, reflection activities, need for reflection, student perceptions

PAPERS:

ID:

1219

Topic:

Engineering Skills
Teaching methods

Title:

Continuous assessment with self-checking tasks

Authors:

Korhonen, Juhamatti;
Naukkarinen, Johanna;
Niemelä, Hanna;
Järvisalo, Heikki;
Silventoinen, Pertti

Abstract:

This paper discusses the applicability and benefits of self-checking tasks in continuous assessment in an electrical engineering course. The method was implemented in the first-year online graduate course of Advanced Power Electronics. The method uses a two-week cycle, where during the first week a task is accomplished on the topic of that week. The tasks include working with data from component datasheets, reading and employing application notes, calculations, and simulations. During the second week, the students self-check their tasks using a rubric provided for them and then turn in a corrected version of the task. To keep the cycle going, during the second week, a new topic is also introduced, and a new task is given. The method was assessed based on a student questionnaire and teacher experiences. The method was new to all students. One of the main findings from the questionnaire was that correcting the original task submission supported student learning more than any other form of teaching on the course. However, there were different interpretations of how this support actually worked. The study also showed that there was significant variation between different types of tasks in how the students assessed the relevance of tasks and their difficulty level. Furthermore, students found that some tasks or their outcomes were more suitable for self-checking than others. This was confirmed by the teacher's insights on the course.

Keywords:

Continuous assessment, self-checking

PAPERS:

ID:

1220

Topic:

Entrepreneurship Education
Mentorship and Tutorship

Title:

STARTUPV: Different approaches in mentoring and tutorship for entrepreneurs in the three stages of a university entrepreneurial ecosystem

Authors:

Griol-Barres, Israel;
Márquez Gómez, María;
Giménez Carbó, Esther;
Gómez-Martín, M. Esther

Abstract:

Year after year, a crowd of students from the Universitat Politècnica de València (UPV), a polytechnic university in Valencia (Spain) with over 30,000 students, are encouraged to start their own business projects. Since 1992, IDEAS-UPV, the Entrepreneurial service at UPV, has been mentoring entrepreneurs. Up till now, IDEAS-UPV has helped in the generation of close to 1000 new businesses with a survival rate of over 60% in five years. In 2012, IDEAS-UPV introduced new mentoring and tutorship activities for students by the creation of a business incubator within the university campus. STARTUPV is currently a 5-year startup incubation programme and an entrepreneurial ecosystem with more than 300 startups and more than 50 million euros of overall private investment

STARTUPV programme is divided into three different stages: (i) STAND UP, in which startups define a business model and complete a validation process; (ii) START UP, in which startups achieve a targeted market share and build their company management team; and (iii) SCALE UP, in which startups achieve maturity and scale to other international markets.

As university students and their startups face different needs in every step of the programme, different approaches for mentoring and tutorship are applied in every stage. For instance, a startup in the first stage is mentored in business modelling or market segmentation, while a scale up requires a more specific mentorship in dealing with corporates and venture capital. These different approaches are analysed in this work including the main findings of the 10 years of this programme.

Keywords:

entrepreneurial ecosystem, mentoring, startups, business accelerator, business incubator

PAPERS:

ID:

1222

Topic:

Building Communities and Coordination
Curriculum Development

Title:

DEVELOPING TEAMWORK SKILLS BEYOND CROSS-CULTURAL BARRIERS: A CASE STUDY FOR ENGINEERING STUDENTS IN HIGHER EDUCATION

Authors:

Krab-Hüsken, Leonie E.;
Pei, Linlin;
Benes, Nieck E.

Abstract:

In 2013, our university has implemented a new educational model that puts team projects at the core of all BSc programmes, requiring that students develop teamwork skills. On top of this, in 2018, our Chemical Science & Engineering BSc has become an English-taught, international programme. In consideration of this challenging transition we have developed additional trainings to facilitate students' acquisition of knowledge, skills, tools, and attitudes to aid conscientious intercultural teamwork. For this, it is paramount that students become aware of, and learn to appreciate, differences in the educational and cultural backgrounds of themselves and their peers. Concurrently, students should practice what they have learned and adjust their behaviour when appropriate.

In this paper we share our experiences, best practices, and lessons learned. More specifically, our study: i) explores which factors are key for a successful intercultural team, ii) investigates how diversity in teams can be cherished and used for the benefit of the team, its members, and its goals, and iii) how these teamwork skills can effectively be taught in engineering programmes. Building on this, the paper finally describes how the new curricular education has been designed, what is taught, and how an inclusive, regardful, and pleasant atmosphere has been created for the intercultural project teams.

Keywords:

teamwork, intercultural skills, engineering education, higher education

PAPERS:

ID:

1223

Topic:

Student Engagement
Mathematics at the heart of Engineering

Title:

Exploring engineering students' engagement with proof without words: The case of calculus

Authors:

Radmehr, Farzad (1,2);
Ezzati, Mahnaz. (2)

Abstract:

Previous studies have reported that many engineering students struggle to develop a conceptual understanding of mathematics in university calculus courses. Engaging with mathematical proofs is one of the approaches to developing a conceptual understanding of mathematics; however, it is not always easy to use standard proofs for this purpose. In the present study, we focus on a type of mathematical proof known as Proof Without Words (PWW). A PWW typically consists of pictures or diagrams that help readers understand why a mathematical statement is true without providing verbal justifications. This study investigates how engineering students engage with PWW tasks related to calculus and also how they perceive its usefulness for teaching and learning calculus. Twenty undergraduate engineering students participated in semi-structured group interviews (in groups of two students), engaging with three PWW tasks related to calculus. Afterwards, students' perceptions of PWW tasks were explored using several open-ended questions. The findings indicate that many students engaged well with this type of activity. Furthermore, all students perceived that PWW tasks could positively impact their mathematical understanding, and many believed they could be used for teaching and learning calculus. Furthermore, several students highlighted that PWWs could also help with comprehending standards proofs and make mathematics learning more enjoyable.

Keywords:

task design, proof without words, mathematics, calculus, integral.

PAPERS:**ID:**

1224

Topic:

Mathematics at the heart of Engineering
Co-Teaching

Title:

The increasing necessity of diversity of skills in team teaching

Authors:

Craig, Tracy S;
Redeker, Stach

Abstract:

The advantages of including technological tools, for example dynamic graphing software, into the teaching and learning of technical subjects have long been recognised. Using such tools effectively in the classroom is at least partially constrained by the teacher's knowledge and skills. Any teaching team benefits from skills diversity and always has, however, in recent years the skills needed for effective use of the tools available are becoming more numerous and more varied. Using a range of tools for assessment, rather than for in-class teaching and learning, demands an extra burden of care. Using an example from our own recent experience we illustrate the need for skills diversity in teams teaching and raise questions related to traditional assessment in mathematics.

Keywords:

team teaching, skills diversity, mathematics assessment

PAPERS:


ID:

1225

Topic:

Engineering Skills

Title:

 Communication Challenges in Distributed Student Projects

Authors:

Huumonen, Jere;

Poranen, Timo;

Zhang, Zheyang

Abstract:

Student projects have been widely adopted in software engineering education. Project teams are composed of students in the same institution, and students can meet and communicate face-to-face regularly. The Covid-19 pandemic, however, forced the student projects to rapidly transition to remote mode and adapt to the virtual team. Virtual teams in distributed environments face challenges due to distance factors that separate collaborators from each other. This study aims at investigating the communication challenges student teams encountered and managed to overcome. We report on an analysis of data collected from reports and interviews in the software project course delivered in fall 2020. There were 57 participants, forming 10 project teams in the study. The results show that remote work negatively affects the social aspects of project teams, especially early communication difficulties in a project. The teams were able to handle most identified challenges but had less interest in tackling those that they did not see as a risk to project completion, which would have most likely caused problems in real-world projects. This study improves understanding of communication challenges in student project teams and the findings serve as a resource for course teachers to design student project courses in the context of virtual teams.

Keywords:

Communication challenges, virtual teams, distributed software development, student projects, case study

PAPERS:

ID:

1230

Topic:

Curriculum Development

Engineering Skills

Title:

An Investigation on Integration of Computational Thinking into Engineering Curriculum at Delft University of Technology

Authors:

Zhang, Xiaoling (1);

Specht, Marcus (2);

Valle Torre, Manuel (3)

Abstract:

Our life is surrounded by digital devices. Engineering education is one of the cornerstones in

higher education for future generations and computational thinking (CT) is deemed as a core component in various engineering curricula. The Delft University of Technology (TU Delft), is the largest technical university in the Netherlands and computing; computational concepts and activities have been integrated into curriculum for years at TU Delft.

However,

there is not a comprehensive investigation on integration of CT into Engineering Curriculum,

this paper presents a case study of Master's level engineering curricula investigating: 1) to what extent CT components are integrated; 2) in what way CT is interpreted and integrated

in the curriculum; 3) what educational and assessment methods have been used. The results

show that CT has been largely integrated into the investigated curriculum mostly with lectures being the educational method and programming assignments as a method for the assessment. Our analysis shows that understanding the context and patterns in problems and solutions was important in different courses and engineering disciplines, indicating possible directions for integration of CT into curriculum.

Keywords:

Engineering Education; Computational Thinking; Curriculum; Intervention Methods;

Assessment Methods

PAPERS:

ID:

1231

Topic:

Sustainability. Sustainable Development Goals
Curriculum Development

Title:

Integrating sustainability in an electronic engineering program: insights and experiences on academic staff involvement

Authors:

Verhulst, Elli;
Bolstad, Torstein;
Reppe Lunde, Solveig;
Randem Lunde, Helene;
Berntsen Henriksen, Robin

Abstract:

There is a growing urgency to incorporate sustainability in all facets of society to stay within the planetary boundaries. Higher education has a significant role by educating their students - our future work forces – with the knowledge and competences that are crucial for working with sustainability challenges. The development of sustainable technology thereby takes a significant place, pointing out the role of engineering education. This article presents the journey of integrating sustainability in the M.Sc programme Electronic System Design and Innovation at the Norwegian University of Science and Technology. We focus on three aspects of this journey. First, we present the approach used and the process stages for the integration of sustainability, which is a renewed version of a toolbox for integrating ecodesign in engineering studies. Secondly, we present how academic staff is involved throughout the integration process. To be able to succeed with incorporating sustainability into a study programme, it is important to engage and empower academic staff, since they have a central position through their responsibility for a study's central building blocks - the different courses. Lastly, we outline insights and experiences from the perspective of academic staff and the project team involved in the integration process. We conclude with how the approach used and the lessons learned can provide useful strategic and practical insights for other engineering programmes in their process of integrating sustainability and plans for future activities.

Keywords:

Sustainability, integration process, electric engineering, study programme, academic staff involvement

PAPERS:**ID:**

1232

Topic:

Physics and Engineering Education

Title:

Investigation of student reasoning skills about flow processes in logistics

Authors:

Uzulis, Max Vincent;
Kautz, Christian

Abstract:

We present preliminary results of a pilot study investigating the reasoning skills of students in logistics and mobility in the context of hydrodynamics. Particularly, we were interested in the connection between students' thinking of parcel flow in logistics and steady-state pipe flow, as well as their understanding of the concept of conservation of mass in a Kirchhoff-like junction in material flows.

Our goal was to investigate if students of logistics would show more, less, the same, or different misconceptions commonly found in students confronted with hydrodynamics problems. We hypothesize that, due to their exposure to flow-like systems (transport chains, band conveyors, hub systems etc.), students develop a certain intuition about flow processes.

Interviews were held with several students that attended "Transportation and Handling Technology" at OUR UNIVERSITY in the two winter semesters of 2020/2021 and 2021/2022.

We found that half of the students were unable to solve questions regarding the parcel flow on a band conveyor or the steady-state flow in a narrowed pipe, while the other half of the participants showed the correct understanding of flow processes to solve all the problems. We present evidence that the anticipated misconceptions about hydrodynamics strongly affected participants' ability to solve logistics problems.

We also discuss the application of our findings for instruction in logistics.

Keywords:

reasoning skills, logistics, hydrodynamics

PAPERS:

ID:

1233

Topic:

Teaching methods

Title:

Students' perception of applied educational and pedagogical approaches at STEM universities: a European overview

Authors:

Nørgaard, Bente (1);

Beagon, Una (2);

Koponen, Jenny (3);

Kövesi, Klara (4)

Abstract:

Engineering (STEM) universities in Europe apply different pedagogical and didactic approaches, which are reflected in the structure of teaching and learning activities that are organised for the students. There is great variation in terms of both semester structure and how teaching activities are carried out. The aim of this study is to shed light on students' observations of the different teaching structures and teaching practices offered and to highlight the impact on students of the different teaching approaches.

The data for the study was collected through a survey distributed by the BEST student organisation with 351 respondents from students in 36 European countries. The survey contained multiple-choice questions that aimed to collect demographic data, but also focused on questions about how their programme and learning and teaching activities were structured and most importantly, their perception of the various approaches used.

Findings show the variation in teaching approaches such as the extent of teacher centred approaches, class sizes, laboratory components and project work. The variation in the delivery of project work, the number of projects, timescale and the extent of collaboration with industry are also described.

The study shows a picture of EU engineering universities from the perspective of the students. It highlights the diversity in structure and teaching activities and most importantly, the extent to which students disengage due to the way they are taught.

Keywords:

Engineering (STEM) universities, teaching structures, teaching practices, pedagogical and didactic approaches, students' perception

PAPERS:**ID:**

1234

Topic:

Ethics in Engineering Education

Title:

Macroethical Development in Civil Engineering Education

Authors:

Polmear, Madeline

Abstract:

This short research paper presents the early stage of an ongoing project in engineering ethics education. Given the impact of civil and architectural engineering and the profession's obligation to uphold public welfare and trust, students must understand macroethics, engineering's responsibilities to the human, natural, and built environment. The Bachelor's curriculum plays a key role in developing ethical responsibility, as a site of professional socialization and the only institutionalized training most engineers receive. Students are also exposed to ethics, values, and the societal impacts of engineering via informal learning before and during their university experience. The present project is designed to explore how civil and architectural engineering students make meaning of their societal responsibilities by examining their conceptualisation of the impact of engineering and the factors that influenced it. This study employs a constructivist grounded theory (CGT) approach and draws on interviews with Bachelor's civil and architectural engineering students in Belgium and the United Kingdom. Data collection and analysis are ongoing simultaneously with the aim of generating a novel theoretical model of macroethical development. This short paper introduces the theoretical and methodological approach of the study, anticipated outcomes, and next steps.

Keywords:

ethics, macroethics, civil engineering, grounded theory

PAPERS:

ID:

1235

Topic:

Student Engagement
Teaching methods

Title:

Teach as you preach – Activating pedagogical training for university teachers in LUT University

Authors:

Suhonen, Sami (1);
Tiili, Juho (1);
Meriläinen, Jenni (2);
Karjalainen, Kristiina (2)

Abstract:

Lappeenranta-Lahti University of Technology, LUT, offers its teaching staff various pedagogical training courses. This paper describes the first module, “University Pedagogy, Basic Module (10 ECTS)”, and its feedback and results. The module itself was compiled in collaboration between two universities: the ordering university LUT and the delivering university Tampere University of Applied Sciences, TAMK. In pedagogical training it is important to teach as you preach. The participants should be able to experience themselves all the methods, principles and skills they are supposed to acquire during the training. It is difficult to learn to activate students or to become student-centered only by listening to lectures. Therefore, the teaching methods should be in line with the learning goals and the participants should be active doers and learn hands-on rather than be passive listeners. The Basic Module contents focused on two main aspects: general activating pedagogical skills and teacher’s digital tools and their use from pedagogical point of view. First, the basic elements of the pedagogical module are presented together with its structure. Second, the results of participants’ experienced learning gains in different categories of the contents are presented together with their perception of the importance of different parts of the content. The anonymized feedback is also analyzed and presented. Based on the feedback and instructors’ experiences, further development of the “University Pedagogy, Basic Module” is also envisioned.

Keywords:

Pedagogical training, activating methods, learning gains

PAPERS:

ID:

1236

Topic:

Entrepreneurship Education
Assessment

Title:

Experiences from using formative feedback in a course with focus on entrepreneurship

Authors:

Løje, Hanne

Abstract:

Formative feedback is a valuable tool that enables educators to provide immediate and ongoing feedback to improve student learning (Shute, 2008). Formative feedback can be done in a variety of ways and can be administered at various times during the learning process (Shute, 2008).

Many studies about feedback and assessment in entrepreneurship education focus on measuring, assessing and evaluating the contribution of the entrepreneurship education to society etc. and only few studies have focus on the didactic question of how assessment and feedback are done in entrepreneurship education (Warhuus et al., 2018).

In this concept paper, we report and reflect on our experiences and learnings from implementing formative feedback as a mandatory part of an entrepreneurial introduction course. The paper builds on experiences from three full courses, which ran in winter 2021, in spring 2021 and in winter 2022.

The feedback design used in the course can be categorized into three situations: (1) from student to student and (2) from student to educator, and (3) from educator to student. The purpose and outcome from using the feedback design is described and evaluated concerning further development. The discussion includes also which initiatives, there are needed to support further development and implementation of formative feedback in entrepreneurial courses.

References:

Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research*, 78(1), 153-189.

Warhuus, J. P., Blenker, P., Elmholt, S.T., (2018). Feedback and assessment in higher education, practice-based entrepreneurship courses: How can we build legitimacy? *Industry and Higher Education*, 32, 23-32

Keywords:

formative feedback, entrepreneurship

PAPERS:


ID:

1240

Topic:

Teaching methods

Title:

 From student to expert in a week

Authors:

Forbrig, Christian;
Rullmann, Edward;
Rappsilber, Juri

Abstract:

It can be challenging to effectively impart higher education content to students. We experienced such difficulty in a lecture series with invited senior scientists presenting their area of Biotech research. Instead of a vivid exchange with the expert, we observed limited and restrained student contributions. In qualitative interviews with these students we learned that they perceive their knowledge disparity as too big and the fear of being embarrassed by asking “stupid” questions obstructed their participation. This let us to radically rethink the course design resulting in our own interpretation of flipped classroom, peer learning and student empowerment. We designed an engineering course that focuses on providing master students with the best possible environment to gain theoretical knowledge in a new field within a limited time period (currently: six weeks - six topics) aiming to empower them in these topics by acquiring new knowledge on their own. Based on seed questions and tag words, students conduct background research and create a team presentation for an invited field expert, thereby getting prepared for a subsequent in-depth discussion with the expert. The current layout is the product of an iterative process over the course of five years, and several rounds of fine-tuning within each year, based on extensive student and instructor feedback. Students particularly appreciate the positive in-course atmosphere with a focus on growth-mindset, the strong experience in teamwork, being taken seriously, and making contact with field experts and frontiers of current knowledge.

Keywords:

student empowerment, theoretical engineering course, iterative process, course framework, self-driven learning

PAPERS:

ID:

1242

Topic:

Entrepreneurship Education
Mentorship and Tutorship

Title:

Know-how transfer in an entrepreneurial ecosystem

Authors:

Pedrós Cayo, Lorena;
Márquez Gómez, María;
Giménez Carbó, Ester;
Gómez-Martín, M. Esther

Abstract:

Universities have a very important role in entrepreneurial education. University students are not only trained in their specific areas, but they are also trained in entrepreneurial skills to lead teams and to develop leading innovations that will be applied into different markets. Since 2012, the entrepreneurial ecosystem from Polytechnic University of Valencia (Spain), StartUPV, has implemented several education programs for its community, creating a whole learning roadmap with specific training for each stage of the startup. For instance: hypothesis validation, sales funnel, finance, etc. However, one of the main challenges was how to transfer the know-how generated by each startup to the entire ecosystem. Beyond mentoring some projects altruistically, the need was detected to create a framework in which the entrepreneurs themselves could share their knowledge with the rest of their colleagues in the ecosystem. To this end, StartUPV Academies were created in 2015.

These sessions consist of small training pills, led by a member of one of the startups in the ecosystem, on a variety of topics: a new programming language, tips for creating marketing campaigns on social networks, how to negotiate with investors, etc.

More than 200 entrepreneurs have attended the StartUPV Academies, and an average of 8 sessions have been held per year. In this paper we analyze these programs, including the main conclusions of more than 5 years of implementation.

Keywords:

entrepreneurial ecosystem, know-how, university entrepreneurship, startups, entrepreneurship training

PAPERS:

ID:

1246

Topic:

Engineering Skills
Teaching methods

Title:

Action research on electrochemistry learning. Conceptual modelling intervention to promote disciplinary understanding, scientific inquiry, and reasoning.

Authors:

Orozco, Mariana;
Boon, Mieke;
Susarrey Arce, Arturo

Abstract:

Students in engineering-science programmes often struggle with theoretical concepts, while they tend to adopt a surface approach to learning. We suggest that this can be tackled by promoting a specific higher-order thinking skill (HOTS) that enables drawing connections between physical phenomena and theoretical concepts representing them. We designed an intervention to support students in achieving deep insight into electrochemical phenomena, while developing this HOTS. Such intervention aims to scaffold students' learning and development by introducing conceptual modelling as an essential thinking skill of engineering-scientists, and as a strategy to build scientific understanding of natural phenomena. Therefore, conceptual modelling constitutes a main learning objective of this novel course. This paper reports an empirical investigation into how students deal with concepts and complexity, and to what extent the intervention has any measurable effects on the learning outcomes. This phenomenological investigation integrates considerations from various disciplines, and relies on multiple data sources, i.e., students' documents (lab journals and reports), observations of students in action (in discussions with their tutors and while performing lab experiments), and video stimulated-recall interviews. The results show little effect of the intervention, as implemented, suggesting how challenging it is for students (and instructors) to shift from traditional learning-and-teaching approaches, towards an epistemology of knowledge construction for specific problems. The findings are informative for revision of the intervention and generate specific recommendations. Concurrently, our operationalisation of the conceptual framework proves powerful in detecting qualitative differences in HOTS. Plausible implications for research and educational practice in science-engineering education are discussed.

Keywords:

electrochemistry, engineering science education, inquiry-based learning in higher education, conceptual modelling, levels of complexity, recurrent difficulties

PAPERS:**ID:**

1247

Topic:

Ethics in Engineering Education

Title:

An Investigation of Entry Level Engineering and Computer Science Students Ethical Perceptions

Authors:

Watterson, Craig Alan;

Lundqvist, Karsten;

Quilty, James

Abstract:

Ethics is considered an essential aspect of tertiary computer science and engineering education and forms a core part of professional accreditation for degree providers. The authors have been unable to locate a study in New Zealand on computer science and engineering students' ethical beliefs, making this study an important exploration in this field. This study investigates the incoming first-year cohort's beliefs and understanding of ethical issues across three areas: students, future employees and members of society. We conducted the study over two consecutive years to investigate cohort beliefs. For most questions, the students provided high ethical responses, except in the areas of "software piracy and copyright" and "misuse of computer resources". In one year a small but significant number of female students indicated very low agreement that plagiarism is unethical. This research identified the importance of gaining an insight into student ethical beliefs as cohorts can differ in opinions. The findings challenge the common practice of teaching the same material over multiple years with the recommendation that teaching is adapted to address differences in students' ethical beliefs.

Keywords:

Ethics, Gender, Engineering Education, Computer Science Education, Entry-level

PAPERS:

ID:

1249

Topic:

Engineering Skills
Teaching methods

Title:

Engineering schools facing the thorny issue of training students in collaborative skills: feedback from the field

Authors:

Lanthon, Antoine (1);
Konan, Paternie-Rodrigue (1);
Filogene, Fedler (1,2)

Abstract:

In a context of transformation and increasing complexity of work due to the development of information technologies, communication and digital networks, the question of the acquisition and development of collaborative skills of engineers in training arises with a particular sharpness. Achieving their acquisition in practice is a major challenge. In France, although included in the training programs for students, the world of training is struggling to find the teaching and learning adapted and capable of developing collaborative skills in engineering students. Thus, the practices and methods implemented are different from one institution to another. It goes without saying that the acquisition and development of collaborative skills that are highly sought after on the labor market are unequally distributed among graduates of the major engineering schools. Thanks to a recombination of theoretical approaches, a qualitative and quantitative study conducted at ISAE-Supmeca, a French engineering school, in order to obtain an overview of the collaborative skills developed by the students during specific problem- and project-based learning modules, and also in order to provide a critical analysis and feedback about the development of collaborative skills into the students' training program through these applied professional projects that immerse them in work contexts close to the future professional realities. The results show a strong gap between skills development and a focus on the development of skills from the "Process – Deliberation" category.

Keywords:

Collaborative skills, problem- and project-based learning, multi-actor context

PAPERS:**ID:**

1250

Topic:

Mentorship and Tutorship

Title:

Peer Mentorship: Exploring the Unmet Needs of Current Mentees During COVID-19

Authors:Christensen, Darcie (1);
Villanueva Alarcón, Idalis (2)**Abstract:**

Peer mentorship is a mutually beneficial relationship that allows two individuals who are at approximately the same experience level to interact with one another with the goal of providing personal, professional, or both types of support. It has been found that peer mentorship within academic settings have generally positive retention, persistence, and student experience outcomes for both mentors and mentees. While peer mentoring research and initiatives are growing, very few instances exist of determining student perceived needs regarding peer mentorship. As such, at a western institution in the United States, students were surveyed to self-report their perceived peer mentorship needs. This survey occurred during Fall 2021, just after the onset of the COVID-19 pandemic. Out of 223 participants, 79 students indicated that they currently had a peer mentor at the time the survey was administered. Students were given both a definition and examples of peer mentorship before indicating they had a peer mentor. Their mentors may have been formally assigned through an existing program at the college of engineering of interest or informally obtained through their own efforts. These 79 participants were asked what additional support they wish their peer mentor could provide. Through phenomenological analysis of open-ended responses, common avenues for additional support were determined. These findings allowed for development of recommendations for shaping the future implementation of more targeted and beneficial peer mentoring initiatives. The recommendations include providing flexibility in peer mentorship, training on resources and events, and a variety of peer mentoring opportunities early and consistently.

Keywords:

Peer Mentoring, Needs Assessment, Mentorship, Phenomenology

PAPERS:

ID:

1251

Topic:

Sustainability, Sustainable Development Goals
Ethics in Engineering Education

Title:

Bringing Visibility to Transversal Skills in Engineering Education: Towards an Organizing Framework

Authors:

Jalali, Yousef;
Kovacs, Helena;
Isaac, Siara;
Dehler Zufferey, Jessica

Abstract:

Professional engineering work occurs in dynamic, complex contexts that require engineers to leverage various skills beyond their technical competencies to work productively with different stakeholders. Problem-solving is not merely a technical endeavor; educators and practitioners have long realized the synergistic connection between technical proficiency and complex personal and interpersonal competencies, such as critical thinking and communication skills.

Since the 1990s, the topic of transversal or professional skills has been a common thread in engineering education literature. Engineering accreditation bodies such as Accreditation Board for Engineering Technology (ABET) and Commission des titres d'ingénieur (CTI), and engineering curriculum models such as the conceive-design-implement-operate (CDIO) have highlighted the importance of various transversal skills in professional engineering work. Today, there is a general agreement among engineering educators and scholars about the value and benefits of transversal skills. What is less clear is which specific skills should be considered transversal and how those skills can be categorized and defined. Efforts in settling these issues ultimately help engineering programs to have a clearer picture of which skills are (and are not) well integrated and assessed in their curricula.

This concept paper discusses a framework for categorizing transversal skills. We build on the relevant literature and the ongoing educational practices in prioritizing transversal skills at the École polytechnique fédérale de Lausanne (EPFL) to bring visibility to essential graduate skills and attributes, including those that are often underemphasized.

Keywords:

Transversal Skills, Engineering Education, Organizing Framework, Curriculum Development

PAPERS:**ID:**

1252

Topic:

Curriculum Development
Engineering Skills

Title:

Implementing a suite of skills modules in a first-year engineering project-based subject

Authors:

Buskes, Gavin;
Chan, Huey Yee

Abstract:

Students commencing engineering at university often have no prior experience of engineering, what the profession entails and the distinctions between disciplines. Consequently, tertiary institutions often offer common first-year engineering subjects that aim to give students an experience of the engineering profession and method, while providing exposure to different disciplines through applied project-based learning. The difficulty with this approach is that there is a wide variance in terms of students' knowledge, skills, past experiences, and expectations. In a team context, these discrepancies could lead to conflict and poor educational outcomes. Furthermore, if the project is of reasonable length, students might be locked into a discipline-focused project that they realise does not suit them as a potential major.

To this end, a suite of self-enrolled skills modules was developed to support student skills development in a first-year, project-based engineering subject under two categories – technical, focusing on skills that had direct applicability to the project-work and general, focusing on skills related to assessment. The modules aimed to (1) improve individuals' skills in a team context; (2) give students an opportunity to learn skills unrelated to their chosen project in a low-stakes context; and (3) promote interaction and peer-learning outside of their project team and class, building a wider sense of cohort.

This paper discusses the creation of the modules and evaluates their outcomes in achieving their goals based on numerous data gathered throughout the semester and student feedback. Initial results have been positive and suggest future directions for development.

Keywords:

skills, project, first-year, design

PAPERS:**ID:**

1253

Topic:

Virtual and Remote Labs

Engineering Skills

Title:

A European vs Australasian Comparison of Engineering Laboratory Learning Objectives Rankings

Authors:

Nikolic, Sasha (1);

Suesse, Thomas (1);

Grundy, Sarah (2);

Haque, Rezwatul (3);

Lyden, Sarah (4);

Hassan, Ghulam (5);

Daniel, Scott (6);

Belkina, Marina (7);

Lal, Sulakshana (8)

Abstract:

Learning objectives are important as they provide direction to teaching staff towards what content should be taught, what activities should be undertaken and what assessments are to be used to confirm understanding. Two decades ago the evolution of new learning modes such as recorded, remote and simulation/virtual started the research process to define and better understand learning objectives in the teaching laboratory. Much is still to be learnt about laboratory learning objectives including which are most important, and if what is deemed important is universal. For example, do academics in Europe and Australasia align in which objectives are most important and which are not? To answer this question, European and Australasian engineering academics were asked to rank laboratory objectives across the cognitive, psychomotor and affective domain using a predefined tool called Laboratory Learning Objectives Measurement. A total of 113 academics from Australasia and 25 from Europe responded to the survey. A statistical analysis was conducted to compare the rankings. The findings from this survey show that substantial alignment occurs across the cognitive and psychomotor domains but differs across the affective domain.

Keywords:

Engineering, Laboratory, Learning Objectives, Skills

PAPERS:

ID:

1254

Topic:

Entrepreneurship Education
Challenges of new European Universities

Title:

Fostering university networks and entrepreneurship education programs: The case of the EntRenew Project at Ideas UPV.

Authors:

Morant-Martinez, Oscar;
Lucas del Rosal, Alexandra;
Márquez Gómez, Maria;
Gómez-Martín, M. Esther

Abstract:

A pan-European network of universities connected with a common goal and involving both students and professors can be a strong catalyst for the professional, economic and social development of the university environment that positively affects not only the university itself but also the other agents or actors in its ecosystem. It is also widely recognized that training and education in entrepreneurship constitutes a solid strategic tool for regional development in which both public and private institutions around the world have made large investments over the past years.

The European Project EntRenew in which the Universitat Politecnica de Valencia - Spain (UPV) participates from 2019 is working in facilitating the exchange, flow and co-creation of new knowledge, enabling professors to teach transdisciplinary studies through innovative methods and stimulate synergies between universities and entrepreneurial support systems throughout Europe.

Ideas-UPV, the entrepreneurial service at UPV has a large experience of 30 years promoting entrepreneurship among students and professors. It also participates in different European projects establishing networks and future collaboration opportunities. The design of entrepreneurship education programs aimed at higher education students is also a core area of the service, not only addressing business plans but also the development of entrepreneurial skills.

This work analyses the current results of the EntRenew program and how this and other initiatives of Ideas UPV have had an impact on the creation of student entrepreneurial ecosystems, fostering cooperation between the actors and establishing connections to the university environments.

Keywords:

University networks, Entrepreneurship ecosystems, Entrepreneurial skills, EntRenew, Entrepreneurship Education program

PAPERS:

ID:

1255

Topic:

Curriculum Development
Engineering Skills

Title:

A roadmap for engineering and technology education reform at The Norwegian University of Technology (NTNU)

Authors:

Øien, Geir Egil Dahle;
Bodsberg, Nils Rune

Abstract:

Through the project “Technology Education of the Future” (FTS), NTNU has over the last 2½ years developed a novel framework for re-design of its educational programmes in technology and engineering. FTS delivered its final report in January 2022. Whereas the project’s earlier sub-reports discussed and made recommendations regarding ‘why’ and ‘what’, the final report focuses on ‘how’ – a roadmap describing the concrete steps NTNU should take in order to implement FTS’ recommendations in the upcoming years. The purpose of this concept paper is to provide an overview of this roadmap. The report outlines 12 main actions within five quality areas, plus an overarching ‘umbrella action’ deemed necessary to enable the 12 main actions. For each action, a handful of prioritized measures are described. Each prioritized measure is discussed in some detail and assigned to one of the following main responsible instances: the Rector, the executive committees for engineering education, the faculties, departments, study program managers, and course responsables. A time schedule is proposed for each prioritized measure, and associated resource needs are qualitatively estimated. The report also provides procedural advice, emphasizing factors deemed critical for a successful FTS implementation - e.g., institutional ownership, clear communication, clear decisions, sufficient resources, and suitable indicators. Finally, FTS is placed in a Theory of Change framework, providing a more complete understanding of how the different project results are related. The final report and recommendations are subject to organizational review in the spring of 2022, with actual implementation expected to start in the fall.

Keywords:

systemic, educational reform, programme re-design, engineering and technology, engineering competence

PAPERS:

ID:

1256

Topic:

Fostering Engineering Education Research
Teaching methods

Title:

What do we need to consider when designing and researching student learning in Challenge-Based Learning?

Authors:

Helker, Kerstin;
Lazendic-Galloway, Jasmina;
Bruns, Miguel;
Reymen, Isabelle M.M.J.;
Vermunt, Jan D.

Abstract:

Challenge-based learning has become specifically popular in higher engineering education. CBL addresses the key characteristics of future engineering programs by embracing authentic, active learning, offering choice in problem-solving and learning practices as well as enabling training in interdisciplinary teamwork and decision-making. This responds to the desire of many students for a sense of meaning in their education. Just as with many other educational innovations, we see a large variety of many different initiatives under the CBL label which is why much research is being conducted on the characteristics of CBL implementation. But the goal for researching different characteristics of CBL experiments is to, in the long run, understand whether CBL influences student learning, and in which way, since prior research suggests positive effects of such active learning approaches. In this short paper we present a framework for capturing the prerequisites, context, process and outcomes of student learning in challenge-based learning. We take a close look at CBL as an educational concept in contrast to the prior ways in which student learning has been described to put forward a heuristic analytical framework that will allow researchers and educators to capture the different aspects of the CBL process and context that could guide further education design as well as research to foster student learning gain in CBL.

Keywords:

Challenge-Based Learning, learning process, learning gains, context

PAPERS:

ID:

1257

Topic:

Industry and Companies liaison. Regional Involvement and Innovation
Digitalisation & Hybrid models

Title:

🏠 LESSONS LEARNED DURING A BLENDED TRAINING FOR NEW EMPLOYEES IN AEROSPACE COMPANIES

Authors:

Pourtoulidou, Despoina;
Frey, Andreas

Abstract:

This research follows a previously published paper presented by Pourtoulidou and Frey which describes the conversion of a classroom-based to blended training for new employees entering aerospace companies [1]. This paper presents the lessons learned that derived from the analysis of the results after evaluating the blended training according to the participants', subject matter experts', and trainer's perspectives.

Prior to the training, Pourtoulidou and Frey analyzed the demands of aerospace companies and the labor market in order to develop this introductory training [1]. The classroom-based training was developed, implemented and evaluated in 2018/2019. Utilizing this evaluation, the blended training consisted of an online phase, which lasted six months and provided access to lecture videos, literature material, quizzes, forums and virtual meetings over the Moodle platform. In the middle of the online phase, a face-to-face session took place in October 2021 in which the participants worked with practical applications and associated with subject matter experts operating directly in industrial projects.

The lessons learned focus on the training development for employees' blended courses and on the specific limitations resulting from developing a joint training for entry-level aerospace engineers. The flexibility and further benefits of the training's online phase were well received from the participants, while the opportunity to meet, work and exchange experiences in person during the training was highly appreciated. The impact of COVID-19 on participants' experience and feedback was also visible and commented on.

Keywords:

entry-level employee training, individualization, aerospace software development

PAPERS:

ID:

1258

Topic:

Engineering Skills
Teaching methods

Title:

Teaching AI Competencies in Engineering using Projects and Open Educational Resources

Authors:

Schleiss, Johannes (1);
Hense, Julia (2);
Kist, Andreas (3);
Schlingensiepen, Jörn (4);
Stober, Sebastian (1)

Abstract:

A major challenge in engineering education is to empower students to use their acquired technical skills to solve real-world problems. In particular, methods of Artificial Intelligence (AI) need to be studied as tools in their respective application contexts. This puts pressure on university lecturers concerning the didactical design and elaboration of a course, and requires them to move towards a practice-based learning approach. Moreover, working on real-world problems leads to uncertainties for the lecturer and their students. Before and during the course, it is not always clear which methods will be used to solve the problem, respectively which competencies the participants need to acquire.

Therefore, we propose to combine two established approaches: a project-based learning approach and the use of digital, curated learning content provided by Open Education Resources (OERs). We hypothesise that a practical study project solving a real-world problem using a combination of OERs and project-based learning is beneficial to AI education. Furthermore, we show implementations of our concept in three different courses.

The first results indicate that student-centred tasks lead to high intrinsic motivation. At the same time, lecturers have to deal with a modified and extended role: They are no longer the broadcaster of knowledge but rather a guide within the learning process. Using the combination of OERs and project-based learning, the courses are attractive and exciting for students and lecturers without becoming unmanageable.

Keywords:

AI Education, Project-based learning, Open Educational Resources, Engineering Curricula, Teaching Methods

PAPERS:

ID:

1259

Topic:

Student Engagement
Teaching methods

Title:

🏠 Challenge-based learning as a tool for creativity and talent expression DigiEduhack as a successful case study from the University of Trento

Authors:

Fiore, Francesca (1);
Scroccaro, Alessandra (1);
Conci, Arianna (2);
Montesor, Alberto (1)

Abstract:

After the stop caused by the pandemic, the University of Trento and its newly born FabLab reopened the doors to DigiEduHack (<https://digieduhack.com/en/>), the decentralized hackathon dedicated to the most pressing challenges of digital and innovative education. More than 30 multidisciplinary students have ventured into the design of innovative learning tools to meet the challenge thrown at them: prototyping educational board games; multimedia artefacts and installations at the intersection of big data, art and technology; co-designing festivals in a combination of art, science and fun; laboratory images to be presented in the classroom. In this short paper, as a case study one, we will outline the DigiEduHack initiative, focusing on the potential of a challenge-based approach in stimulating and strengthening introspection, creative thinking and talent's expression. Supported by a set of qualitative data collected before and after the event, this work reports an education case study and shows the progress and preliminary reflections of the students and educators involved.

Keywords:

challenge-base, hackaton, creativity

PAPERS:

ID:

1260

Topic:

Industry and Companies liaison. Regional Involvement and Innovation
Teaching methods

Title:

🏠 Associations between TAFE teachers' conceptions of, and approaches to, ICT-enhanced teaching and their conceptions of ICT use in the workplace

Authors:

Khan, Md Shahadat (1);
Markauskaite, Lina (2)

Abstract:

This paper builds upon the authors' previous research on Technical and Further Education (TAFE) teachers' conceptions of (first paper), and approaches to (second paper), ICT-enhanced teaching in professional education (third paper). This paper aims to examine relationships among the above three aspects, that is: between TAFE teachers' conceptions of, and approaches to, ICT-enhanced teaching and their associated view about ICT use in the workplace. Phenomenography, a qualitative research approach that emphasizes the importance of people's experience of a phenomenon, was selected as a research methodology for this study. A cohort of 23 teachers from three TAFE institutions in NSW, Australia, participated in semi-structured, in-depth interviews. This study found that teachers' conceptions of, and approaches to, ICT-enhanced teaching, and conceptions of ICT in the workplace are linked. More specifically, TAFE teachers who hold a particular conception of ICT-enhanced teaching tended to adopt related approaches to ICT-enhanced teaching that are further linked with conceptions of ICT in the workplace. TAFE teachers who expressed 'student-centred/activity-oriented and/or industry-oriented conceptions of ICT-enhanced teaching were more likely to adopt a 'student-focused' approach to ICT-enhanced teaching. The teachers within this group were more likely to hold an understanding of the role of ICT in the workplace as an effective or essential tool in professional activities. This paper offers new insights that contribute to bridging the gap between ICT in teaching and ICT in workplace practice. These findings could help develop new initiatives to address the existing gap between teaching in TAFE institutes and current practices in the workplace.

Keywords:

teachers' conceptions, phenomenography, teaching approach, industry-oriented teaching

PAPERS:

ID:

1261

Topic:

Sustainability. Sustainable Development Goals
Virtual and Remote Labs

Title:

Programming 1 and Sustainability

Authors:

Castro, Jorge (1);
Cortadella, Jordi (1);
Gabarro, Joaquim (1);
García, Albert (2);
Vidal, Eva (1)

Abstract:

Computer programming is an essential skill for today's engineers, and sustainability plays a role of growing interest in any of the design phases of an engineering project. The fundamentals of sustainability, with basic concepts such as "carbon intensity", must be covered in any engineering curriculum.

We propose a basic computer programming course in which the lab sessions incorporate exercises related to the computation of environmental impacts. For instance, an exercise might request the computation of the carbon footprint of the lab sessions during a whole year. Lab sessions use an automatic evaluation server, so called BigMaster, that assesses about the correctness of the programs submitted by the students. New exercises concerning sustainability topics are included in the BigMaster course.

The course involves the effort of a multidisciplinary team. First, lecturers on basic programming are required. An expert on automatic evaluation of computer programs is essential to prepare the statements and the test sets of the proposed exercises. Finally, the advice of economists and sustainability experts is crucial to guarantee judicious conclusions are drawn from each exercise. Forming a team with this profile is a challenging task.

Our CS department lectures basic programming courses to more than 1700 students/year. The success of this approach could bring a substantial social impact in our ecosystem.

Keywords:

Programming 1, Sustainability, Carbon footprint, SDG, Automatic Evaluation.

PAPERS:

ID:

1262

Topic:

Curriculum Development
Digitalisation & Hybrid models

Title:

A matrix for making sense of digital competences in formal engineering education curricula

Authors:

Lyngdorf, Niels Erik Ruan;
Bertel, Lykke Brogaard;
Lindsay, Euan

Abstract:

In this paper we present the development of a matrix used to assist study boards and stakeholders in embedding digital competences into their engineering curricula. The matrix was developed by reviewing existing frameworks of digital literacy and competency at the citizen, upper secondary and higher educational levels and modifying them to suit the context of problem- and project-based learning (PBL) in engineering education. The matrix draws together three categories of digital competences (general academic competences, problem-based learning competences, and discipline specific competences) and an interdependent taxonomy of digital competences (user competences, development competences and reflexive competences), resulting in a matrix of nine distinct types of digital competences. The resulting matrix makes accessible the concepts of digital competences enabling different stakeholders in the curriculum design process (study boards, industry advisory bodies, students etc.) to make meaningful contributions to the curriculum development process.

Keywords:

Keywords: curriculum design, digital competences, engineering education, problem-based learning

PAPERS:

ID:

1263

Topic:

Engineering Skills
Teaching methods

Title:

How does the extent of student-active learning in engineering programmes influence students' perceived learning outcomes?

Authors:

Øien, Geir Egil Dahle;
Pettersen, Ivar;
Bodsberg, Nils Rune

Abstract:

Through the project "Technology Education of the Future", the Norwegian University of Science and Technology has over the last 2 ½ years developed a novel framework for re-design of its educational programmes in technology and engineering. One of the main findings is the need for a broader, more multidimensional view of graduate competence than what has traditionally been the case. This showcases the need to fully integrate training of several important non-technical professional skills in future programmes. To enable such integration, student-active pedagogical methods built on integrated learning principles are often seen as key tools. This paper quantitatively investigates to what extent the use of such approaches actually makes a difference to learning outcomes across a variety of skill types (here called competence dimensions). Using statistical analysis of data from the national student survey Studiebarometeret.no, we investigated the correlation between students' perceived degree of active student participation facilitated by their study programmes, and their self-evaluated learning outcome for 10 different competence dimensions. The analysis was done both on individual student level and on study programme level. The results show a significant positive correlation for several dimensions of competence, with correlation being strongest for the 'nontechnical' competence dimensions. On study program level, we also found that students' perception of the extent to which student-active learning is used is in good agreement with actual known programme characteristics. Thus our results provide a quantitative indication that increased use of student-active learning methods indeed improves learning across a broad set of future-relevant competence dimensions.

Keywords:

student-active learning, engineering competence, non-technical skills, statistical analysis, learning outcomes

PAPERS:**ID:**

1264

Topic:

Entrepreneurship Education

Title:

Fostering the entrepreneurial intention of university students: the role of Challenge-Based Learning approach

Authors:

Colombelli, Alessandra;
Serraino, Francesco;
Cannata, Eugenio

Abstract:

Building on the Theory of Planned Behavior, the aim of this paper is to investigate the moderating effect of entrepreneurship education in the relationship between attributes like attitude, social norms and perceived behavioral control, and the entrepreneurial intention of university students. Specifically, the moderation effect of entrepreneurship programs that adopt a Challenge-Based Learning approach is analyzed. To do so, the Italian sample of university students who participated in the 2021 Global University Entrepreneurial Spirit Students' Survey (GUESS) was used. Results confirm that participation in entrepreneurial programs that adopt a Challenge-Based Learning positively moderate the relationship between Theory of Planned Behavior attributes and entrepreneurial intention of the students. Specifically, the results show that participation in Challenge-Based programs increases the positive effect of attitude on entrepreneurial intention.

Keywords:

Entrepreneurship education; Challenge-Based Learning; Entrepreneurial intention; Student entrepreneurship; Theory of Planned Behavior

PAPERS:

ID:

1265

Topic:

Engineering Skills

Lifelong Learning

Title:

🎓 MINDFULNESS AS A MEANS FOR ENHANCING LEARNING IN ENGINEERING EDUCATION

Authors:

Forster, Kai;

Shaw, Corrinne

Abstract:

Technology evolves rapidly, thereby introducing more complex problems that engineers must be able to engage with. Increasingly complex problems require new ways of thinking, and more innovative, creative, and collaborative responses. To lead this technological evolution, engineers are challenged to engage with lifelong learning and ongoing problem-solving. The learning and creative thinking skills needed for innovation relies on an open and receptive mindset – a key component of mindfulness. Mindfulness has previously been shown to enhance creativity, focus, mental clarity, and divergent thinking skills required for problem solving. Furthermore, mindfulness has been shown improve interpersonal relationships and communication – paramount to effective collaboration when working towards solutions to complex problems as a team. In this paper, the perceptions of mindfulness and its effects on engineering professionals in the workplace are explored. Data were collected using structured interviews with a purposive sample of practicing South African engineers, and a survey sent out to a larger sample. Data were analysed using content analysis for the interviews and statistical regression analysis for the survey. It was found that engineers believed that consistent learning was a vital aspect of job performance. Findings revealed that mindfulness was correlated to lower stress, fatigue, and turnover intention, while improving productivity, innovation, and communication. Results indicate that through cultivating mindfulness, engineering professionals will be more equipped to continuously learn, create, and innovate in a productive manner. The study proposes that mindfulness is introduced at undergraduate level in engineering education as a key skill in preparing graduates for the workplace.

Keywords:

Learning, mindfulness in practice, innovation, creativity

PAPERS:

ID:

1266

Topic:

Entrepreneurship Education
Mentorship and Tutorship

Title:

When problem based learning becomes entrepreneurial – a facilitator view on student challenges

Authors:

Holgaard, Jette Egelund;
Du, Xiangyun;
Guerra, Aida

Abstract:

Integration of entrepreneurship in current engineering education emphasizes the need for engineers to initiate and drive innovation processes that transform ideas into societal value. Learnings from the history of engineering and the at times unsustainable impact of technology on society have drawn attention to user requirements and the societal context of technological innovations. In addition to this view, entrepreneurial education underlines the need to move beyond reactively addressing user requirements and societal developments to pro-actively creating opportunities and realizing their potential to change societal patterns and trajectories. Grand challenges as climate change and the recent COVID-19 pandemic have indeed confirmed the need for such abilities.

This paper argues that when integrating entrepreneurship in engineering education, the pedagogical approach to how we teach entrepreneurial engineering will inevitably have to be re-visited. The study aims to explore the facilitation of entrepreneurial projects in a problem based learning (PBL) environment. Design based research was conducted to co-develop and test guidelines and models for entrepreneurial PBL based on existing PBL approaches. In this process, ten facilitators of entrepreneurial PBL projects were continuously challenged to change their perspective from being facilitators to students, from being practitioners to reflective practitioners. In this paper, we specially report on the part of the study investigating: What challenges do students experience when PBL becomes entrepreneurial?

The paper concludes with insights on the nuances of entrepreneurial PBL and closes with a short discussion of the need for more research to ensure integration and not addition of entrepreneurship in engineering education.

Keywords:

Entrepreneurship, problem based learning, project facilitation, design based research

PAPERS:

ID:

1267

Topic:

Building Communities and Coordination
Cooperation for Development

Title:

Identity and agency of engineering educators in Zimbabwe

Authors:

Ventura-Medina, Esther (1);
Mamuse, Antony (2)

Abstract:

Educational transformations require educators with competences to deliver quality education. This raises the issue about capacity building in staff and in particular in the engineering disciplines where pedagogical practices are heavily reliant on didactic approaches such as traditional lectures and tutorials. The global Covid19 pandemic has forced educators to move away from traditional approaches and although the response was quick it is unclear if many of these changes will remain in future, given that they were not done by design but as a reaction to the unexpected situation. This study considers the training of engineering educators in different engineering disciplines and in a number of higher education institutions in Zimbabwe who were part of a HEPSSA-Royal Academy of Engineering UK project. At this conceptual stage the study explores how effective capacity building activities are in enabling educators to transform their practice to an active student-centred approach both in face-to-face and online modes. It further explores how the training experience might empower educator's sense of agency and change their identity within the boundaries of their institutions and country. The research design is grounded on the theories of agency and, self-efficacy and motivation. It uses an interpretative approach, Qualitative Content Analysis, for the analysis of data collected via interviews with the engineering educators participating in the project. This research design aims to find how engineering educators can be supported through their educational transformation journey and also to inform policy makers at institution and national level in order to enable sustain development.

Keywords:

educator's competences, identity, agency, educational transformation

PAPERS:**ID:**

1268

Topic:

Building Communities and Coordination
Student Mobility

Title:

Developing Strategic Partnerships through a Sustainability Enrichment Week

Authors:

Hitt, Sarah Jayne (1);
Hairstans, Robert (2);
Leitch, Kenneth (3);
Connell-Skinner, Kirsty (4)

Abstract:

This paper describes the development of a mini-module focused on sustainability and timber engineering as a component of a strategic partnership designed to broaden Transnational Education, staff/student mobility, and industry and community links within two universities. Edinburgh Napier University (ENU) draws students from around the world to Scotland and is internationally recognised for timber construction and wood science. The New Model Institute for Technology and Engineering (NMITE) is a new higher education provider in England pioneering an innovative approach to engineering education integrating business, engineering, the liberal arts, and professional skills. ENU and NMITE are leveraging these strengths to develop a strategic partnership that brings together staff, students, industry, and the community for opportunities that create impact beyond traditional learning approaches. This can be seen through the development of a Sustainability Enrichment Week hosted by NMITE's Centre for Advanced Timber Technology (CATT) and attended by ENU MSc Environmental Sustainability students. Students investigate interfaces between buildings, humans, and nature through experiential learning based around the construction of the CATT building, which has been developed as a Living Lab. Each day features activities aligned to identified learning outcomes and themed around one of five sustainability competencies: systems thinking, values thinking, strategic thinking, future thinking, and collaboration. The Sustainability Enrichment Week also serves as a trial for a short course soon to be offered as part of a Timber Technology, Engineering, and Design programme. This project could be a model for other universities seeking to create similar strategic partnerships and learning experiences.

Keywords:

Sustainability, Timber Engineering, Experiential Learning, Industry Engagement

PAPERS:

ID:

1269

Topic:

Curriculum Development
Digitalisation & Hybrid models

Title:

Digital documentation and planning of student projects in engineering and product design using e-portfolios

Authors:

Riess, Christian;
Walter, Michael S. J.;
Tyroller, Maria

Abstract:

The use of e-portfolios is very rare among academic teaching on engineering design and product design especially in Germany. Written exams and reports are not always suitable to evaluate competencies and skills of students gained through such projects. A wide range of competencies is required and a variety of results (sketches, 3D-CAD-models, real prototypes, user feedback, etc.) are generated, that cannot be adequately represented in a written exam or report. We see the use of e-portfolios as a solution to this problem. Our goal is to enable the documentation and planning of the entire product design process using e-portfolios for student projects in a course on product design - and thus also include the production and assembly of the individual parts until the real final product.

This short-paper will detail the necessary preparations and changes in content and organization to a course on product design and how the students are introduced to the use of e-portfolios. We develop a three-step process, that supports i) the preparation of e-portfolios (in advance to the course), ii) the design of individual e-portfolios (during the course) and iii) the evaluation at the end of the course.

The main findings of this work are seen in a provided recommendation on structure and design of an e-portfolio based course on product design (integrating required and useful software-tools and manufacturing machine interfaces) as well as the identified specific requirements of students and lecturers that need to be fulfilled to successfully implement e-portfolios.

Keywords:

e-portfolio, engineering design, project-based learning, digital laboratory

PAPERS:

ID:

1270

Topic:

Curriculum Development

Teaching methods

Title:

Developing Engaging Engineering Education Resources Based on Students Learning and Educators' Teaching Styles

Authors:

Chakrabarti, Soma;

Fredriksson, Claes

Abstract:

The learning styles of engineering students have evolved over the years with the advent of technology-enhanced education. Educators have also changed their teaching styles to incorporate student-centric pedagogy and educational technology. While the COVID-19 pandemic proliferated online teaching worldwide, often forcing educators to conceptualize and convert face-to-face teaching materials to online learning modules, Ansys education endeavors have also pivoted to support educators and digital learning. This paper highlights the Ansys Education Resources, aimed at helping undergraduate materials and simulation-based design educators teach and inspire students. These are also perfect for students and self-learners who are looking to complement classroom content. The latter is also great for professors assigning supplemental homework or capstone projects. The resources, of which 80% are openly accessed, are categorized as lectures, case studies, micro-projects, exercises, etc., and make the educators' job easier in inspiring and engaging the students' digital learning process through the undergraduate curricula. Solutions to exercises and projects are restricted to educators with current Ansys product licenses. In developing these resources, the content developers consider different teaching and learning styles with special emphasis on project-based learning and incorporate questions that inspire students consider societal impact and ethical choices. Some resources are purposely prepared for discussions and debates. The impact of these resources is measured through qualitative questions-answers in user group meetings, periodical surveys, and quantitative performance (such as download numbers) of the website repositories.

Keywords:

teaching resources, engineering education, learning styles, teaching styles, project based learning

PAPERS:

ID:

1271

Topic:

Engineering Skills
Teaching methods

Title:

Experiences from the First Implementation Round of Two Electronics Courses Utilizing Flipped Learning Method

Authors:

Laine, Katja;
Sipilä, Erja

Abstract:

During the past years we have witnessed various development trends in learning. More and more the learning has moved online thus making it independent of time and place, students' responsibility of their own learning has increased, methods that promote active learning have gained more interest as they result in better learning results, and the role of a teacher has shifted towards a facilitator of learning. Consequently, the flipped learning pedagogical approach has become more common in recent years as it is one way to answer these trends.

This concept paper introduces two studies of practice in which flipped learning approach was implemented for the first time in a bachelor level university course of electronics during the academic year 2021 – 2022. The structure of the flipped courses consisted of online pre-class study materials and assignments, face-to-face learning events, various individual and group learning assignments and so-called prime-time small group meetings with the teacher. Flexibility and versatility of the learning experiences, both-way feedback possibilities as well as a combination of individual and collaborative face-to-face and online learning were emphasized in the course design.

According to the feedback many students felt that this flipped learning approach promoted learning and encouraged to study evenly throughout the entire course. Furthermore, the teachers' thoughts after the first implementation round are considered, e.g. which parts and practices were successes, and which need further development. In addition, thoughts about teachers' workload and institute's support in utilization flipped learning method are shared.

Keywords:

flipped learning, electronics

PAPERS:

ID:

1273

Topic:

Physics and Engineering Education
Assessment

Title:

First Results of Computerized Adaptive Testing for an Online Physics Test

Authors:

Müller, Ute Carina (1,3);
Huelmann, Thorben (4);
Haustermann, Michael (5);
Hamann, Fabian (3);
Bender, Esther (2);
Sitzmann, Daniel (1,3)

Abstract:

Tests are an essential tool to assess students' ability. In online education these tests are mostly of static nature with the same questions for each student. In contrast computerized adaptive testing concepts take into account the information about the test user automatically collected in an online test. The aim is a comparably precise test result with fewer test items (questions). The implementation of such a computerized adaptive test (CAT) is presented here. The adaptation process is based on the precise knowledge of the item parameters, e.g. difficulty, in the item pool. An estimation of the knowledge level of the test user has to be performed in real time after each answer. With this information the next item can be selected accordingly. This leads to a highly individualized test for each test user. For all items the parameters were determined with methods of the item response theory (IRT) in the framework of the probabilistic test theory. For that real test results of former first year students in engineering science had been analyzed. The prototype of such a CAT has been developed. It focusses on a physics test for prospective students in the STEM fields. In fall 2021 the pilot phase was conducted with first year students in engineering science. The CAT shows that the same precision can be achieved with a mean of 9.3 items compared to 12 in the static test. The acceptance among the students is high. The correlation between the static test and the CAT is satisfactory.

Keywords:

computerized adaptive testing, item response theory, online test, physics, prospective students

PAPERS:

ID:

1274

Topic:

Navigating Open Learning Environments
Engineering Skills

Title:

Introducing Autonomous Vehicles into an Undergraduate Engineering Course

Authors:

Blesa, Joaquim;
Ponsa, Pere;
Calomarde, Antonio;
Garcia, Jonathan;
Repecho, Victor

Abstract:

Autonomous vehicles (AVs) are of great interest for the automotive industry and are expected to revolutionize mobility and public transportation. The university can contribute to the design and development of autonomous vehicles both in the field of teaching and in research and technology transfer. In this paper, it is described how this topic is introduced in an undergraduate engineering course, "Implementation of Automatic Control Systems (IACS)". The IACS course is based on learning by doing methodology. Several practical examples that correspond to real automatic systems are discussed throughout the course and one of them, a low-cost AV to which a Raspberry pi has been adapted, forms the basis for a final project of the course. The control algorithms are developed on MATLAB/SIMULINK and are sent to the Raspberry through a wireless communication network. The control objective of the system is the automatic guidance of the vehicle through a single lane indoor closed circuit, the detection and identification of different traffic signals and the automatic response to these signals. Students check the behavior of the vehicle and proceed to make improvements. Based on the assessment of the students and the robustness of the autonomous vehicles, it is time to consolidate this type of project within the course. Students that want to get deeper into the matter have the opportunity to do a final degree project related with the AV.

Keywords:

Autonomous Vehicles, Learning by doing, Low-cost AV, Undergraduate students

PAPERS:

ID:

1276

Topic:

Fostering Engineering Education Research

Title:

Mapping the engineering education research landscape in Ireland and the UK

Authors:

Wint, Natalie (1);
Murphy, Mike (2);
Valentine, Andrew (3);
Williams, Bill (2,4)

Abstract:

The growth of Engineering Education Research (EER) has led to claims about it becoming a globally connected field of inquiry. This paper presents data on the development of EER within the UK and Ireland with the aim of contributing towards our understanding of the field. A computer-aided process was used to extract the names of authors, affiliated with UK and Irish institutions, that had published in a sample of 13 different EER journals in the years 2018 and 2019. We identified 122 UK authors and 17 from the Republic of Ireland. Selected experts in both countries were contacted to obtain complementary data that was used to build a picture of the research landscape in which EER practitioners function. Similarities and differences between EER in both contexts were identified.

In both contexts there were few institutions that were listed as having EER centres, and it was more common for participants to refer to individual researchers. There also appeared to be a lack of formal PhD programmes and funding opportunities in EER within both countries. Whilst recognition for EER in the UK was primarily associated with teaching awards and fellowships, in Ireland, EER appeared to be as valued as disciplinary research activities.

The overall portrait that emerges from the data collected suggests that in both the UK and Ireland, EER does not benefit from a national support infrastructure but rather is typically carried out by individuals or small groups of researchers.

Keywords:

Engineering education research, UK, Ireland

PAPERS:**ID:**

1277

Topic:

Assessment

Title:

Exploring usage of summative peer assessments in engineering education

Authors:Petrović, Juraj;
Pale, Predrag**Abstract:**

Summative peer assessment is an assessment method where the one's work is typically graded by several other anonymous peers using predefined criteria. The value of summative peer assessments in higher education stems from the fact that they can provide scalability in assessment for large enrollment classes for a variety of different assessment types. The main disadvantages of using summative peer assessments are questionable validity and reliability. In this paper, the first results of using summative peer assessments in a large enrollment professional skills course at the University of Zagreb, Faculty of Electrical Engineering and Computing are reported and discussed. The main research question of this work is how well, given specific conditions of the conducted summative peer assessments, do assignment credits assigned by peers correlate with assignment credits assigned by course lecturers. Data were obtained from four summative peer assessments through the course. A random sample of 50 submitted works per peer assessment was evaluated by course lecturers and corresponding assignment credits were compared to assignment credits awarded by students. Data analysis results suggest a moderate to high correlation between several measures of assignment credits awarded by peers and lecturers.

Keywords:

peer review; communication skills; peer review assessment; engineering education;

PAPERS:

ID:

1279

Topic:

Niche & Novel

Title:

International practice of capacity building in engineering education: a comparative case study

Authors:

Kövesi, Klara (1);

Langie, Greet (2);

Gardner, Anne (3);

Griffiths, Jennifer (4);

Kálmán, Anikó (5);

Lönngren, Johanna (6);

Ruth-Polmear, Madeline (7)

Abstract:

Capacity building is a corner stone for having well prepared and effective teaching staff in engineering education. Despite the importance of capacity building in engineering education, there is relatively little research on this topic. In this paper, we address this gap by reporting on an international comparative study on capacity building practices in university-level engineering education. We examine how capacity building is organised in seven European institutions (in Belgium, Finland, France, Germany, Hungary, Sweden, UK) and Australia, based on institutional education policies and practices. We compare the preparation of teaching staff, their initial training, and continuing capacity building activities throughout their careers. To do this, we applied a qualitative approach, collecting data through (1) a structured questionnaire answered by the members of the SEFI SIG on Capacity building and (2) written notes produced during an international workshop on capacity building at the 2021 SEFI conference. We then conducted a comparative case study, exploring similarities and differences between incentives for permanent academic staff to engage in capacity building, how capacity building is organised, and at what point in their careers staff engage in it. Our findings indicate very diverse approaches, rules and practices as well as different obstacles and challenges for engineering education. The outcomes of our study can be used by policy makers to inform capacity building practices and engineering education in HEIs (Higher Education Institutions), and our questionnaire provides a tool for monitoring and reporting practices throughout the sector.

Keywords:

capacity building, teaching staff's professional development, comparative study

PAPERS:

ID:

1280

Topic:

Mathematics at the heart of Engineering

Title:

📖 Understanding of differential equations in a highly heterogeneous student group

Authors:

Fuhrmann, Tina A. (1);

Kautz, Christian (2)

Abstract:

Differential equations (DEs) are an important mathematical concept for a wide variety of disciplines in engineering. Hence, students need to develop a good understanding of the basic concepts of DEs. However, they encounter many difficulties when studying DEs and often exclusively focus on procedural knowledge. This study therefore investigates the difficulties concerning DEs encountered by engineering students at a university of applied sciences in Germany.

In contrast to previous studies on this topic our investigation differs in two aspects. First, the group of first-year engineering students at this university is highly heterogeneous; e.g. while some begin their studies immediately after secondary school, others have completed vocational training and joined the workforce for some time. Second, the engineering study programs considered here provide for only two semesters of mathematics and do not include specific courses on (ordinary) differential equations. The subject of DEs is dealt with in a three- to four-week period at the end of the second semester.

We conducted think-aloud interviews lasting about 45 min with 9 students after completion of the relevant course. We found that the main difficulties students experience are connected to: substantial lack of prior knowledge, attempting (sometimes unsuccessfully) to apply memorized procedures, and a failure to understand both the difference between a DE and a normal function and what a solution to a DE is.

The results shall be used to design three to four collaborative-group worksheets that build on students' ways of thinking and aim at improving student's conceptual understanding.

Keywords:

conceptual understanding, differential equations, undergraduate mathematics

PAPERS:

ID:

1281

Topic:

Student Engagement
Navigating Open Learning Environments

Title:

Promoting progress and personalising online learning journeys: monitoring student engagement in a virtual learning environment for a research methods module

Authors:

Schrock, Lauren;
Iqbal, Asima;
Masood, Maryam

Abstract:

A monitoring system embedded into a virtual learning environment (VLE) can assess student progress to ensure no student is left behind. This is significant to support student engagement and learning in a blended transferrable skills and research methods module delivered to over 1,200 students from 15 different postgraduate engineering and business courses at a UK university. Therefore, this short paper addresses the question, "How can a monitoring system for student progress be implemented in the VLE?", through a reflexive evaluation of a monitoring system that recognises individual student's weekly progress using a series of badges. A badge is awarded to a student when they have successfully completed or passed a set of required learning activities, and it enables students to self-monitor their progress. As a work in progress, this short paper presents a way to implement a monitoring system using badges in a large class VLE, along with an initial discussion about the challenges for implementing this system and the use of this system to prompt interventions. Further research will advance this short paper by examining the impact of badges to motivate student engagement and learning.

Keywords:

Student progress, Monitoring system, Virtual learning environment, Student wellbeing

PAPERS:

ID:

1282

Topic:

Fostering Engineering Education Research
Lifelong Learning

Title:

🎓 A quantitative exploration of engineering students' professional belonging

Authors:

Sanna, Camilla (1);
Wallin, Patric (2)

Abstract:

In today's fast-moving world, we must continuously adapt to changes in all areas of life, and the ability to do so is increasingly highlighted as a key skill particularly for engineering graduates. At the same time, research shows that having a stable professional identity, and identifying with one's field is important for aspects such as job-satisfaction and productivity, in addition to overall well-being. However, research of higher education have been criticised for apparently viewing professional identity and employability as synonymous, and an end 'goal' of education, rather than exploring the continuous processes of professional socialisation that take place in the everyday practices of universities. Accordingly, we ask: what affects engineering students' professional identity constructions while they are students?

To explore the proposed research question, a quantitative survey instrument measuring professional identification, as well as previously identified related aspects has been constructed. In the research literature, there is little consensus on how to measure professional identity quantitatively, thus, developing a comprehensive measure that can provide insight into these processes is the focal point of the study. Subsequently, the data material consists of 271 engineering students at the Norwegian University of Science and Technology.

Keywords:

professional identity, professional belonging, students, engineering

PAPERS:**ID:**

1284

Topic:

Engineering Skills

Title:

EXPLORING THE PRACTICAL USE OF A COLLABORATIVE ROBOT FOR ACADEMIC PURPOSES

Authors:

Ponsa, Pere;
Tornil, Sebastian

Abstract:

This article presents a set of experiences related to the setup and exploration of potential educational uses of a collaborative robot (cobot).

The basic principles that have guided the work carried out have been three. First and foremost, study of all the functionalities offered by the robot and exploration of its potential academic uses both in subjects focused on industrial robotics and in subjects of related disciplines (automation, communications, computer vision). Second, achieve the total integration of the cobot at the laboratory, seeking not only independent uses of it but also seeking for applications (laboratory practices) in which the cobot interacts with some of the other devices already existing at the laboratory (other industrial robots and a flexible manufacturing system). Third, reuse of some available components and minimization of the number and associated cost of required new components.

The experiences, carried out following a project-based learning methodology under the framework of bachelor and master subjects and thesis, have focused on the integration of mechanical, electronic and programming aspects in new design solutions (terminal element, cooperative workspace, artificial vision system integration) and case studies (advanced task programming, cybersecure communication, remote access).

These experiences have consolidated the students' acquisition of skills in the transition to professional life by having the close collaboration of the university faculty with the experts of the robotics company.

Keywords:

collaborative robot, project based learning

PAPERS:

ID:

1285

Topic:

Student Engagement
Curriculum Development

Title:

CHALLENGE-BASED LEARNING CURRICULUM DEVELOPMENT: A SUITABLE FRAMEWORK FOR ENGINEERING EDUCATION

Authors:

Gomez Puente, Sonia M.;
Doulougeri, Karolina

Abstract:

Collaborative learning communities are becoming popular in engineering education. The department of Industrial Design at Eindhoven University of Technology (TU/e) has almost 20 years of experience in the organization of small-scale and challenge-based education (CBL). In Industrial Design, students work in 'collaborative communities' called 'squads' that share an interest in specific application domains. Within the squads, vertical learning takes place and students from different bachelor and master years exchange experiences and learn together in a learning community while solving open-ended societal challenges. The purpose of the research was to map the characteristics of two ID squads (for the purpose of this study we will name the squads Vitality and Crafting Everyday Soft Things (CEST), and study the educational elements influencing students' learning. In nature, the two squads share the same educational principles, however, they differ in the organization of education and the level of guidance provided, decreasing, to some extent, the open-endedness characteristics of CBL. To conduct the study, we used the constructive alignment as a research framework to map the alignment between vision, teaching and learning activities and assessment of the squads. Results show alignment of the Intended Learning Outcomes (ILOs) with teaching and learning activities, and assessment in the two squads. The analysis draws attention to the similarities and differences between the two squads, especially in the manner of structuring learning. Finally, the suitability of the framework to analyse the CBL curriculum in engineering education contexts is demonstrated. This research opens up opportunities for future studies to investigate learning in small communities.

Keywords:

Challenge-based learning, vertical learning, community of practice, self-directed learning

PAPERS:

ID:

1286

Topic:

Niche & Novel

Physics and Engineering Education

Title:

Scaling-up Practical Teaching: the one-thousand student week

Authors:

Di Benedetti, Matteo;

Day, Harry;

Archibald, Sarah

Abstract:

Multidisciplinary Engineering Education (MEE) is a specialist department at the University of Sheffield, dedicated to the practical teaching of all the University's engineering students. To deliver this, MEE has a unique building comprising workshops, study spaces, and most importantly 16 laboratories offering a spectrum of lab activities to a population of approximately 4000 students.

Effectively managing our resources (staff, equipment, lab space) is challenging due to the heavy demand of student numbers, but an effective approach allows at-scale teaching while ensuring the institutional vision of teaching excellence.

This paper presents the approaches used to optimise the "Cantilever Truss" activity, taking place in the MEE Structures Lab. Over the last 5 years, several key stakeholders helped develop this activity's efficiency and scalability which include academics, technicians, MEE's timetabling manager and teaching assistants.

The key factors in developing the activity were; tuning the learning outcomes for transferability across 3 major courses, optimising the activity tasks for constructive alignment, cross-departmental timetable management, and specialised training for the teaching assistants.

The improvements are measured by several teaching design parameters (teaching hours, student numbers, lab "up-time", cross-disciplinarity), and considered alongside information gathered from teacher reflection forms as well as informal student feedback. This paper discusses how the approaches used have yielded value in optimisation and improvement, before suggesting general elements that could be useful 'take-aways' for different contexts and institutions.

Keywords:

Practical teaching, scalable lab, multidisciplinary, timetable management

PAPERS:

ID:

1287

Topic:

Student Engagement

Teaching methods

Title:

A Meta-Analysis of the Effect of Peer Feedback on Academic Achievement in the STEM Fields of Higher Education

Authors:

Pereira, Priyanka Donald;

Heitink, Maaïke;

Schildkamp, Kim;

Veldkamp, Bernard;

Feskens, Remco

Abstract:

Recently, there has been a significant increase in the use of peer feedback in higher education. However, the evidence of the effect of peer feedback on students' academic achievement does not seem conclusive and, to our knowledge, there has not yet been a meta-analysis of the effect of peer feedback on general academic achievement in the STEM fields of higher education. Therefore, we conducted a meta-analysis to determine whether peer feedback is beneficial to STEM higher education students' academic achievement. The final data set for the meta-analysis consisted of 286 effect sizes from 90 independent samples in 75 studies, with a total of over 14,000 participants. All effect sizes were calculated as Cohen's d values. A random-effects model used to synthesise the effect sizes indicated a significant positive summary effect size ($d = .421$, $SE = .037$, 95% $CI = .350, .493$, $p = .000$). The variance of the true effect sizes (T^2) was $.069$. The Q_w value of 644.167 was significant ($p = .000$) and the I^2 value of 88.512 was high. Therefore, in order to identify the source of the between-study heterogeneity, moderator analyses were conducted to evaluate the influence of various methodological quality characteristics and peer feedback intervention characteristics on the effect of a peer feedback intervention. The results of this study will provide researchers, policy makers and practitioners with the information they need to decide whether or not to use peer feedback and to be able to design peer feedback interventions for maximal effectiveness.

Keywords:

STEM higher education, peer feedback, meta-analysis

PAPERS:

ID:

1288

Topic:

Artificial Intelligence in Education
Curriculum Development

Title:

🏠 An Interdisciplinary Competence Profile for AI in Engineering

Authors:

Schleiss, Johannes;
Bieber, Michelle Ines;
Manukjan, Anke;
Kellner, Lars;
Stober, Sebastian

Abstract:

The use of Artificial Intelligence (AI) in engineering is on the rise and comes with the promise of cost reductions and efficiency gains. However, classical engineers often lack the necessary skills to implement data-driven solutions. At the same time, computer scientists lack the required understanding of engineering systems. Thus, we need to extend the current set of competencies of engineers across the boundaries of disciplines to include competencies of Artificial Intelligence as well as skills necessary for interdisciplinary work. In this paper, we propose a competence profile of a so-called AI Engineer that combines the expertise of AI systems in the context of engineering. Based on perspectives from literature and interviews with experts from industry and research, we highlight the most important set of competencies across the professional, methodological, social, and self-competencies. The contributions of our paper can act as a reference point for developing and advancing future engineering curricula. Furthermore, it serves as a guide for professional self-development.

Keywords:

AI Education, AI Literacy, Cross-Discipline Learning, Engineering Curricula, Future Skills

PAPERS:

ID:

1289

Topic:

Student Engagement
Mentorship and Tutorship

Title:

Minding the gap between secondary school and university

Authors:

Fabregat, Jaime;
Jiménez, Patricia;
Balanya, Teresa;
Blanco, Mònica;
Boza, Santiago;
Coll, Maria Teresa;
Ginovart, Marta

Abstract:

A renewal in engineering education is an education more affected by the circumstances of students who, if known, help to bring them to the future. It is about articulating the students towards learning, with more complete experiences of the factors related to the acquisition of knowledge, and for teachers to share it. The specific aim of the current study is to deepen what it means for students to transition from high-school to university and introduce the changes to reduce the failures it origins.

The causes of low grades in the initial phase have been analysed; subsequently some remedies have been included. First, to gather information, student surveys and interview activities, led by an expert, have been conducted. Subsequently, compensatory actions have been organized by experts, for students and teachers.

The surveys have been designed to know the self-assessment of new students on dedication and performance, and passed to those who failed the first important exam, capturing how they have experienced the university entrance and the first failure. They have manifested some personal causes of low performance: organizational deficiencies of time, impediments to devoting to study continuously, and difficulties of adaptation. Half believe their dedication would deserve better learnings and qualifications, and stand out the difficulties linked to an insufficient level of secondary education and to the types of exams.

This study, supported inside the framework of the activities dedicated to educational improvement at the UPC, has highlighted the convenience of implementing guidance and accompaniment actions devoted to first-year students.

Keywords:

Failures, first-year, gap, guidance, transition

PAPERS:

ID:

1290

Topic:

Mentorship and Tutorship
Assessment

Title:

Assessment of competency development in challenge-based learning course: Can coaches be objective assessors?

Authors:

Petrová, Nikola;
Chapel, Leonie;
Buunk, Luuk G. A.;
Kaptijn, Rianne

Abstract:

Higher education institutions aim to incorporate competency development into engineering curricula, which can prepare engineering students to be independent critical thinkers with entrepreneurial mindsets. However, no solid methods exist to evaluate the acquisition of these competencies. Such assessments' objectivity often is ensured by distinguishing between who supervises a student group and who grades its project outcome. The assessor's active involvement in the learning process is essential for assessing competency development during the learning process, but such involvement may lead to assessor bias. This study aims to investigate whether and under what conditions coaches can be objective assessors. An intraclass correlation coefficient (ICC) was used to measure the level of agreement between assessors and coaches when using the same rubric to assess students' deliverables. Four assessors and seven coaches from the University of Twente assessed 24 students' individual learning processes based on individual reflection deliverables. The coaches assessed the students they supervised during a challenge-based learning (CBL) course, while the assessors were assigned randomly to students without participating in the learning process. The means were compared using SPSS, which indicated, among other things, that coaches generally awarded higher scores than assessors. This may indicate that coaches are biased because of their involvement in the learning process. Despite this, the results also indicate that coach assessment was in line with assessors when the coach was an appointed and experienced examiner.

Keywords:

assessment of competency development, coaching, challenge-based learning, grading biases, engineering education

PAPERS:**ID:**

1291

Topic:

Fostering Engineering Education Research
Engineering Skills

Title:

Exploring engineering skills transformation through a comparison of institutional practices in Mexico and Scotland

Authors:

Caratozzolo, Patricia (1,2);
Smith, Christopher J.M. (3);
Muñoz-Escalona, Patricia (4);
Membrillo-Hernández, Jorge (1,2)

Abstract:

The future of engineering education does not depend only on the curricula designed by universities, but increasingly on the needs of society and the complex requirements of Industry 4.0. Now there is an urgent need to work on an educational approach based on the close collaboration of three stakeholders: the university, which facilitates authentic learning opportunities for students and professionals and ensures the quality of learning outcomes; the industry, which establishes the skill sets and competencies it requires of its workforce; and finally, governments and professional associations, which can influence, provide global collaboration frameworks to support transformation and funding for reskilling, upskilling, as well as institutional responses. This study presents an analysis and comparison of the engineering skills "eco-system" that considers not only the technical education in response to the Fourth Industrial Revolution, but also the problem-solving needs of society and the human factors that shape the transition to the labour market in global contexts.

Keywords:

educational innovation, higher education, meta-skills, education 4.0 skills, industry 4.0

PAPERS:**ID:**

1292

Topic:

Attractiveness of Engineering
Engineering Skills

Title:

Including Digital Awareness as a Competence in a Network Engineering Degree

Authors:

Vidal, Rafael;
Alcober Segura, Jesús;
Cervelló-Pastor, Cristina;
Garcia-Villegas, Eduard;
Yúfera Gómez, José M.

Abstract:

Information and communications technology (ICT) engineers play a key part in our society's digitization process. To foster that role, the Castelldefels School of Telecommunications and Aerospace Engineering (EETAC) of UPC's Degree in Network Engineering currently includes a new competence termed digital awareness. This report demonstrates the initiative's first outcomes, including the teaching resources created, and feedback from students and teachers. In addition, the findings of a high school poll are presented, indicating a high level of interest in this new competence.

Keywords:

digital awareness, network engineering, degree competences, attractiveness of engineering, social impact of engineering

PAPERS:

ID:

1293

Topic:

Building Communities and Coordination

Teaching methods

Title:

🏠 Engaging leaders from students' perspective and the impact of professors as role models

Authors:

Krén, Heléna;

Séllei, Beatrix

Abstract:

Preparing students for the labour market is an essential part of education, and academic personnel usually influence this process. Students' experiences with leading figures, like supervisors and other professors, can affect their expectations about future leaders. For this reason, our research aims to assess students' beliefs and expectations and make suggestions for higher education representatives who can serve as a leadership model for them.

We conducted focus group interviews mostly with engineering students at a Hungarian technical university in spring 2022. Thirty students participated in our research and were assigned to the focus groups according to their work experiences. After coding interviews, we categorized their answers into three groups: leadership qualities and professional and social expectations. According to them, a leader must be competent, socially active, and have a good personality. His or her behaviour must reflect these qualities to be engaging and a good role model.

Our results showed that school and university experiences are a critical starting point and reference when students formulate their expectations towards future leaders. Therefore, it is important to raise professors' awareness about their leadership roles and develop their leadership skills to be good role models for young people.

In our study, we discuss leadership requirements and suggest developmental methods, respectively, to the university's characteristics. In addition, we recommend integrating leadership development programs into engineering education, from which both professors and students could benefit.

Keywords:

academic leadership, leadership development, student expectations, role models

PAPERS:

ID:

1295

Topic:

Fostering Engineering Education Research
Gender and Diversity

Title:

An argument for incorporating sociological approaches into phenomenological analyses in engineering education research

Authors:

Cruz Moreno, Sandra Ileri;
Chance, Shannon;
Bowe, Brian

Abstract:

Despite numerous research studies that have examined why women are underrepresented in engineering education programmes, the phenomenon is still not fully understood, and no effective general solutions have been found. In this context, analysing women's experiences in engineering education can provide insights regarding the evolution of the students' learning strategies and socialization processes as well as contextual factors that influence their choice to persist in or leave their courses. This paper explores the pertinence of enhancing phenomenological analyses conducted in engineering education research by incorporating sociological perspectives, drawing on sociological studies that explore the relationship between gender, STEM education and persistence in STEM courses. The aim is to contribute to building a conceptual framework that, on the one hand, captures lived experience in engineering education and, on the other hand, analyses the social settings around engineering itself, i.e., the objectively significant circumstances, that condition female students' attitudes, behaviours, and expectations towards persisting or not in engineering courses. Conclusions suggest the conceptual framework around subjectively meaningful experiences, proposed by Alfred Schutz, who followed the phenomenological school of thought initiated by Edmund Husserl, might be useful in understanding not only (a) the representations of the subjective social world for women in engineering education (that induces feelings of identification, security, symbolic values, and ultimately social actions), but also (b) the intersubjective social system that structures daily life, legitimizes behavioural patterns, assigns roles, and defines group membership along education in engineering. Expanding engineering education researchers' conceptions of phenomenology can help generate increasingly meaningful research.

Keywords:

Gender, Phenomenology, Methodology, Sociology, STEM

PAPERS:

ID:

1297

Topic:

Challenges of new European Universities
Engineering Skills

Title:

Struggling at the core: multilingualism and multiculturalism in a European University Alliance

Authors:

Kjellgren, Björn (1);
Taylor, Danielle (2);
Serrano Van Der Laan, Marta (3)

Abstract:

With the ultimate aim of finding ways to improve the systematic integration of linguistic and cultural competencies in engineering education, this paper addresses how culture and language competency education is discussed within a technical European University Alliance and how this discourse is translated – or not – into educational initiatives and activities. By doing this, we aim to put focus on the gap between a certain European Union ideology – “united in diversity” – which is at the very heart of the EU project, and the everyday practices at technical universities, where linguistic and cultural competency education are often considered as marginal activities or elective add-ons compared to the hard core of technical subjects.

The paper is based on European University Alliance documents and the observations and experiences made within one alliance’s working group on cultural and linguistic training during 2020-2022. We suggest that the gap between the rhetoric of multilingualism and multiculturalism and the reality of teaching and learning within the alliance has at least two sources: a tendency to engage in magical thinking where global competence develops “spontaneously” in international settings and a tendency to avoid addressing difficult questions, e.g., what multilingualism and multiculturalism actually mean in contemporary engineering education. This paper will provide some of the crucial questions that need addressing if we want to move beyond the empty rhetoric, as well as some practical suggestions for a systematic integration of cultural and linguistic competency education into engineering education.

Keywords:

European University Alliance, multilingualism, multiculturalism, global competence, engineering education, Internationalisation

PAPERS:

ID:

1298

Topic:

Teaching methods

Digitalisation & Hybrid models

Title:

Factors of acceptance of digital tools: the example of the 3DExperience platform in the context of collaborative projects

Authors:

Lanthony, Antoine (1);

Konan, Paterne-Rodrigue (1);

Fedler, Filogene (1,2)

Abstract:

In face of the omnipresence of digital technology in all aspects of life, education and training players are encouraged to adapt to digital tools. This should enable learners to grasp and take advantage of the potential it offers, while developing the various dimensions of digital skills. However, the introduction of digital tools in education and training environments still raises many challenges, especially because any new technology requires from all actors, teachers and learners in particular, a change in their habits and postures. This action research takes as a theoretical analysis framework the model of instrumental acceptance applied to information and communication technologies developed by Caron and Heutte (2017). It focuses on the factors of acceptance and use of a digital tool in general, in particular the 3DExperience platform, by learners involved in applied collaborative projects. It is based on several experiments carried out with students from ISAE-Supmeca, a French engineering school, and other students from partner institutions as part of the EXAPP_3D educational research project. With a methodology that focuses on interpretative phenomenological analysis (Restivo et.al., 2018), it provides scientific support for the sometimes complex challenges of integrating new tools in engineering schools.

Keywords:

Digital tools, factors of acceptance, 3DExperience

PAPERS:**ID:**

1300

Topic:

Entrepreneurship Education

Title:

The implications of entrepreneurs' previous experiences on using a scientific approach to decision making: Evidence from a randomized control trial

Authors:

Panelli, Andrea;
Colombelli, Alessandra

Abstract:

This study aims to investigate if previous managerial or entrepreneurial experiences of entrepreneurs could moderate the use of a scientific approach to decision making. To test this, we embedded an RCT experiment involving 132 real startup from Italy. We collected data on performances using phone calls for 64 weeks. Using econometrics analysis, we find that previous managerial or entrepreneurial experiences moderate the effect of this entrepreneurial decision making approach on startup performances, such as whether they decided to terminate their entrepreneurial idea, number of pivots and the amount of revenue gained. The moderating effects differ according to the experiences possessed by entrepreneurs.

Keywords:

Entrepreneurship education; RCT; Human Capital; Decision-Making

PAPERS:

ID:

1301

Topic:

Virtual and Remote Labs

Virtual and Augmented Reality in Education

Title:

Remote Learning and Examination based on Augmented Reality

Authors:

Acevedo-Reveron, Aaron M. (1);

Camilleri, Christian (2);

De-Raffalle, Clifford (2);

Deguara, David (2);

Zammit, Edwin (2);

Smallegange, Jan (3);

Butnaru, Adrian (3);

Mora, Carlos E. (1)

Abstract:

REmote Learning and Examination based on Augmented Reality (RELAR) is a European Erasmus+ project (2020-1-NL01-KA226-VET-083043) that aims to create a crisis-proof resilient education environment by enabling remote coaching and digital skills training on the basis of AR. RELAR integrates seven European partners –Vocational Training Institutions and Higher Education Institutions– all linked to the maritime industry. The industry itself is also represented.

With help of a reference group, a set of learning outcomes has been defined for developing three demo scenarios to test and demonstrate the RELAR system, which is based on the RealWear HMT-1 assisted reality hands-free computer. All scenarios are scaffolded on the same framework that integrates active learning pedagogy, curriculum requirements and technological integration.

This digital active learning process pedagogy incorporates two processes for instruction: a remote instruction process called ‘Expert Coaching’ that gives the students the possibility of receiving instant feedback while taking actions and decisions; and a remote assessment process named ‘Digital Workflow’ that incorporates formative assessment to consolidate learning. The curricular aspect focuses on the professional competencies students will acquire, the expected learning outcomes, the required knowledge, and the transferable skills required by students to perform professionally. Finally, the technological integration describes how and when assisted reality system should be incorporated to add value to the learning process.

This paper describes the work in the learning spaces currently under development by the partnership on the basis of the same methodological and pedagogical foundations.

Keywords:

Augmented Reality, Assisted reality, Remote learning, Remote coaching, Digital active learning

PAPERS:**ID:**

1302

Topic:

Entrepreneurship Education

Title:

How do students transform good solutions from an educational challenge in a startup? A case study to entrepreneurship education.

Authors:

Braga, Marco (1);

Pifano, Frederico (1,2);

Boehm, Rodney (3);

Maria, Alves (3)

Abstract:

In many universities around the world several events of short term PbL are taking place. These are challenges proposed to the engineering students from concrete problems given by NGOs, governmental institutions, or enterprises. In general, they are named hackathons or bootcamps. The goal is to spark interest and develop skills linked to the design and the engineering project development in short-time sprints. However, most of these solutions are never implemented in practice by the teams that created them. The universities consider these practices as part of the education in engineering. Two Brazilian institutions (CEFET/RJ-Federal Center for Engineering Education-Rio de Janeiro and UFRJ-Federal University of Rio de Janeiro - Brazil) participated and won the international event named "Invent for the Planet" organized by Texas A&M University in 2019. The students developed an interface for blind people to walk on the streets avoiding obstacles. Back in Brazil, these students patented the product and created a startup to produce and introduce that solution in the market. Today they have an accessibility startup with several other solutions in addition to the one created at the event. This research has the goal to understand the ways that made these students transform an educational project into a feasible/successful entrepreneurial action. What was the motivation of these students? Where did they get additional entrepreneurship training? What lessons can this case provide to engineering education? A set of interviews has been carried out to understand the process that can contribute to engineering entrepreneurship education in the universities.

Keywords:

Entrepreneurship education, educational bootcamp, skills development, innovation, startups

PAPERS:

ID:

1303

Topic:

Teaching methods

Digitalisation & Hybrid models

Title:

🏠 Relevance of Digital Education and its different aspects of development

Authors:

Macan, Anja;

Yilmaz Yildirim, Ali;

Cojan, Claudia;

Pipidis, Vasileios

Abstract:

The ongoing digitalisation of the learning processes has both opportunities and obstacles for the educational attainment of students in STEM subjects. In this paper, we summarise student experiences with digitalisation during the COVID-19 pandemic and provide recommendations for how to improve teaching methods of STEM education.

The research was conducted through focus groups in a workshop format at 15 European STEM universities across 8 different countries obtaining 147 responses from students.

This paper also aims to analyse how the digital competency of both students and professors has been impacting the effectiveness of new teaching methods and education tools during online classes since the start of the pandemic. Students have a variety of needs, with some students preferring the flexibility and anonymity online work gives them, while others thrive better when they are face to face with instructors and dislike the limitations that exist in virtual communication. In addition, we looked at how students view changes in the evaluation of projects and tests that have occurred to prevent cheating.

The results show the relevance of digital education and which aspects of it need to be developed further. The paper further explores possible solutions for the issues identified in our research, including learning, methodological and skill development aspects. Overall, we propose hybrid classrooms where students have the choice to explore which method of learning best fits them and how professors can support them to ensure the best educational outcome.

Keywords:

digitalisation, digital education, teaching methods

PAPERS:

ID:

1305

Topic:

Challenges of new European Universities
Flexible Study Pathways

Title:

Unite! European University: Main difficulties regarding Flexible Study Pathways identified by Partners with Impact on Joint Programmes – Results of a survey across Europe

Authors:

Bossuyt, Sven (1);
Brogueira, Pedro (2);
Castro, Carlos (3);
David, Filipa (2);
Dellabale, Anne (4);
Freihöfer, Jana (5);
Valero García, Miguel (6);
Gonçalves, Isabel (2);
Hack, Jochen (7);
Nordström, Katrina (1);
Simões, Francisca (2);
Simões, Patrícia

Abstract:

The European Universities Initiative (EUI) promotes European values and identity and aims to revolutionise the quality and competitiveness of European Higher Education. As part of this effort, the University Network for Innovation, Technology and Engineering (Unite!) is working on developing a Joint Program (JP) offer with embedded mobility and flexibility. To achieve this goal, we present in this paper the major challenges in implementing Flexible Study Pathways (FSP) at a transnational level identified in a survey conducted at the seven partner Universities of Unite!.

The most desirable forms of flexibility regarding content of course/program were Elective Courses outside the domain and inside the degree of specialisation. Main difficulties identified by partners are related to academic calendars, time cost to organise FSP, legal matters, program agendas and ensuring the achievement of learning outcomes.

The results of this analysis show possible directions for the development of a European degree, which will require effective communication and stakeholder coordination and engagement.

Keywords:

Flexible Study Pathways, European Universities Initiative, European Degree, Survey Results

PAPERS:

ID:

1307

Topic:

Co-creation with students

Engineering Skills

Title:

🎓 A 3D printed f5 Newtonian telescope: Development of a student project for outreach, education, and dissemination

Authors:

Macías, Roger (1);

Casamor, Oriol (1,2);

Marzoa, Antonio (1,2)

Abstract:

An Engineering student's Final Degree Project based on the design and manufacturing of a 3D printed telescope is presented. The project involves both optical, mechanical, and electronic design, the construction of the instrument, and the numerical and experimental analysis of the prototype. Furthermore, the project explores the possibilities offered by the current 3D printed technologies for the manufacturing of telescopes that may be used both for teaching and disseminating Astronomy and the basis on how to build such instruments. In this communication the current development of a student Final's Degree Project, consisting of the design and construction of a 3D printed Newtonian telescope, is presented. Both the project and the learning experience are shown as an example of the possibilities of this kind of study at the final stages of the academic formation of engineers, and the possibilities for outreach, education and dissemination of both science and engineering are explored.

Keywords:

3D printing, 3D printers, astronomy, telescopes, design

PAPERS:

ID:

1308

Topic:

Virtual and Remote Labs
Physics and Engineering Education

Title:

📖 Two applications for teaching and illustrating Telecommunication Engineering students the atmospheric effects on the optical channels. Applications in Astronomy, Mechanical Engineering and Telecommunications

Authors:

Salazar, Ferran (1);
Marzoa, Antonio (1,2);
Crusellas, Marc (2)

Abstract:

Atmospheric turbulence is one of the limiting phenomena in interesting applications and fields such of optical telecommunications and Observational Astronomy. Both Telecommunication and Aerospace Engineering students may encounter those applications in their professional careers, thus, there is the necessity to introduce this phenomenon and its impact on those fields at the academic formation stage.

In order to teach students of the principles and effects of the atmospheric turbulence in optical propagation, and to illustrate how to solve these problems, two different applications written in MATLAB© were developed.

In this communication both applications and the theoretical background are presented, and the designed activity for Telecommunication Engineers is shown. Results obtained by students and their experience performing the activity are also presented.

Keywords:

Optical Astronomy, Optical communications, Atmospheric turbulence, Adaptive Optics, Active Optics, Great Telescopes, Optical propagation

PAPERS:

ID:

1310

Topic:

Fostering Engineering Education Research
Mathematics at the heart of Engineering

Title:

RESEARCH ON MATHEMATICAL COMPETENCIES IN ENGINEERING EDUCATION:
WHERE ARE WE NOW?

Authors:

Wong, Jacqueline;
Papageorgiou, Elli;
Klaassen, Renate G.;
van der Wal, Nathalie J.;
Menschaart, Laura;
Cabo, Annoesjka J.

Abstract:

In tertiary mathematics education for engineers (hereafter called service mathematics education, SME), there is a long-lasting controversy on what and how to teach. The goal of SME is to provide a base for engineering-specific courses and to develop mathematical competencies needed for academic success and professional practice. A leading question in engineering education is how to take mathematical competencies into account when designing content. Mathematical competencies are employed to understand, judge, do, and use mathematics in a variety of mathematical contexts and situations in which mathematics could play a role [1]. Although mathematical competencies have been introduced for about two decades, Alpers [2] noted that research in engineering higher education had focused chiefly on the modelling competency and less on other competencies. By means of a scoping review, the current study aims to examine how mathematical competencies are investigated in higher education research. The main research question is "To what extent and in what ways have mathematical competencies been examined in higher engineering education research?" Papers were retrieved and qualitatively reviewed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A systematic search yielded 166 records, of which, 65 unique records were relevant to engineering education and screened for eligibility. A synthesis of 23 studies reviewed showed that problem-solving and modelling were the most investigated mathematical competencies and were often investigated together or with other mathematical competencies. The inconsistencies in the terminologies used suggest a need for clearer conceptualizations to advance research and inform practice on mathematical competencies.

Keywords:

service mathematics, engineering education, mathematical competencies, scoping review, curriculum development

PAPERS:

ID:

1312

Topic:

Teaching methods

Digitalisation & Hybrid models

Title:

Post-Pandemic Intended Use of Remote Teaching and Digital Learning Media in Higher Education. Insights from a Europe-wide Online Survey.

Authors:

Huth, Margaux Antonia (1,2);

Meyer, Bea (3);

Tscheikner-Gratl, Franz (4);

Cominola, Andrea (1,2)

Abstract:

The COVID-19 pandemic has had a transformational and potentially long-lasting impact on higher education institutions, with the rapid shift to “Emergency Remote Education”. Two years after the begin of the pandemic, institutions are either returning to presence formats with different speed or converging towards hybrid formats, begging the question what remains of the newly acquired skills and experience with remote teaching and digital learning media? Here, we present the findings of the first European-Union-wide survey on the potential long-term impacts of COVID-19 on higher education, evaluating over 800 responses from students and faculty members of higher education institutions located in 17 different European countries. Our survey – developed in the context of the ide3a university alliance (<http://ide3a.net/>) highlights possible differences between students and instructors in their attitude toward retaining digital teaching formats and media, examines which formats have increased in use over the course of the pandemic, and investigates which of them are intended to be kept and consolidated post-pandemic. The tools and formats examined in this survey include tools for communication and collaboration, formats of didactic activity, as well as assessment formats. Survey responses reveal that all evaluated tools and format have significantly increased in use during the pandemic and most of them are intended to be used at lower frequency in the future, while still at significantly higher frequency than before the pandemic. Moreover, attitudes toward long-term use of remote teaching and digital learning media seems to be comparable between students and faculty members, except regarding some tools.

Keywords:

e-learning, blended learning, didactic shift, COVID-19 response

PAPERS:

ID:

1314

Topic:

Physics and Engineering Education
Teaching methods

Title:

Experiences with short videos in a flipped classroom design in physics

Authors:

Rolstad, Knut Bjørkli;
Andersen, Trine Højberg

Abstract:

We have implemented a methodology for using short videos as a part of a flipped classroom design in an introductory, multi-campus physics course for engineering students. These pre-recorded videos introduced theory and concepts to students ahead of in-class sessions, which enabled a reduction in the time used for traditional lectures. The time spent in classes puts emphasis on student activities, such as quizzes, Q&A sessions with the lecturer answering student-submitted questions, and problem solving.

The physics course has a modular design for customized delivery to a multitude of study programmes and is coordinated by a team of teachers who provide localized classes at several campuses. Although teachers manage individual classes, the course uses an open learning environment which allows enrolled students access to all study materials published by any teacher.

We present results from a questionnaire investigating student experiences with the use of short videos, by measuring the overall level of satisfaction with the videos, as well as collecting students' comments to the videos. We investigate correlations between student satisfaction with the videos and the comments they make, and whether students whose teacher is featured in the video are more satisfied than students without a personal relationship with the featured teacher.

Students report overall satisfaction with video length and level of precision, while requesting more worked examples and detailed calculations. We identify a set of good practices for flipped classroom designs, based on the students' feedback.

Keywords:

Flipped-classroom, teacher collaboration, short videos, physics, multi-campus

PAPERS:

ID:

1315

Topic:

Sustainability. Sustainable Development Goals
Engineering Skills

Title:

Towards 21st Century Citizenship through Sustainable Development Goals in Foreign Language Education

Authors:

Ulker, Nilufer;
Ayar Gemalmaz, Ozlem;
Yilmaz Yuksek, Yasemin

Abstract:

Since learning, literacy, and life skills have become essential for individuals in the information age, the focus on education has shifted to preparation of students for the knowledge society. This is valid for all levels and spheres of education including but not limited to foreign language teaching in higher education. With this in mind, a new English for Academic Purposes (EAP) Course aiming to equip freshman level university students with necessary learning skills has been launched. A particular emphasis has been given to developing the students' English language skills so as to facilitate their communicative competence both in their academic and professional lives. The course adopts a challenge-based learning approach, which provides students with a meaningful framework for learning as it is based on solving real-world problems. In the course, the students work on real world challenges based on the 17 sustainable development goals (SDGs) of the United Nations (UN) while using the learning skills (the four C's) of the 21st Century, namely critical thinking, creativity, collaboration, and communication. During the course, the students work together on the issues highlighted as challenges in United Nation's report on Turkey's performance regarding the 17 SDGs, and offer solutions in groups in the form of poster presentations, academic papers and oral presentations. The course has been implemented since fall 2021. In this concept paper, the researchers will share their experiences and research plans about the evaluation of the course based on Stufflebeam's Context, (C) Input (I), Process (P), Product (P) (CIPP) Evaluation Model.

Keywords:

21st Century Skills, SDGs, CIPP, Challenge-based Learning

PAPERS:


ID:

1317

Topic:

Physics and Engineering Education
Virtual and Augmented Reality in Education

Title:

 Preliminary investigation of a CFD-assisted virtual reality experience in engineering education

Authors:

Solmaz, Serkan (1);
Kester, Liesbeth (2);
Van Gerven, Tom (1)

Abstract:

Virtual reality has become a significant asset to diversify tools in the support of engineering education and training. The cognitive and behavioral advantages of virtual reality (VR) can help lecturers reduce entry barriers to concepts that students struggle with. Computational fluid dynamics (CFD) simulations are imperative tools intensively utilized in the design and analysis of chemical engineering problems. Although CFD simulation tools can be directly applied in engineering education, they bring several challenges in the implementation and operation for both students and lecturers. In this study, to tackle these challenges, we developed the “Virtual Garage” as a task-centered educational VR application with CFD simulations. The Virtual Garage is composed of a holistic immersive experience to educate students through a real-life engineering problem solved with CFD simulation data using a VR headset. The prototype is tested by graduate students (n=24). Participants assessed usability, user experience, task load and cybersickness via standard questionnaires together with self-reported questions and a semi-structured interview. Preliminary results reflect that the Virtual Garage is well-received by participants. We identify features that can further enhance the usability and user experience.

Keywords:

virtual reality, engineering education, computational fluid dynamics, complex learning

PAPERS:**ID:**

1318

Topic:

Curriculum Development

Title:

Dimensions of Engagement beyond the classroom in Challenge-based learning

Authors:

Jimarkon, Pattamawan;
Shahverdi, Masoumeh;
Dikilitas, Kenan

Abstract:

The study investigates and reports on the process of engagement in learning through the innovative pedagogical framework – Challenge-based Learning (CBL) – their changing perspectives of learning and their interaction with each other while conducting authentic challenges. This gives way to understanding how learners construct and create meaning out of learning activities, course content and beyond the course objectives. Our mixed method research explores potential impact dimensions of the implementation of challenge based learning on teachers and students. To reveal the potential impact we conducted a focused group interviews with the learners who took part in CBL-integrated lessons and surveyed 68 number of students who participated in CBL trainings. Our preliminary findings showed that students undertook news roles by driving their own learning, developing collaborative skills, exploring knowledge to be acquired, and establishing relevance of course content in real contexts which made it meaningful for them to understand. In our presentation, we would like to discuss the implications of CBL implementation on the way higher education can be redesigned by assigning students a more active role in learning and the engagement that occurred during their learning experiences.

Keywords:

Challenge-based learning, engagement, authentic learning, learner roles

PAPERS:


ID:

1319

Topic:

Student Engagement
Attractiveness of Engineering

Title:

 Making spatial pedagogy: using insights from spatial ability research to develop maker education pedagogy

Authors:

Westerhof, Marten Berend;
O'Kane, Colm;
Duffy, Gavin

Abstract:

Maker education has been shown to effectively raise children's interest for STEM subjects. Creative maker activities, which mostly take place in informal learning environments such as museums and libraries, hold potential to teach children scientific concepts and train cognitive abilities that are critical to success in engineering in an engaging way. One of these often-overlooked skills fundamental to STEM is spatial ability, which is known to commonly function as a gateway skill to STEM disciplines. Spatial ability is malleable, and training can effect gains not only in psychometrically assessed spatial ability but also in mathematical skills, further demonstrating its importance to STEM learning. In practice maker education often lacks explicit pedagogical attention to the development of scientific skills and cognitive abilities such as spatial ability, instead overemphasising technological skills, and thus limiting its potential to increase learning related to science and engineering. Therefore, maker education practice would greatly benefit from a pedagogy that recognises spatial elements and scaffolds spatial ability development. In this paper the opposing pedagogies that lie at the roots of the maker education and spatial ability education are examined, as a prerequisite step to redesigning maker education practice. The final aim is to transform maker education practice into a STEM learning practice through which spatial ability development is scaffolded and can be assessed. This would help realise maker education's potential for scientific learning and may help a wider audience to meaningfully partake in STEM-related activities from a young age.

Keywords:

maker education, spatial ability, pedagogy, STEM, hands-on learning

PAPERS:


ID:

1321

Topic:

Attractiveness of Engineering
Curriculum Development

Title:

 An Ongoing Spatial Intervention Project in Irish Secondary Schools for Improved Engineering Education

Authors:

Benedičič, Urša (1);
Duffy, Gavin (1);
Sorby, Sheryl (2)

Abstract:

Spatial skills have been shown to strongly predict STEM attainment and can therefore be a determining factor in choosing to pursue high-paying engineering careers. This strong reliance on them particularly limits students with low spatial skills – a group over-represented by girls and students of low socioeconomic status. It has also been demonstrated that spatial training leads to meaningful improvements in skill development. In Ireland, as in most countries, spatial thinking is not explicitly taught at the pre-college level, even though it could influence students' eventual career paths. Currently, only a person's previous experiences outside the classroom influence skill development. In order to increase the number of students who select engineering and other STEM occupations as a career path, an explicit emphasis on training spatial thinking is likely to be very beneficial in pre-college education. An established spatial intervention course was selected for delivery to secondary schools in Ireland. Through training and ongoing support, teachers' spatial skills, and pedagogical content knowledge for spatial thinking are being developed to be shared with their students, leading to an increase in students' spatial skill level and future employment opportunities.

Keywords:

spatial intervention, spatial ability, secondary school education, engineering

PAPERS:**ID:**

1323

Topic:

Curriculum Development
Engineering Skills

Title:

Student perceptions on a collaborative engineering design course

Authors:

van Helden, Gitte (1,2,3);
Zandbergen, Barry (1);
Specht, Marcus (2,3);
Gill, Eberhard (1)

Abstract:

To adequately prepare engineering students for their professional career, educational institutions offer projects in which students collaboratively solve engineering design problems. It is known from research these projects can lead to a variety of learning outcomes and student experiences. However, studies that provide insights in the influence of different features of an educational design are rare. In the current study we use Cultural Historical Activity Theory (CHAT) as analytical framework to understand how different elements of an educational design affect students' experience. Additionally, we use the notion of contradictions to identify opportunities for structural course improvement. Focus groups were conducted with 12 Master students in Aerospace Engineering, that participated in a collaborative engineering design course. During the course, students applied Systems Engineering (SE) and Concurrent Engineering (CE) and worked in the Collaborative Design Laboratory (CDL), which is a state-of-the-art facility that holds a variety of industry relevant tools. It was found that students valued the guidance of their coach and experts, co-located collaboration and the freedom to structure their own process. However, they perceived challenges with regard to adoption of tools in the CDL, sharing their progress with their supervisor, coordination of collaborative efforts and scheduling issues. An analysis using CHAT revealed what contradictions caused these challenges. Finally, recommendations are given on how course structure can be structurally improved.

Keywords:

focus groups, course design, team based learning, project based learning, learning technology

PAPERS:**ID:**

1324

Topic:

Sustainability. Sustainable Development Goals
Engineering Skills

Title:

Innovation Strategies to Develop Specific Professional Skills on Photovoltaic Systems
Engineering

Authors:

Silvestre, Santiago

Abstract:

This work describes experiences learned in teaching photovoltaic (PV) courses in Engineering Master Degrees at the UPC. These PV courses are included as elective courses in the Master of Energy Engineering included in the international master programs: Environmental Pathways for Sustainable Energy Systems (SELECT) and Renewable Energy (RENE) and in the Master Degree in Electronic Engineering at the Universitat Politècnica de Catalunya (UPC) in Barcelona, Spain.

These Master Degrees are aligned with the objectives of the European SET plan and the objectives of KIC InnoEnergy in the field of renewable energies and aim at delivering education for high competency and quality engineering skills in the field. The content of these programmes is focused to the renewable technologies concept of “learning by doing”, so combining deep theory knowledge (top-down approach) with internship in industry co-advised by the university and the industry (bottom-up approach) in an international environment.

The courses are focused on technical skills required for engineers in the field of PV applications. Moreover, from a transversal point of view, a special effort is done to enhance training the students in soft skills such as communication, economics, business administration and, very specially, to promote the orientation to innovation and the entrepreneurship spirit by means again, of the “learning by doing” concept.

Keywords:

Photovoltaic Engineering. PBL.

PAPERS:

ID:

1325

Topic:

Physics and Engineering Education
Challenges of new European Universities

Title:

ADVANCED MATHEMATICAL SKILLS AND RELATING FACTORS OF ENGINEERING APPLICANTS: A CROSS-SECTIONAL STUDY

Authors:

Vierula, Jonna (1);
Tiili, Juho (2);
Björkman, Jouni (3);
Miekkala, Ulla (2);
Ojanen, Jussi (4);
Talman, Kirsi (5)

Abstract:

Higher Education Institutions (HEIs) assess applicants with entrance examinations to identify and rank the applicants with adequate ability to proceed in their studies. Engineering students form a significant group of higher education students both in Europe and in Finland. Finnish Universities of Applied Sciences (UASs) developed and harmonised their student selection in the Development Project in 2017–2020. In the Project, a new national digital Universities of Applied Sciences entrance examination (UAS Exam) was developed. A cross-sectional study was conducted to assess engineering applicants' success in the advanced mathematical skills section of the newly developed UAS exam. The section contains mathematics and physics problems. Altogether 1205 engineering applicants consented to the study and performed the exam section. The data was collected via the digital exam system and analysed statistically. The applicants' mean scores were 4.8 (SD 5.2, median 3.9, range -4.9 pt – 20 pt) out of 20 maximum points. Over 20 percent of the applicants got a failed exam result. Some of the background variables explained the applicants' success and failed exam result indicating that older applicants scored better than younger ones, male better than female, and high-school graduates and applicants with previous higher education degree better than applicants with vocational diploma. The results indicated that engineering applicants' advanced mathematical skills were on a rather poor level and it may be possible that engineering applicants lack basic skills in mathematics and physics, but this may vary between applicants.

Keywords:

student selection, mathematics skills, physics skills

PAPERS:

ID:

1326

Topic:

Student Engagement
Co-creation with students

Title:

The UPV Design Factory, what is it good for?

Authors:

Collado López, M. Francisca;
Villalonga Grañana, Inmaculada;
Giménez Carbó, Esther;
Gómez-Martín, M. Esther

Abstract:

Universities have the challenge and responsibility to society to train good professionals. Moreover, they must adapt to current demands and must do so not only by improving the contents of the different degree programmes, but also by incorporating new programmes and activities that help students to develop soft skills, teamwork, connections between university and real life, etc. that will make them into the best professionals and excellent citizens.

To this end, in 2014, the UPV launched a program called Design Factory to channel and frame initiatives that were being carried out by students with the objective of developing their prototypes and participating in student competitions.

The program is based on the creation of interdisciplinary learning communities, in which students are committed to their goals, their teams and the university. The spirit of the program is to encourage learning in an eminently practical way. Students have to lead the projects, attract and select candidates, manage a budget, carry out their activities and try to achieve their goals, which involves using what are often referred to as soft skills.

Currently, Design Factory-UPV has 68 teams classified as technological, cultural, scientific, motor racing, professional, design and technological and more than 2,000 students involved. The model is present in other universities and some of them belong to Design Factory Network.

This paper will analyse and explain how the implementation of a programme such as UPVDF improves the training of graduates and prepares them for their incorporation into the labour market.

Keywords:

Student engagement, talent, learning innovation, learning communities

PAPERS:

ID:

1327

Topic:

Engineering Skills

Lifelong Learning

Title:

Lifelong learning as an explicit part of engineering programmes: What can we do as engineering educators? – a scoping review

Authors:

Van Den Broeck, Lynn (1);

Craps, Sofie (1);

Beagon, Una (2);

Naukkarinen, Johanna (3);

Langie, Greet (1)

Abstract:

Whilst engineering education has primarily focused on providing students with the required technical competencies, new visions emphasise the importance of lifelong learning (LLL) . They point towards the need to acquire the necessary competencies for LLL during the study programme. This requires a shift in mindset for both lecturers and students. Other studies have provided some key recommendations on how HEIs should integrate the development of LLL competencies in study programmes such as using authentic discipline-specific learning contexts and explicit teaching of the LLL competencies. This scoping review will provide an overview of which LLL interventions have already been implemented in higher education and aims to answer the question: How can HEIs support the development of students' LLL competencies? The included LLL interventions are categorised based on the type and content of the intervention, the duration, the target audience, the effectiveness, and the efficiency. The outcomes of this review serve a dual purpose: (1) to define research gaps and (2) to provide educators with advice regarding the integration of LLL in engineering study programmes.

Keywords:

Lifelong learning, interventions

PAPERS:**ID:**

1329

Topic:

Physics and Engineering Education
Curriculum Development

Title:

Factors that Influence Multidisciplinary Teamwork in a Challenge-Based Learning Course

Authors:

Mesutoglu, Canan;
Bayram-Jacobs, Dürdane Dury

Abstract:

For our students to work on the global challenges facing humankind, they should be raised to appreciate the importance of science and engineering in real-life contexts. Challenge-based learning (CBL) courses have merit in accomplishing this goal by facilitating students' innovative solutions to authentic, complex problems. The fundamental characteristics of CBL include real-world challenges, collaboration, and multidisciplinary. The presented work describes a CBL course where applied physics and mechanical engineering students worked in multidisciplinary teams. An instrumental case study was conducted to identify factors that influence multidisciplinary teamwork in this CBL course. Data were collected using interviews, reflection reports, and observations of team meetings. Transcribed video recordings were searched for instances of demonstrating the codes revealed with analysis of interview transcripts and reflection reports. The research results showed the significant factors influencing multidisciplinary teamwork: a) disciplinary connections to the challenge, b) receiving tutor guidance, c) making presentations in teams, d) exchanging science and engineering perspectives, e) readings and videos on course Canvas, and f) student motivation. Implications are discussed, and suggestions for future research and practice are presented.

Keywords:

Multidisciplinary teamwork, challenge-based education

PAPERS:

ID:

1330

Topic:

Student Engagement
Physics and Engineering Education

Title:

Collaborative, multidisciplinary, international, and societal relevant: A framework combining challenge-based learning and thesis writing across European universities

Authors:

Stahlberg, Nadine;
Brose, Andrea;
Diedler, Sascha;
Kuchta, Kerstin

Abstract:

ECIU^[i] University is an EU-funded European University initiated by a network consisting of 13 universities across Europe. At its core is collaborative learning and research on a European level in close connection with various stakeholders to tackle societal challenges. Learners are engaged in joint project work based on the approach of challenge-based learning (CBL). Here, learners are actively involved in a real and relevant setting. Teams are composed of learners coming from different cultural backgrounds, disciplines, and levels of progress in their individual studies. A challenge within the ECIU framework starts with a “Big Idea” in the area of the UN Sustainable Development Goal 11 “Sustainable cities and communities” that has potential for societal impact. ECIU University offers four types of challenges that differ in length and depth. Within this paper, the first run of an ECIU Strategic Challenge, the most complex challenge type is introduced. The Strategic Challenge is a six-month format that combines individual working phases while working on one’s master’s thesis with collaborative working phases while working on the team challenge. Hence, it offers a framework in which the progress of challenge and master’s theses are expected to go hand in hand. The concept of how students collaborate in the Strategic Challenge is based on work from the Erasmus+ projects COLIBRI (Collaboration and Innovation for better, personalized, and IT-supported Teaching) and its follow up EPIC (Improving Employability through Internationalisation and Collaboration).

[i] ECIU is the European Consortium of Innovative Universities.

Keywords:

Challenge-based learning, thesis writing, Sustainable Development Goal 11, ECIU University

PAPERS:

ID:

1331

Topic:

Curriculum Development
Engineering Skills

Title:

New tools to motivate STEM students towards early-career self-management

Authors:

Torres, Francesc (1);
Kopecká, Eva (2);
Garrido, Núria (1);
Pechová, Helena (2);
Silvestre, Santiago (1);
Hrad, Jaromír (2);
Zeman, Tomáš (2)

Abstract:

This article presents a new academic approach to motivate STEM students to acquire relevant early professional skills and towards career self-management, improving their self-awareness and self-esteem.

In order to cope with fast-changing social and economic environments STEM graduates are increasingly needing specific personal and professional development techniques aligned to their career evolution in the technology business. To embrace continuous innovation, companies are progressively flattening, less hierarchical, evolving from traditional pyramidal and segregated organizations to an organizational model of shared responsibility. This new and highly demanding context requires the STEM graduate to undertake a rapid change in attitude and work methodology to evolve from a user culture (student) to a service provider culture (employee or entrepreneur). That is, moving quickly from a task executor role (doing) to assuming greater responsibility in terms of management roles (directing) and finally to leadership roles (deciding).

This paper develops an innovative approach, based on the concept of service, aimed at facilitating a smooth transition to the tech job market mindset. The concept of service determines which competencies need to be introduced and to what level of depth. It helps students to improve their self-awareness and self-esteem by visualizing the key competences already developed in their academic stage, but also what are the early career skills that require further development and the need for career planning, with a short and long-term perspective.

Keywords:

Career development, transition to labour market, skills and competences

PAPERS:


ID:

1332

Topic:

Teaching methods

Title:

 Departmental seminar series and journal club with enhanced learning outcomes

Authors:

Rullmann, Edward;

Forbrig, Christian;

Rappsilber, Juri

Abstract:

Listening to scientific presentations and reading scientific literature are core activities of any scientist, and frequent components of students' curricula. When employing these activities in teaching, finding the right balance between student instruction and autonomous learning is important for best learning outcomes and teachers' workload. We here present our course design for a coordinated lecture series and journal club, that finds this balance by leveraging modern learning concepts in a digital environment. Participating students were tasked to read a landmark scientific paper every week ahead of a lecture by a scientist with practical experience on the topic of that paper, often an author of that week's paper. Students then had to hand in written answers to three questions probing their understanding of the topic and the paper. In a subsequent seminar, activating questions were discussed by the students in break-out rooms and then answered by randomly chosen students in class, followed by a broad discussion that included the homework questions. Students gave weekly feedback on their learning progress and experience, and the course was then dynamically adapted accordingly. This yielded a course with largely increased course capacity, reduced teachers' workload, and substantially enhanced learning outcomes, qualitatively and quantitatively compared to previous implementations of the course.

Keywords:

seminar series, journal club, paper reading, digital learning, feedback driven

PAPERS:

ID:

1333

Topic:

Fostering Engineering Education Research
Physics and Engineering Education

Title:

🏠 Concept development in microengineering: unpacking underlying processes and developmental paths

Authors:

Vergara, Martín

Abstract:

Concepts are a matter of importance for engineering education. Believed to be critical for developing expertise and engineering competence, conceptual knowledge has become a focus for research and training. Despite focusing on it, engineering graduates still often do not understand core concepts for their practice. With a few exceptions, most research concerning conceptual knowledge in engineering has been developed on assumptions of cognitive psychology, which have been subject to strong criticisms. One of these criticisms points out that mainstream approaches on concepts do not account for the socio-material conditions in which concepts are used and transformed. Some researchers in engineering education have moved beyond, taking a situative perspective. These studies have shown how, compared to training, knowledge in the practice is highly contextualized, depends on tools in which it is inscribed, and is distributed among collaborators. However, while stressing the socio-material dimension of conceptual knowledge and the differences in concept use between training and practice, the situative perspective does not account for the way in which conceptual knowledge develops. Alternatively, the cultural-historical theory of concepts offers an approach that overcomes the weaknesses of mainstream approaches while addressing the problem of development. Drawing on cultural-historical theory, this paper presents an ongoing research aimed at the study of concept development in microengineering teaching and practice. I will present the respective methodological approach—borrowed from a French tradition of work psychology—for studying concept development from interactions in work and teaching activities. Expected results and implications for engineering education will also be discussed.

Keywords:

Concept development, Conceptual understanding, Cultural-historical theory, Work analysis, Microengineering

PAPERS:

ID:

1334

Topic:

Curriculum Development
Engineering Skills

Title:

Tackling perception and deception in STEM: A critical thinking skill for early-career development

Authors:

Torres, Francesc (1);
Moura Santos, Ana (2);
Elias, Antoni (1);
Teixeira, Miguel C. (2);
Montemor, Fatima (2)

Abstract:

This paper addresses the need for young STEM graduates to develop the principles of a skeptical attitude towards the information and stimuli we perceive in order to tackle uncertainty, biased information, and hidden agendas.

With a rate of almost full employment in STEM, the university's concerns are progressively evolving to improve the quality of graduates' employment and its contribution to economic growth and the well-being of society. This raises the need to help students with career planning and the development of personal and professional skills. To effectively transform the industry, progress in STEM professional careers requires the development of interpersonal and transversal skills and increased management and leadership capacity. In addition, the rapidly growing impact of AI on the labor market requires young STEM professionals to further develop "more human" skills to thrive in the labor market and ensure long-term employability. Among these, we find highly cognitive skills that cannot be easily automated, such as critical thinking or creativity.

This article focuses on how we acquire and transfer knowledge and the main sources of information bias. To improve the decision-making process, STEM graduates need to effectively deal with fake news, framing, nudging, and storytelling techniques. To thrive in the job market, STEM graduates must also deal with potential sources of deception from misleading graphs, statistics, (poor) data analysis, and fallacies of probability.

Keywords:

Critical thinking, career development, skills and competences

PAPERS:

ID:

1335

Topic:

Entrepreneurship Education
Teaching methods

Title:

I&E Project Concept for Urban Mobility Education

Authors:

Sayrol, Elisa (1);
Roncoli, Claudio (2);
Aba, Attila (3);
Banfi, Miklos (3);
Bloemer, Alexander (4);
Bragós, Ramon (1);
Estrada, Miquel (1);
Macario, Rosario (7);
Marques da Costa, Nuno (8);
Minner, Stefan (4);
Mohammadi, Roozbeh (2);
Pinhas, Nathan (6);

Abstract:

The Project is developed with the goal of generating a new model for Innovation and Entrepreneurship Challenge-Driven Projects for Master Schools. The added-value comes through collaborating and sharing best practices among institutions in seven different countries with the aim to develop student's skills with an international perspective and Knowledge-Triangle exposure.

The consortium partners of the Project already had experience in different types of teaching and learning activities which are suitable for this purpose, but not on all of them and not in the same degree. Thus, the goal was to create a framework that would allow to know the advantages and pitfalls of different approaches in a practical way, while running courses in the Urban Mobility field and involving more than 100 students in two years. Guidelines to design more suitable teaching and learning methods for I&E oriented Master Programmes were generated. These included the following aspects: teaching and learning activities; time distribution of the activities; multidisciplinary; challenge selection; role of the external stakeholders; assessment of CBP; IP and sponsorship; sustainability and Engineering Ethics; and international Perspective. Some added elements include: the impact of covid in the development of the project and the activities in I&E courses; and the opportunities of Accelerator Programmes for Master students.

Most emphasis was set on the methodology of delivering the course, on the sharing of activities and looking for best-practices and finding stakeholder implication.

Our experience might be useful for Universities that want to open student's mind towards I&E.

Keywords:

Innovation, Entrepreneurship, International Education, CBP, Urban Mobility

PAPERS:

ID:

1336

Topic:

Ethics in Engineering Education

Title:

What is the role of ethics in accreditation documentation from a global view?

Authors:

Junaid, Sarah (1);
Gwynne-Evans, Alison (2);
Kovacs, Helena (3);
Lönngren, Johanna (4);
Jiménez Mejía, José Fernando (5);
Natsume, Kenichi (6);
Polmear, Madeline (7);
Serreau, Yann (8);
Shaw, Corrinne (2);
Toboşaru, Mircea (9);
Martin, Diana A (10)

Abstract:

Ethics in engineering has long been an important element in engineering programmes, however these subjects are often taught at a basic learning level with little attempt to connect to demonstrative learning outcomes. In recent years there has been a step change in the importance of ethics as an integral part of engineering programmes and is reflected in the text of accreditation documents. In this paper we expand our analysis from an earlier study, which focused on four European countries, to understand the role of ethics on a more global scale. We conducted a multi-country analysis on how and where ethics features in accreditation documents in twelve countries across five continents (Belgium, Canada, Colombia, France/Switzerland, Ireland, Japan, Romania, South Africa, Sweden, UK and USA). We identified explicit or implicit references to ethics education, extracted verbs relating to learning outcomes, and compared definitions of key terms. A comparison to Bloom's taxonomy showed considerably higher frequency of verbs linked to ethics teaching associated to lower levels of cognitive learning. Definitions of terms relating to the process of accreditation were often lacking in documents, highlighting a need for setting terms of reference. This study highlights differences in how ethics is described in accreditation documents. However, more needs to be done to explicitly highlight ethics as an integral part of engineering education. Relying on implicit links to ethics leaves the role of ethics open to interpretation, resulting in uneven emphasis in the translation of ethics within programme designs.

Keywords:

Engineering Ethics, Accreditation, Global Analysis

PAPERS:

ID:

1337

Topic:

Sustainability. Sustainable Development Goals
Teaching methods

Title:

Establishing a new seminar to combine learning about Technology and Society

Authors:

Berbuir, Ute

Abstract:

For the transformation we face in industry and society, we need a broad societal consensus and collaboration among different stakeholders. With this in mind, the Environmental Engineering program focuses on environmentally relevant technical developments and the consideration of systemic interrelationships while incorporating societal frameworks.

The recently implemented course „Technology - Dialogue – Society“ was developed as an introduction to these complex tasks for first-year students. It focusses on topics of the energy transition sector and public participation. The learning objectives of the course are the acquisition of methodological competencies as well as the promotion of communicative competencies, teamwork skills and the ability to reflect. An overarching goal of the course is also onboarding of students in the program.

A wide set of teaching-learning methods is used to achieve this broad objectives. In addition to lectures, collaborative and dialogue-oriented teaching-learning methods such as problem-based learning, peer review of student work, conversational simulations and reflection assignments are used. A particular challenge of implementation was the course size of approximately 100 students and the need for online teaching due to the Corona crisis.

The structure of the course is described and the evaluation results of the first run are presented.

Keywords:

problem based learning, public participation, online collaboration

PAPERS:

ID:

1339

Topic:

Artificial Intelligence in Education

Title:

Life in the AI era - First result of the Erasmus+ HEDY project

Authors:

Careglio, Davide (1);
Angulo Bahón, Cecilio (1);
Dimova, Rozalina (5);
Dovramadjiev, Tihomir (5);
Ejubovic, Adisa (4);
Jakobi, Antonia (3);
Kollar, Csaba (2);
Alves Moreira, Ana Isabel (3);
Sukhovii, Evgenia (4);
Szabo, Gyula (2)

Abstract:

HEDY - Life in the AI era is a 2-year Erasmus+ project started in November 2021 targeting higher education audience. Its goal is to offer a comprehensive and shared view of how Artificial Intelligence (AI) is affecting our lives and reshaping our socioeconomic, cultural, and human environments and to define which topics related to AI are of interest to different university studies and how they should be addressed. Four specific free and accessible sources of information will be produced to reach these goals, the first of which is the Booklet, the subject of this paper. The Booklet is an essay defining the HEDY position on life in the AI era and its aim is to identify the challenges, opportunities and expected impact of AI on four different areas: business, governance, skills & competencies, and people & lifestyle. In this paper, we summarise the content of the Booklet. In particular, we describe our methodology to build our rationales based on collecting information from two sources: i) Literature survey, and ii) Focus groups. These two sources provide a unique contribution on AI panorama by combining state of the art research with first-hand opinions and debated questions, concerns, and ideas of interacting individuals. The main finding is that there is the necessity to train citizens in AI by providing teachings, courses and trainings in schools and higher education institutes to facilitate the use and adoption of AI for young people and future generations.

Keywords:

Artificial intelligence, impacts, literature survey, interaction with people

PAPERS:

ID:

1341

Topic:

Teaching methods

Digitalisation & Hybrid models

Title:

Challenge Based Modular Education Upscaled: Piloting and Evaluating an Implementation Procedure

Authors:

Mesutoglu, Canan;

Stollman, Saskia;

Lopez Arteaga, Ines

Abstract:

Modular approach in education, with a perspective of individualized instruction, provides the advantages of student self-pacing, autonomy, and receiving frequent feedback from the instructor. In 2021, the project; CMODE-Up (an Upscaling of the earlier undertaken project Challenge-based Modular On-demand Digital Education) provided evidence-based design principles and an accompanying teacher guide for modular courses in engineering education. A next step towards actually implementing the design framework, is piloting it. In this pilot, we will ask several teachers from our university to work with the framework to redesign their engineering course into one or more challenge-based modules. We will start off with a half-day workshop to get teachers motivated to work with us and to gather data using researcher field notes and audiotaped teacher interviews. Teachers will be recruited based on willingness and experience with modular courses. During the workshop, the teachers will engage in course design exercises using the framework. Results will shed light on teacher views and experiences about the implementation leading to an adapted version of the design principles.

Keywords:

engineering education, modular approach, course design

PAPERS:

ID:

1342

Topic:

Niche & Novel
Engineering Skills

Title:

Where's the Value in Engineering?

Authors:

Williams, Bill (1,3);
Trevelyan, James (2)

Abstract:

New theoretical perspectives on how engineers generate economic and social value have emerged from research on engineering practice, complementing the conventional entrepreneurship emphasis on innovation and start-up enterprises. This research demonstrated, apparently for the first time, how most engineers generate significant economic value with limited if any opportunities for innovation, research and development in their work.

In the absence of appropriate theory, students acquire limited understanding on the contributions they will make to society as engineers. Observations from engineering practice provide a more compelling research-based narrative that could attract a more diverse student population, and help graduates secure well-paid employment.

Many engineering faculty share uneasy feelings that their students will rarely use the advanced mathematical analysis techniques taught in classes. Research explains how practice solving traditional textbook problems builds tacit knowledge that enables rapid technical decision-making in engineering practice. The research also provides insights on how typical engineering science research supports engineering practice.

We argue the benefits from widely disseminating the findings presented in this paper to help faculty staff and students better understand how they will contribute to our collective future. This can help overcome current significant engineering performance shortcomings in sustainability and productivity growth without major curriculum changes.

Keywords:

value creation, productivity, engineering practice

PAPERS:

ID:

1343

Topic:

Curriculum Development
Engineering Skills

Title:

A cross curricular Comparison of Professional Capabilities in Engineering Education

Authors:

Klaassen, Renate G. (1);
Bossen, Linette R.H. (2);
Sies, Puk H.J. (3);
Hellendoorn, Hans (4)

Abstract:

Current educational trends, such as embedding challenge-based education (CBE) and reflective activities, presume that professional skills training in CBE contexts strengthens students' professional capabilities. It should prepare them for a better professional qualification after their higher Engineering Education. However, the variety in curricular design, the moment of measurements, and students' profiles will likely impact students' perceptions of their capabilities. This paper investigates three types of CBE offered on critical parameters and the impact of students' reflective journey in CBE on their perceived professional abilities.

The three CBE contexts concern (1) an MSc Programme in Robotics, (2) a fundamentals course in Bio-Medical Engineering and (3) a Second-year master course focused on interdisciplinary projects with external stakeholders. These all include CBE elements, such as; real-life cases, multi -interdisciplinary learning, stakeholder involvement, collaboration, (transversal) skills development, self-directed and reflective learning. Professional capabilities, as measured, consist of the concept of the "deliberate professional" of Trede (2019) being; personal development, collaboration, critical evaluation skills and contextualisation.

A survey has been administered to investigate the perceived professional capabilities across the different contexts. Response percentages were between 20 and 30%.

Preliminary results show the fundamentals course students lag in personal development, whereas the interdisciplinary project has the most optimistic students' perception on all four elements of the deliberate professional. The most impactful aspects were emotional reflexivity, evaluation of information, critical stance, and interprofessional competence. We will examine the curricular differences and the implications for developing Professional Capabilities during the presentation.

Keywords:

Challenge Based Education, Reflection, Professional Capabilities, Deliberate professional

PAPERS:**ID:**

1344

Topic:

Ethics in Engineering Education

Title:

Why Change Engineering Education?: Pragmatic Perspectives from the Humanities and Social Sciences

Authors:Staley, Thomas;
Bairaktarova, Diana**Abstract:**

Engineering education in the early 21st century is being transformed in many ways to meet the technological challenges of the future. In particular, the role of the humanities and social science in engineering coursework is under new scrutiny, as educators attempt to strengthen students' proficiencies in aspects of the profession including interpersonal and intercultural skills, assessment of broader impacts of technical work, and especially ethics. These developments are often framed as responses to the demands of employers and institutions, who view these 'soft' skills as increasingly relevant to the work life of technical professionals. In this concept paper, we wish to pursue a somewhat different line of thought: We will examine arguments from the philosophy of science and technology, and from the social sciences, about the value of teaching engineers (as well as other technical professionals) to think through humanistic, social, and cultural lenses. We will review a range of perspectives supporting educational reform along these lines, with a particular focus on work in the recent pragmatic tradition (including Sellars, Mitcham, and others). Having established a range of theoretical defenses for educational reform along these lines in engineering fields, we will then consider the distinctions among them and how these insights might be applied most effectively in engineering curricula. We will conclude by reviewing available evidence for the practical utility of such interventions. We hope, by situating current reforms more firmly within a principled framework of ideas, to provide deeper support for positive change in the education of future engineers.

Keywords:

ethics, engineering, education, social sciences, humanities

PAPERS:

ID:

1345

Topic:

Ethics in Engineering Education

Title:

Personality Dimensions, Global and Ethical Perspectives and Engineering Students' Ethical Decisions

Authors:

Snyder, Samyel (1);

Bairaktarova, Diana (1);

Giménez Carbó, Esther (2)

Abstract:

Motivation is an important predictor of ethical awareness; however, it is not easy to assess. The goal of our study is to examine the relationship between motivation and ethical awareness in engineering students. We focus on two personality measures: person-thing orientation and spheres of control and test their association with ethical awareness using engineering scenarios that present ethical dilemmas. We predict that engineering students who score higher on the personality dimension of person-thing orientation will display more ethical awareness than those who score lower. We also predict that students with a higher level of personal control will also display more ethical awareness.

Two groups of students were involved in the study. Group 1 was formed by fifty-three first-year engineering students from University in the United States and Group 2 was represented by sixty-four sophomore engineering students in Engineering School in Spain. Students worked individually on case studies that presenting ethical dilemmas; they were asked to write short essays describing how they would respond to each situation. Then the essays were analyzed using an ethical reasoning and a global awareness rubric.

Results revealed that 1) the context/nature of the students' responses to the case study varied greatly, 2) personality traits and global and ethical perspective, all correlate to students' ethical decisions as measured by their responses to the case studies scores, 3) there is an alignment between the SOC and the Global Perspective Inventory (GPI) dimensions that merits further exploration.

Keywords:

personality traits, global education, ethics education, case studies

PAPERS:

ID:

1346

Topic:

Student Mobility
Teaching methods

Title:

 Simulating an engineering workplace: A new approach to prototype-based team project

Authors:

Chan, Brian;
Bin Asad, Talha;
Bairaktarova, Diana

Abstract:

This paper documents the remote management of a first-year foundations of engineering course with special focus on students' learning by completing a prototype-based project in an online course. The COVID-19 pandemic brought on unprecedented challenges to the teaching and learning communities around the world. Educators made purposeful changes in their teaching approaches, shifting rapidly from in-person to online mode of instruction. This study documents a project-based course that adopted an asynchronous mode of instruction as a part of the general engineering curriculum at a large Southeast university in the United States during the pandemic. This asynchronous course – through implementing necessary changes and adaptations – simulated the experience of a cross-border engineering workplace. The course content focuses on engineering design and problem-solving, physical prototyping, simulated data collection and analysis, contemporary software tools, and professional practices and expectations (e.g., communication, teamwork, and ethics). Learning activities are designed to introduce students to the types of work that engineers do daily and to challenge students' knowledge and abilities as they explore the different elements of engineering by completing an aesthetic wind turbine project. Our paper reports on the development of the course site as informed by recent national developments in scholarship and practice for online teaching and learning. The principles of course design alignment as well as instructor presence and learner interaction as suggested by these national standards are discussed. Further, the study records strategies adapted to enable students to complete a successful prototype-based project working in geographically distributed and virtual, international teams.

Keywords:

simulations, project-based learning, remote learning

PAPERS:

ID:

1347

Topic:

Engineering Skills

Lifelong Learning

Title:

ESSENTIALITY OF KNOWING TRANSVERSAL COMPETENCIES: TOWARDS ENGINEERING EDUCATION SUSTAINABILITY AND INDUSTRY READINESS OF ENGINEERING STUDENTS

Authors:

Sangwan, Devika;

Venugopal, Abhijith

Abstract:

Engineering education is to prepare engineers for real-world challenges and seek novel solutions to cater to society's different needs. There is an increase in the global demand for industry-ready engineers. Engineering education sustainability and industry readiness are mutually inclusive, where the former is the combination of different skills and transversal competencies, while the latter is all about their applicability. Transversal competencies, transferable across disciplines, chisel engineering students to become versatile and practical on the shop floor. Sustainability in engineering education is usually discussed only from the ecological/environmental viewpoints. This paper tries to find out the relevance of transversal competencies from the perspectives of engineering students at three levels: the most recurring competencies, the competencies they lack, and the ones that need improvement. Recurring and essential transversal competencies such as problem-solving, creativity and innovation, communication, lifelong learning etc., were identified from different policy frameworks of accreditation agencies, industry reports, organizational reports, and academia. Primary data was collected from final-year engineering students for this exploratory research through semi-structured interviews. These transversal competencies, latent throughout the formative years, have a definite role in the engineer's industry readiness, making engineering education sustainable. The need for industry readiness of the engineering students indicates the sustainability of engineering education, which can bridge the gap between the industry and academia. The paper reveals opportunities for further expansion of the competency frameworks in the policymaking and accreditation procedures.

Keywords:

Transversal Competencies, Sustainability, Engineering Education, Lifelong Learning

PAPERS:**ID:**

1350

Topic:

Attractiveness of Engineering
Engineering Skills

Title:

Learning path for Construction 4.0 based on tinkering and STEAM

Authors:

Chacón, Rolando

Abstract:

This article describes the outcomes of a completed study of practice in civil engineering education. The study is aimed at infusing Construction 4.0 content to a Bachelor degree on Civil Engineering. A set of STEAM-rich activities are created in the form of an individual learning path. These activities are conceived with a threefold perspective: i) Construction 4.0-related, ii) STEAM vision by-design and iii) hardware-software independent (open-source, accessible, affordable). Cornerstone and capstone projects as well as a set of workshops represent some demonstrators of these activities. All these demonstrators are knitted together in a single path in that is pegged to the traditional curriculum. The STEAM perspective provides completeness to the whole development. During the last two years, design, development and implementation of several demonstrators have been completed. Some results related to the application of some activities are already available. In the years to come, it is expected that an improved systematic deployment of such activities will allow assessing the evolution between tools, pedagogies and the needs of the sector. In this paper, the description of the activities together with the discussion on the potential of tinkering on Construction 4.0-based curriculum is addressed.

Keywords:

tinkering, STEAM, Construction

PAPERS:**ID:**

1354

Topic:

Physics and Engineering Education
Attractiveness of Engineering

Title:

"It's not like it's popular science we are doing" - Popular science, motivation, calculations, and conceptual understanding among physics and engineering students

Authors:

Kjelsberg, Ronny;
Thorseth, Trond Morten

Abstract:

This paper discusses the role popular science and science dissemination texts can have in learning physics in higher education for physics students and technical physics engineering students. In a mixed-methods study, students' attitudes, experienced motivation, and learning is mapped through a quantitative survey (N=155) and two qualitative surveys with in-depth interviews, one with six master level students and one with four 1st year students. The interview data shed light on two aspects of popular science's role in learning physics. Students report that reading popular science is highly motivating, but they do not have the perception of having learned physics from it. This converges with a division between calculations and conceptual understanding among the students. The paper then questions whether this gap could be closed or made smaller with greater emphasis on conceptual understanding in physics classes.

Keywords:

physics, popular science, motivation, perceived learning, conceptual understanding

PAPERS:

ID:

1356

Topic:

Sustainability. Sustainable Development Goals
Curriculum Development

Title:

Systematically developing a chemical engineering department education toward digitalization and sustainability at NTNU

Authors:

Abtahi, Niloufar;
Jäschke, Johannes;
Knuutila, Hanna K.;
Andreassen, Jens-Petter

Abstract:

This work presents a method for developing the chemical engineering department's education toward digitalization and sustainability. A "super course" focuses on modelling and programming skills using examples on sustainable processes. The "super-course" consists of parts that are embedded in the regular course portfolio, such that it interconnects the different courses given at the department. It aims to develop bachelor-level candidates' digital competence skills and their awareness of how their engineering skills contribute to sustainable development. The "super-course" development starts with defining the learning outcomes at a program level and after that, designing learning outcomes and activities in the different courses, building toward programs' learning outcomes. This top-down approach guarantees constructive alignment of the learning activities and the desired results.

In the first phase, the project focuses on students in the study program Chemical Engineering and Biotechnology (an integrated 5-year master's degree) and then adapts the two-year Master's program. In the first three years of the program, the Department of Chemical Engineering provides seven out of 24 courses. The work here focuses on the seven chemical engineering courses, where we hope to have progress in modelling and programming skills while also ensuring students get a clear understanding of how chemical engineering contributes to the sustainable development in industry and society by challenging students first with simple problems before introducing them to more complex chemical engineering problems.

The project is aligned with the CDIO standards and will develop the teaching of digital and sustainability skills in the department.

Keywords:

Chemical Engineering Education Research, Digitization, sustainability

PAPERS:**ID:**

1357

Topic:

Student Engagement
Physics and Engineering Education

Title:

PBL ACTIVITIES AS LINK ELEMENT IN THE BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATION ENGINEERING

Authors:

Martínez-García, Herminio;
García-Vílchez, Encarna

Abstract:

This paper describes the experience carried out within the Bachelor's Degree in Industrial Electronics and Automation Engineering taught at the Eastern Barcelona School of Engineering (EEBE) of the Technical University of Catalonia–BarcelonaTech (UPC). Specifically, the experience is based on the realization of a cross project that is under the framework of the degree intensification named Application Design in Electronics Engineering (ADEE). This intensification, consisting of a block of two courses, taught in the Fall and Spring semesters, and offered for students in their final year, allows the fulfillment, for two semesters, of the aforementioned project. This includes the design, simulation, implementation (assembly), testing and experimental results (corroboration) of an electronic system or equipment within the field of Electronic Engineering.

As is well known, technical studies, especially those concerning engineering, require a highly recommended (and, indeed, almost necessary) practical aspect. It serves not only as main key from a practical point of view of this typology of University degrees, but also it can be used as a motivational tool to current students and future engineers. The idea of cooperative learning-based activity that is shown in this paper started as a result of the detection by course professors of a lack of students' motivation and academic level and ability the Bachelor's Degree in Industrial Electronics and Automation Eng. In particular, this degree, which started in September 2009, was launched along with the Bologna Process. It is offered at the EEBE of UPC in the European Higher Education Area (EHEA) framework.

Keywords:

PBL, Electronic Engineering Education.

PAPERS:

ID:

1358

Topic:

Mathematics at the heart of Engineering
Assessment

Title:

Changes in learning strategy and learning time in the wake of the pandemic

Authors:

Sipos, Bence (1);
Berezvai, Szabolcs (1);
Szilágyi, Brigitta (1,2)

Abstract:

University studies were also significantly affected by the pandemic. The freshmen had already spent the last months of high school, which are especially important for graduation, in distance learning. In Hungary, the graduation procedure was changed due to the epidemic. Education was completely digital, in hybrid education: the lectures were held online, the seminars were attended in person, and from September of 2021 again in person.

Our research team has been monitoring learning time and effectiveness for years using the EduBase online educational platform which provides a framework for all teaching aids for the calculus subject.

In our research, we analyzed the learning processes and their effectiveness of mechatronic and energy engineering majors, who were admitted to BME in 2020. The results were compared with the learning habits of the class of 2018, with whom a detailed study was also performed. It can be stated that the learning time was greatly influenced by the pandemic: students took advantage of the available practice opportunities to a greater extent in digital education, which did not reduce the practice time during the end-of-semester spurt, thus learning became more balanced. Considering the results of high school, it can be observed that on average those who took advanced level subjects spent more time practicing, even though they had already mastered some calculus in high school. In addition, test scores also influenced practice time. Our students successfully coped even with the challenging tasks.

Keywords:

time spent on studying, COVID-19, productivity, engineering students

PAPERS:

ID:

1359

Topic:

Ethics in Engineering Education
Curriculum Development

Title:

Can decolonising the curriculum provide an enhanced engineering education?

Authors:

Collins, Graham John

Abstract:

Decolonisation is defined and discussed. University College London has several initiatives to decolonise the curriculum and enhance diversity and inclusion. In 2022, a series of online flipped lectures were developed for the postgraduate software engineering module. The aim was to provide a range of perspectives on artificial intelligence (AI) ethics. Teaching was through the decolonisation lens, highlighting historical viewpoints and imbalances in power. Students could reflect on the ethics of AI systems and how these systems perpetuate colonial biases.

Students had previously indicated their interests in AI, environmental and social issues, including climate change. Before lectures, students completed questionnaires, providing an understanding of their prior knowledge of topics.

A qualitative analysis of the reading material using coding within ATLAS.ti provided insight to select schemas to scaffold students' knowledge. The suggested reading was then adapted to ensure a greater diversity of viewpoints. The analysis also indicates that adding these additional perspectives may not increase cognitive load.

Lectures include real-world perspectives from guest speakers from diverse backgrounds, reinforcing the importance of different opinions. Students greatly valued the different perspectives and opportunities to discuss ethical dilemmas. Students' answers, following ethics discussions, indicated an improved understanding of engineering concepts. This study suggests that incorporating a range of views can enhance the topics students want to learn. Providing different perspectives can also deliver a more balanced engineering pedagogy. Adopting a decolonisation approach that recognises the past but provides alternative narratives may strengthen opportunities for engagement with other universities: creating new scenarios in engineering education.

Keywords:

decolonising the curriculum, AI ethics, engineering education, curriculum development, cognitive load

PAPERS:**ID:**

1360

Topic:

Ethics in Engineering Education

Title:

Engineering Ethics Education for Systemic Change: A Case for Sub-Saharan Africa

Authors:

Nyamapfene, Abel (2);

Magara, Irene (1)

Abstract:

Unlike in the western world, engineering practice in Sub-Saharan Africa remains mired in corruption, ethical malpractice, poor ethics governance and lack of effective leadership. This situation has, and continues to, negatively impact national infrastructure, health, education, and economies across Sub-Saharan African countries. Non-ethical engineering practices continue to occur despite the existence of national ethics legislation in Sub-Saharan African countries, and despite codes of ethics underpinning business operations in most public and private sector organisations that employ engineers. This is also despite the existence of codes of conduct and ethics prescribing professional engineering practice that have been developed, and are policed, by national engineering institutions and regulators. Increasingly, engineering education providers have incorporated engineering ethics education in their curricula. However, despite this, Sub-Saharan African engineering graduates transitioning into employment still face significant difficulties in dealing with the myriads of ethical dilemmas they meet in their professional practice. This raises two questions, the first one being: Can the introduction of engineering ethics education in Sub-Saharan African engineering curricula help to improve ethical conduct in engineering practice? Assuming that this question can be answered affirmatively to some degree, this leads to the second question: How can engineering ethics education curricula be redesigned to provide systemic change in Sub-Saharan engineering practices? In this paper, we engage with the engineering ethics education literature and documentary evidence from a range of engineering institutions in Sub-Saharan Africa to suggest a way forward.

Keywords:

engineering ethics education, Sub-Saharan Africa, systemic change

PAPERS:

ID:

1361

Topic:

Attractiveness of Engineering
Gender and Diversity

Title:

Early career patterns, experiences, and influences: reflections from women engineers in senior roles

Authors:

Marinelli, Melissa Jane (1);
Lord, Linley Anne (2);
Male, Sally Amanda (1)

Abstract:

Early career experiences provide the foundation for career progression and inform career choices and decisions. For women in the engineering profession, positive early career experiences have been linked to increased career satisfaction, career commitment, persistence and retention.

A recent focus on early engineering careers has provided insight into early career roles types and related competencies, competency demands and capability gaps experienced by novice engineers, identity development and early career socialisation, and their perceptions of meaningful work. These studies have highlighted the socio-cultural-technical nature of early engineering practice. There is opportunity to further diversify and contextualise the current understanding by exploring early career experiences of women in the engineering profession, and by considering the influence of gender in this career stage. This paper reports on an empirical investigation of the career experiences of 22 women engineering in senior roles within engineering organisations in the Australian context. Phenomenological and temporal analysis of their career reflections provides evidence of three early career patterns of varied duration and focus. The influences shaping these career paths are described.

By making explicit possible, diverse career paths, determinants and outcomes, this paper aims to continue to bridge the engineering education-practice gap and to contribute to greater diversity and inclusion within the profession.

Keywords:

early career, women in engineering, career paths, gender, engineering practice

PAPERS:

ID:

1363

Topic:

Student Engagement
Co-creation with students

Title:

First year engineering students' internal and perceived expectations

Authors:

Berg, Veslemøy;
Wallin, Patric;
Bolstad, Torstein

Abstract:

Expectations that first-year students have when entering the university play a central role in how they experience higher education. While there has been a significant number of studies on first-year student experiences, much less is known about which role expectations play on a qualitative level. We will in this study approach the question; How students' expectations of higher education shape and are shaped by their experiences of entering the university. The electrical engineering study program at NTNU, is context for this study. We will explore the research question by drawing on a qualitative thematic analysis of nine interviews with first-year students.

Based on this analysis, it is apparent that students' own expectations and perceived expectations from others, are key elements in experiencing the learning environment and culture at the university. Their expectations influence how they view themselves and how they position themselves in relation to others in a complex social mesh of rituals, traditions, and hierarchies. The data also reveals a strong dynamic in how students negotiate their own positions and are socialized into the university culture.

Grounded in the empirical material and in light of the contemporary research literature on first-year students, learning environments and university pedagogy, we argue that transitioning from high school to university can be challenging on many levels. How the students' transition and adjust, is of general interest for engineering education. By exploring students' positions, we want to better understand the social mesh that they interact within during their first year at the university.

Keywords:

Expectations, new space, electrical engineering, learning environment, culture

PAPERS:**ID:**

1364

Topic:

Ethics in Engineering Education

Title:

Debates on tech-related moral dilemmas usign ethical theories to teach engineering ethics

Authors:

Casañ, Maria Jose;
Alier, Marc

Abstract:

A significant number of universities where engineering is taught, acknowledge the influence on society and the environment of the scientific and technological practice, as well as the ethical problems it presents, and the need to provide their students with courses covering this as a subject. The accelerated pace of innovation in these fields amplifies the issue.

Computer Engineering schools are no exception. So, the IEEE/ACM Computer Science Curriculum 2013, identifies social issues and professional practice as one of the key knowledge areas that computer undergraduate students must learn. Students should be knowledgeable about the interplay of ethical issues, technical problems, and aesthetic values that play an important part in the development of computing systems.

Authors have taught for many years an optional course about the social, environmental aspects of ICT as well as ethics. In this paper authors propose an approach to study ethics in Computer engineering schools. The approach consists in providing students with general ethic frameworks to reason about moral dilemmas as well as providing the basics of deontology. The lessons are complemented with case studies where technology is a key factor. Students are assigned roles to work the cases and in the end a discussion is done in the classroom.

After the lessons, authors have observed that students are able to understand and use the tools provided by the teachers to reason about moral dilemmas.

Keywords:

ethics, morals, technology ethics, ethical theories

PAPERS:

ID:

1365

Topic:

Mathematics at the heart of Engineering
Engineering Skills

Title:

Learning to learn, bolt-on, or integrated? Analysis of student feedback from a pilot with learning to learn integrated into first-year engineering mathematics.

Authors:

Thorseth, Trond Morten

Abstract:

Learning to learn is one of the generic skills that are important to becoming an engineer. One outcome of the education is to be prepared for a role as an engineer with lifelong learning. In this paper, I convey experiences gained from two different approaches when implementing "learning to learn" into engineering math courses. The first approach, learning to learn was added to a mathematical course as a "bolt-on" approach in two initial pilots. A second approach was to include learning to learn in the course. In this approach, I wanted to utilize feedback cycles and provide information on learning to learn "as needed". Interviews of students and experiences from the pilots have been analyzed using thematic analysis. Two different experiences were described by the students in the two classes that were included in the pilot. In one group, the smallest of the two pilot classes, not a single student dropped out in the remaining three-year of the study program. The program had a major impact. The other group, the biggest class, was more resistive. In the second approach, I wanted to utilize the role of a mathematics teacher. Here I could use the authority and the relation as a math teacher. However, introducing learning to learn as a teacher conflicted with the role as a teacher. Here I discuss key findings from four focus group interviews, in addition to my experience as a teacher, that can help to plan future course design when learning to learn is included.

Keywords:

Learning to learn, assessment

PAPERS:

ID:

1367

Topic:

Attractiveness of Engineering
Gender and Diversity

Title:

Enhancing (future) students' professional awareness to increase diversity and inclusion in engineering education

Authors:

Craps, Sofie (1);
Cannaerts, Mieke (1);
Veldman, Jenny (2);
Draulans, Veerle (1);
Van Laar, Colette (1);
Langie, Greet (1)

Abstract:

The shortage of engineering talent leads to a loss in economic output. This shortage-combat has to be fought on several fronts, one of them is attracting and retaining more currently underrepresented students. This paper discusses the need to improve a sense of belonging and to increase professional awareness, or the understanding of the different roles an engineer can take on, in order to increase diversity in engineering. Based on an extensive literature review an overview is given of previous research on this topic from an interdisciplinary perspective.

Research has shown that professional identity development has high impact on persistence and study success. Although identity development is a hot topic in engineering education research, several studies indicate that engineering students still have difficulties in grasping what it is to be an engineer and often fall back upon the rather stereotypical, harsh technological, male image. However, research also shows that it is important for students to know what to expect and value in order to develop feelings of belonging or fit. The former European project PREFER has developed promising tools in this regard. However, these tools have not been tested regarding inclusiveness.

The paper also outlines the next steps that will be taken by the authors as part of an interdisciplinary project URGENT to increase attractiveness and retention of underrepresented groups in engineering education. This URGENT project proceeds on the outcomes of the PREFER project and will focus on the attraction and retention of female students and students with a migration background.

Keywords:

identity, belonging, gender, migration background, attractiveness, retention

PAPERS:

ID:

1368

Topic:

Fostering Engineering Education Research
Teaching methods

Title:

Variation theory in teaching and phenomenography in learning: What's their impact when applied in engineering classrooms?

Authors:

Hasan, Mahbub (1);
Khan, Md Shahadat Hossain (1);
Ahmed, A. K. M. Foysal (4);
Karim, Azharul (2);
Hossain, Md. Akbar (3);
Iqbal, A.K.M Parvez (4)

Abstract:

Although phenomenographic research approach has been widely used by education researchers to investigate students' learning, little attention has been paid to the relationship between a pedagogical approach adopted by teachers and students' learning outcomes, particularly in engineering education. This experimental study proposes integrating variation theory as a pedagogical approach to a face-to-face classroom environment for teaching complex engineering contents and adapting a phenomenographic approach to evaluate students' learning outcomes. The teachers who participated in the experimental group incorporated the variation theory in their teaching process. In contrast, the teachers in the control group, being ignorant of the variation theory, taught the same content to achieve the same specific learning outcome. Drawing on data from students' written responses both from experimental and control groups, this article illustrates how teachers implemented variation theory in the classroom and its impacts on student learning. The implementation of variation theory was confirmed by classroom observation, and the variation in understanding the topic was emerged from students' written responses and interview data through phenomenographic analysis. The findings indicate that teachers informed by variation theory use variation and invariance that creates necessary conditions for learning. This study demonstrates how, by incorporating variation theory, a faculty member designed different pedagogical approaches, which helps students conceptualize complex engineering topics more systematically than those who do not discern variation. The study concludes with theoretical, empirical, and pedagogic implications for teacher education in engineering.

Keywords:

Variation theory, Phenomenography, Engineering education, Teacher education, Student learning

PAPERS:

ID:

1372

Topic:

Sustainability. Sustainable Development Goals
Gender and Diversity

Title:

A UPC innovation teaching project for the incorporation of the gender perspective in nautical, marine and naval engineering

Authors:

Barahona-Fuentes, Claudia;
Castells-Sanabra, Marcella;
Ruiz, Ángela;
Codina, Mercè;
Fernández-Cantí, Rosa Maria;
Vela, Montserrat;
Ordás, Santiago;
Isalgué, Antonio;
Martín, Agustí

Abstract:

There has been a rising awareness in recent years of the gender inequalities within STEM-related programmes and the need to overcome them and so bridge the gender gap in these academic disciplines. Different initiatives have arisen, among which there are gender equality policies, regulations and programmes. In line with this, the Catalan University Quality Assurance Agency (AQU) promoted a regulation for the incorporation of the gender perspective in all the bachelor's and master's degrees in tertiary education in Catalonia by 2021. To comply with this regulation and also to promote a culture of equity and equality of opportunities for women, the Universitat Politècnica de Catalunya (UPC) fostered different projects within its community. One of these projects has been developed by the Gender Equality Commission at Barcelona School of Nautical Studies and consists in the development of a web platform with resources for lecturers to incorporate this new transversal competence of gender perspective in the nautical, marine and naval engineering study plans. The main objective of this teaching innovation project is to aid teachers with the incorporation of this competence not only by providing online tools and resources but also gender-focused teacher training to allow them to design tailor-made activities and strategies. Some tests were also developed to assess the effectiveness of the implementation of these newly-designed gender equality practices in the classroom with a view to providing a bank of examples and good practices for the incorporation of gender mainstreaming in the disciplines of nautical, marine and naval engineering.

Keywords:

gender mainstreaming, nautical marine and naval engineering, teaching innovation project

PAPERS:

ID:

1373

Topic:

Mathematics at the heart of Engineering
Physics and Engineering Education

Title:

Active Learning in Mathematics for STEM: Real-life Engineering Applications

Authors:

Salim, Salim Mohamed

Abstract:

An opinion piece in Scientific American [1] discusses how a fraction of students ultimately complete a STEM degree and cites research [2] that disengagement with traditional calculus courses as one of the causes. It goes on to highlight examples of several promising calculus reforms and recommends that STEM faculty take the lead in introducing changes by collaborating and co-creating across disciplines to make mathematics more relevant and interesting to students.

Feedback from module surveys indicate that students learn much better when the link between theoretical and practical knowledge is captured and echoes pedagogical literature. The author introduces past experiences of active learning approaches to enhance the teaching of mathematics to first-year engineering students. Class discussions incorporate real-life engineering applications highlighting example problems from a wide variety of core engineering modules such as Fluid Mechanics, Vibration, and Mechanics of Materials. The impact of this approach has not been directly measured and documented for the module being discussed here and is motivated by encouraging student feedback where they shared that they find the teaching interesting, fun, engaging, and interactive. The present concept paper therefore outlines how past pedagogical practice have influenced the enhancements in the delivery of engineering mathematics with a particular focus on interdisciplinary approach. It then goes on to demonstrate some examples of implementation and offers initial reflections based on student feedback. Finally, the author proposes future steps of detailing the effect on student learning experience via class surveys, interviews and making comparisons to comparably taught modules.

Keywords:

Engineering Education, Active Learning, Problem-Based Learning, Real-life Applications, Interdisciplinary

PAPERS:

ID:

1374

Topic:

Fostering Engineering Education Research
Engineering Skills

Title:

🏠 Developing and improving competence profiles of project teams in engineering education

Authors:

Mikhridinova, Nargiza (1,4);
Ngereja, Bertha Joseph (2);
Sastoque Pinilla, Edwar Leonardo (3);
Wolff, Carsten (4);
Van Petegem, Wim (1)

Abstract:

This concept paper reflects an ongoing research on designing students' team projects in engineering education with a focus on soft skills development. The core idea is to relate project tasks with relevant team situations and team roles which require and train certain sets of soft skills. The paper proposes: a) a model for developing the relevant soft skills out of project tasks, and b) an approach to relate individual competence profiles of team members with an overall team competence profile. A core assumption is that if a team is formed, individual competences are aggregated in a certain way to form a single team competence profile. However, in the case of soft skills this aggregating is more complex than simply adding skill levels, e.g., soft skills in teams are a result of specific combinations of competences. Understanding these effects is relevant for project management and engineering education. The paper proposes a first draft of a systematic framework for investigating such effects and for making them usable for the design of student projects in engineering education. It also provides insight into an example of an agile cross-border project conducted fully online and using the scrum method. The paper is considered to be a contribution to the development of project-based learning.

Keywords:

competence profile, engineering education, project team, soft skills

PAPERS:**ID:**

1375

Topic:

Entrepreneurship Education

Title:

Learning and Progression in (too much?) of an Entrepreneurial Challenge during Covid-19

Authors:Haneberg, Dag Håkon (1);
Solvoll, Sølvi (2)**Abstract:**

A venture creation programme (VCP) is an academic programme where students' creation of a new entrepreneurial venture is a central vehicle for learning. A VCP puts students in the role of entrepreneurs, with real opportunities and challenges. The entrepreneurial journey is a bumpy ride, and COVID-19 has added significant challenges on entrepreneurs, including students in VCPs. Previous research emphasise how entrepreneurial learning occurs through handling entrepreneurial challenges. The purpose of the present paper is to investigate the role of Covid-19-induced challenges on VCP students' learning. We applied fuzzy-set qualitative comparative analysis (fsQCA) on data from students in a technology-oriented VCP in Scandinavia collected in April 2021. FsQCA offers the opportunity to investigate complex logic combinations of factors that explain an outcome and is particularly suited for small samples. Multi-item measures assessed (1) progress of students' ventures, (2) entrepreneurial learning, and (3) perceived challenges from COVID-19. We also asked if students had entered or exited an entrepreneurial project and if these projects were run by a team or only the individual student. We found that COVID-19-induced challenges as such prevents VCP students' learning and that students' individual progress is important for learning during crisis situations. Thus, entrepreneurship educators should help students get 'back on the horse' – which means; involved in new entrepreneurial projects – if their challenges lead them into stagnation and inactivity. Progress both in students' ventures and for students as individuals should be nurtured by entrepreneurship educators.

Keywords:

PAPERS:

ID:

1376

Topic:

Student Engagement
Teaching methods

Title:

Utilizing Zoom-stamps in synchronous online workshop implementations

Authors:

Sipilä, Erja;
Vihriälä, Tanja;
Elo, Charlotta;
Ihalainen, Tiina;
Virkki, Johanna

Abstract:

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In engineering education, and in work life in general, the past two years have been struggling with Covid-19 pandemic. When considering studying, learning, and working, the teachers and other facilitators have been forced to create innovative methods for online working, aiming to good work efficiency, student engagement, and learning results. Along the development of various online working possibilities, it has been noticed that especially interaction among participants in synchronous online sessions is a challenge. Even if some participants are actively discussing and working in online sessions, some participants remain very silent and indistinguishable. Furthermore, even though the technical tools for online working and learning have developed rapidly during the recent years, technical problems still exist quite often.

There are numerous ways for increasing interaction in online sessions, including, for example, asking questions, using camera, utilizing chat or third-party applications like Padlet, and small group discussions in breakout rooms. In this paper, we will present how we utilized Zoom-stamps in two types of workshops. The basic idea in utilizing Zoom-stamps was to increase interaction and communication among participants and help them to further develop ideas created and discussed in the workshop. The lessons learnt from the first type implementations were considered when planning the second type implementations. We will describe the pros and cons of the Zoom-stamp utilization in synchronous online working as well as share our future development ideas.

Keywords:

Synchronous online teaching, workshop, interaction in online session

PAPERS:

ID:

1377

Topic:

Physics and Engineering Education
Assessment

Title:

A Contribution to Students' Assessment Adjusts of Multiple Choice Questionnaires with Fuzzy Logic

Authors:

Martínez-García, Herminio;
Domingo-Peña, Joan

Abstract:

In University environment, it is common to use multiple-choice objective tests with three or four possible answers, of which only one is correct and the rest are erroneous. In this type of tests, usually the wrong answers are penalized in order to avoid the effect of the random answers. However, there are questions that hardly students answer since their difficulty is high. On the other hand, there are also questions that answer virtually all students since their difficulty is simple. While sometimes the course professor chooses to suppress these questions, it is also common to leave them as part of the calculation of the overall score. This communication proposes a way of, without suppressing any question, making a readjustment of the grades based on fuzzy logic techniques. To do this, it is considered, on the one hand, the initial grade obtained by each student and, on the other, the total difficulty index of the test. With these two variables, an approximation can be made to a system of linguistic variables that allows correcting the final grades of each student based on the objective difficulty of the test and a set of rules established by the professor. This will revert to greater "justice" in students' mark system, since it will be a function of the difficulty of the test.

Keywords:

Fuzzy logic, objective tests, multiple-choice questionnaires, grade correction, students' assessment

PAPERS:

ID:

1379

Topic:

Gender and Diversity

Title:

📖 The influence of gender stereotypes on women's spatial abilities and their underrepresentation in the field of engineering

Authors:

Malkogeorgou, Styliani;
Duffy, Gavin

Abstract:

Technological innovation and scientific progress are important components for improving human condition and economic success. Therefore, a workforce that includes a critical amount of experts in science, technology, engineering, and mathematics (STEM) domains is needed. Evidence supports that males and females often present differences in their performance and preferences towards some STEM courses and occupations, especially engineering. Specifically, the number of women that decide to pursue careers in the engineering field is relatively low. One possible factor contributing to this gender gap that has gained a lot of interest recently is gender stereotyping and distinct gender roles among societies. Segregation between women and men's societal roles result in psychological gender differences, emerging from early childhood, and can later affect career choices. Additionally, different gender related standards imposed by the society drive women towards activities, majors and careers perceived as more "feminine". Another way gender stereotypes contribute to these differences is by affecting the development of cognitive skills that are hugely involved in engineer learning and thinking. Spatial abilities are part of such skills that play an important role in academic and occupational achievements in STEM domains, is strongly correlated with engineering education and can, on average, be less developed among women relative to men. In this paper we are going to review the literature on the influence of gender stereotypes on women's spatial ability development, and how this may later prevent them from pursuing a career in engineering.

Keywords:

spatial abilities, gender stereotypes, gender gap

PAPERS:**ID:**

1380

Topic:

Curriculum Development

Title:

Towards a New Pedagogy for Engineering Education in the 21st Century

Authors:

Ó Sioradáin, Domhnall;
Carr, Michael

Abstract:

There have been many advances over the past four or five decades in understanding brain architecture, and how the process of learning aligns with this architecture. One of the more interesting results has been that of John Sweller [and his theory of cognitive load. Sweller identifies the task of learning as effecting change in long-term memory. This long-term memory is, in his view, almost limitless. The problem lies in working, or short-term memory, which has a bottleneck of around five items. Any instructional mode which places too many items into working memory will be, at best, inefficient, and at worse pointless.

Over the same decades new instructional modes, such as problem-based learning (PBL) have become popular]. Sweller, and others such as Paul Kirschner], argue that PBL cannot work as advertised, as the student is faced with too high a cognitive load; they can either learn how to solve the problem, or learn the underlying concepts, but not both.

.This paper outlines the theoretical background to this issue, and presents an intervention undertaken over the last decade to devise new instructional modes which take account of cognitive load problems, whilst maintaining some of the advantages and benefits of PBL.

This intervention initially followed the ideas of Louis Bucciarelli of MIT on open design in Engineering education but was later adjusted to take into account the ideas of Kirschner on minimizing cognitive load in developing problem solving skills.

Keywords:

cognitive load, working memory, open design, PBL

PAPERS:

ID:

1381

Topic:

Mentorship and Tutorship
Co-creation with students

Title:

🏠 Students designing for students: a peer mentorship toolkit for a cross-campus, EDI engineering transition scheme

Authors:

Economides, Sophia B.;
Gou, Beilei;
Dai, Dina;
Noskova, Karin;
Waring, Sophie;
Preston, Anne

Abstract:

The smooth transition of students from secondary education to university study is seen as a factor of student retention and achievement. This is especially important in the case of students from non-traditional backgrounds who may lack the social capital that could help ease their transition. Peer transition mentoring is one of the tools universities use to enhance the experience of new students. This study examines how the transition mentoring scheme of a highly selective institution (UCL) could be modified to cater for the students of a new EQF level 3 engineering preparatory programme (Foundation Engineering) which is aimed exclusively at students from under-represented groups. The transition mentoring scheme needs to address two practical obstacles: the lack of peer mentors with knowledge of the needs of the non-traditional student demographic and the physical distance between the main campus, where the peer mentors are located, and the off-campus location of the preparatory programme. A Students as Partners approach is implemented to examine the transition mentors' perceptions of their role. Semi-structured interviews with 16 current and former transition mentors were conducted to investigate the experiences of peer mentors and to establish their training needs. The paper concludes with practical guidance on best practice for organising and managing training for students mentoring peers from non-traditional backgrounds.

Keywords:

peer mentorship, transition, EDI, Students-as-Partners, mentor training

PAPERS:

ID:

1382

Topic:

Challenges of new European Universities
Curriculum Development

Title:

Students' perceptions of a major engineering curriculum shake-up

Authors:

Langie, Greet;
Craps, Sofie;
Van den Broeck, Lynn

Abstract:

As the demands of industry are evolving and new generations of students are entering universities, many engineering faculties invest time in curriculum reforms based on inspirational innovations, underpinned by engineering education research. The Faculty of Engineering Technology (FET) of KU Leuven (Belgium) had an additional argument to implement a huge programme reform in 2020-2021 after three years of preparation. This rather new faculty, hosting more than 6000 students spread across seven campuses in Flanders, was an amalgam of different traditions and visions. Their merge into one faculty in 2013 aimed to optimize the organisation of research, education and community service. The goal of the programme reform in FET is tenfold: enhancing our typical profile of (1) hands-on engineering in (2) strong interaction with the labour market and setting up (3) a technology hub in (4) an international context with more attention to (5) multidisciplinary, (6) professional competencies, (7) personal development & support and (8) lifelong learning. Of course, the reform also aims to increase the (9) attractiveness of the programmes and (10) the internal coherence within the faculty exploiting the strength of the multicampus structure. In this paper we describe how we have adapted the curriculum in order to achieve these goals and we present the results of perception measurements organised among the first-year students who followed the old programme in 2019-2020 and first-year students who started the new programme in 2020-2021. Of foremost importance is the improved feeling of hands-on or a practice-based learning.

Keywords:

curriculum reform, engineering education, multicampus, merger

PAPERS:

ID:

1383

Topic:

Mathematics at the heart of Engineering
Assessment

Title:

Investigation of processing test results based on knowledge similarity

Authors:

Sipos, Bence (1);
Szilágyi, Brigitta (1,2)

Abstract:

The traditional scoring is based on the difficulty of the task. However the same total score can be earned with different knowledge, hence it is difficult to create homogenous groups by only relying on the total score. In our work, we aim to present a new scoring method where such knowledge-based groups can be created, as opposed to the previous point-based method.

For comparison of the test result done by the students, we utilized different distance measures. The main challenge with finding the similarities between the results is the high dimensionality of the data compared to the total number of observations.

First, we used the traditional Minkowski distance with different p values, then we used local similarity hashes and high dimensional embedding techniques designed originally for natural language processing. With these never before used techniques, we were able to identify students with similar skillsets and knowledge. Furthermore, we utilized dimension reduction methods (t-SNE and UMAP) to make a lower dimension representation where we can cluster the data easier. These clusters and pairwise similarities were assessed by oral exam subjective scores.

The teacher's subjective scores correlated more with this new metric-based method of scoring than the total test score itself. The presented procedures can not only be used effectively in research but can also help to get a more complete picture of the students' knowledge we teach in everyday practice.

Keywords:

similarity, knowledge based, classification

PAPERS:

ID:

1384

Topic:

Building Communities and Coordination
Fostering Engineering Education Research

Title:

🏠 Acceptance of Pedagogical Agent (PA) enhanced eLearning communities by software engineering students in Southern Africa.

Authors:

Chikasha, Samuel (1);
Van Petegem, Wim (1);
Goeman, Katie (1);
Valcke, Martin (2);
Mbiza, Servious (3)

Abstract:

Covid19 outbreak has seen eLearning becoming a viable alternative to the traditional face-to-face teaching globally. Software Engineering education has not been an exception to these changes. The use of multimedia enhanced eLearning communities is also on the increase in the teaching of software engineering. However, there is limited research on the acceptance of such technologies by African learners. Some of the multimedia being used to enhance these learning communities includes animated pedagogical agents (PAs) combining text, animation, audio, and video. Considering learner differences and aiming to achieve personalized learning, there is a need for institutions to understand how such technologies are being accepted by learners and the factors that influence the acceptance. This study focuses on the acceptance of pedagogical agent enhanced eLearning communities by Southern African learners in the teaching of Software Engineering. The aim of the study is to identify the factors that influence the acceptance of such communities. This will help eLearning designers to try and address the needs of learners in different contexts to achieve personalized learning. This study involved 137 software engineering students from South Africa and Zimbabwe who were being introduced to eLearning community enhanced with PAs. The unified theory of acceptance and use of technology2 (UTAUT2) was used in this study. The study revealed that only performance expectancy, and hedonic motivation constructs had an effect on behavioral intention to use these eLearning communities enhanced with PAs.

Keywords:

: Pedagogical Agents, eLearning community, Multimedia, Technology acceptance, Software Engineering, Practical ability

PAPERS:**ID:**

1385

Topic:

Student Engagement

Title:

Exploring students' perceptions of engineering culture: A comparative analysis between Chile, Colombia, Ecuador, and the United States

Authors:

Murzi, Homero (1);

Marquez, Mervyn (4);

Morris, Lloyd (2);

Guerra, Miguel Andres (3)

Abstract:

Several studies have explored engineering culture in terms of how it is perceived by engineers, students, or faculty members. However, less is known about how engineering culture varies (or not) when considering national culture as the lens. The purpose of this study is to explore how engineering students perceive different dimensions of national culture and identify if there are any patterns that connect to how they perceive their engineering programs. We are using Hofstede's theory of dimensions of national cultures to measure culture in different patterns in the student's perceptions of engineering. Data were collected using a validated survey that explores dimensions of culture and the sample included engineering students from Chile, Colombia, Ecuador, and the United States. The survey was translated into Spanish and was reviewed by several native Spanish speakers. We piloted the survey with several students. Data were analyzed using descriptive and inferential statistics. Results provide preliminary information on how students perceive aspects of culture like individualism, power distance, uncertainty avoidance, and masculinity. We discuss the comparison of the different countries and provide implications of these results to our understanding of engineering culture.

Keywords:

Engineering culture, Disciplinary culture, Engineering identity, Comparative study

PAPERS:

ID:

1386

Topic:

Engineering Skills

Title:

Engineers' perceptions of the importance of empathy and care: initial insights from engineers practicing in Australia

Authors:

Marinelli, Melissa Jane (1);

Male, Sally Amanda (1);

Chapman, Elaine (2);

Strobel, Johannes (3)

Abstract:

Empathy and care influence aspects of engineering practice including collaboration, teamwork, stakeholder engagement, and work quality. Empathy has been identified as a key employability skill for professionals, and is the foundation for many skills and attributes anticipated as required by future engineers. The understanding of empathy and care, and consideration of the development of empathetic and caring competencies, are increasingly relevant for engineering education. Recent studies have explored the conceptualisation of and value placed on empathy and care in engineering practice, from the perspectives of practicing engineers in US and German contexts. We broaden this to include the Australian setting.

Engineers' perceptions of empathy and care within Australian engineering practice were collected using an online version of the Empathy and Care Questionnaire (ECQ) instrument developed by Hess, Strobel, Pan and Wachter Morris (N = 183). Statistical analysis of survey questions relating to the perceived importance and benefits of empathy and care to engineers, and relevance within a range of engineering practice situations was undertaken.

Analysis of gender, years of experience, and organisational role indicated that female engineers perceived empathy and care to be more important, and more impactful on engineering practice than male engineers. Perceptions of empathy and care did not vary with duration of engineering work experience, however engineers in positions of organisational leadership placed greater importance on empathy and care in their roles than others. These differences contrast with results of US and German studies. Further analysis is required to understand where, when and why these differences occur.

Keywords:

empathy, care, engineering practice, professional skills, employability

PAPERS:**ID:**

1387

Topic:

Student Engagement

Teaching methods

Title:

Application of innovative software to the subject Project I of the Degree in Engineering in Industrial Technologies (GETI)ECHNOLOGIES (GETI)

Authors:

Buj Corral, Irene

Abstract:

Project I is a subject of the second year of the Degree in Engineering in Industrial Technologies (GETI), which is offered by the School of Industrial Engineering of Barcelona (ETSEIB) of Universitat Politècnica de Catalunya (UPC). It is a mandatory subject. However, the groups are divided into smaller groups of 16 students or less, with the purpose of developing a collaborating project along one semester. One of the possible themes is prepared by two different departments: Mechanical Engineering and Statistics and Operative Investigation. It deals about measuring the diameters of aluminium cylinders with a micrometre, to assess the appropriateness of a measurement system. In order to improve the measurement process, the students use a 3D printed support, previously designed and manufactured. Traditionally many activities of the subject were recorded in handwritten reports. The present academic year 2021/2022 a project was started at UPC, called EQUIPA'T (equip yourself), which aims to apply innovative software to subjects with collaborative work. In the present paper the main results of the project are presented. As for the methodology, first the teachers attended a training course. Then, the application of software to different sessions of the subject was planned. Finally, the software was implemented. Google forms was used to gather information to prepare subgroups of students, Edpuzzle was employed to add questions to videos about metrology and turning, and Trello was used to manage the design of a 3D printed support. Next year, it is expected to improve the use of these tools.

Keywords:

collaborative work, innovative software, project development

PAPERS:**ID:**

1389

Topic:

Student Engagement
Fostering Engineering Education Research

Title:

Analyzing student-teacher interactions in a challenge-based learning course

Authors:

Doulougeri, Karolina;
Vermunt, Jan D.;
Bombaerts, Gunter;
Bots, Michael

Abstract:

Challenge-based learning (CBL) exposes students to the complexities of open-ended and real-life challenges and encourages them to be in the lead of their learning. The role of teachers remains important but shifts from being the expert to the role of a coach who gradually scaffolds students into becoming independent learners. Accordingly, the interplay between teachers' and students' regulation of teaching and learning can result in friction and influence students' learning experience. This study explores incidents of constructive or destructive friction between student and teacher regulation during a 9-week CBL course for first-year engineering students. Thematic analysis is employed to identify critical incidents of friction during students' learning via analyzing students' weekly learning portfolios. Results suggest that students' experience in CBL is not linear, and there is a constant interplay between students' ability to regulate their learning and teachers' scaffolding. Initial exposure to CBL was characterized by friction in student and teacher interactions. Several students increased their self-regulated learning skills by resolving the initial friction by adopting a more proactive approach to their learning by actively asking questions and feedback from their teachers. The findings of this study are particularly relevant for CBL, where much attention is paid to students' autonomy, self-directedness, and collaboration. Building on the insights of this research, we make recommendations for further research and educational practice.

Keywords:

challenge-based learning, self-regulated learning, portfolio

PAPERS:

ID:

1390

Topic:

Fostering Engineering Education Research
Ethics in Engineering Education

Title:

TEACHING ETHICS THROUGH THE BACK DOOR? – EMPLOYING IDEAS FROM ASSEMBLAGE THEORY TO FOSTER A RESPONSIBLE INNOVATION MINDSET

Authors:

Herzog, Christian (1);
Diebel-Fischer, Hermann (2)

Abstract:

Adding ethics courses to engineering curricula seeks to equip students with the critical mindset that enables careers committed to serving humanity. Yet, the knowledge of ethical theories is neither a necessary, let alone sufficient condition for being good. There is no automatism that translates ethical knowledge into action, overriding attitudes that were developed during the enculturation of a student. However, we deem teaching assemblage theory a promising means to achieve a sustained commitment to responsible innovation practice. We base our argument on assemblage theory's capacity to conceptualize the interplay of human actors and technological artefacts in terms of dynamic evolutionary systems. The notion of an assemblage as a collection of potentially heterogeneous elements that—despite displaying consistency—remains malleable through reorganization, interconnection and, (re-)attribution forms the ontological basis that guides a conceptual approach to thinking in-between the extremes of technological determinism and social constructivism. Information algorithms, e.g., can be regarded as having the power to facilitate ethical action as part of a larger assemblage and artificial intelligence can arguably only be understood as “trustworthy” within socio-technological systems in which a shared responsibility realizes both epistemic and moral conditions for trust. Ultimately, we intend engineering students to realize the extent of their influence on the world and, therefore, their responsibility for contributing to a prosperous community. Thus, ethics is not only taught by conveying its classical normative theories but rather explored by discovering the entangledness of technology and society.

Keywords:

Engineering Ethics; Assemblage Theory, Responsible Innovation, Socio-Technical Systems, Artificial Intelligence

PAPERS:

ID:

1392

Topic:

Ethics in Engineering Education
Teaching methods

Title:

EVERYTHING YOU WANT TO KNOW AND NEVER DARED TO ASK — A PRACTICAL APPROACH TO EMPLOYING CHALLENGE-BASED LEARNING IN ENGINEERING ETHICS

Authors:

Herzog, Christian (1);
Breyer, Sabrina (1);
Leinweber, Noah-Art (1);
Sonar, Arne (1);
Bombaerts, Gunter (2)

Abstract:

Challenge-based learning (CBL) for engineering ethics tasks students with identifying ethical challenges in cooperation with an external partner, e.g., a technology company. As many best-practice parameters of such courses remain unclear, this contribution focuses on a teacher-centric introduction into deploying CBL for engineering ethics. Taking Goodlad's curriculum typology as a point of departure, we discuss practical issues in devising, maintaining and evaluating CBL courses for engineering ethics both in terms of the temporal dimension (before, during and after the course) as well as in terms of the people involved. We will discuss selecting learning objectives, forms of knowledge acquisition, supporting self-organization, and fostering discursive etiquette, as well as cooperative, yet critical attitudes. Additionally, we will delve into strategic matters, e.g., ways to approach potential external partners and maintain fruitful cooperations.

Keywords:

Engineering Ethics, Challenge-Based Learning, Course Design

PAPERS:

ID:

1393

Topic:

Curriculum Development
Engineering Skills

Title:

Project Based Learning for Mathematics in General Engineering Curriculum

Authors:

Delacour, Julia;
Boy-Dalverny, Agnès;
Cossonniere, Anne;
Marty-Guilhaumon, Marilyne;
Trajin, Baptiste

Abstract:

The National Engineering School of Tarbes (ENIT) is a French engineering school with a curriculum from undergraduate to graduate studies for general engineers. Curriculum ends by an equivalent Master degree in sciences. ENIT students are particularly involved into mechanical, civil, industrial engineering, material science and design of integrated systems. From the first year of study, students tackle theoretical tools for engineers. Moreover, in a curriculum composed of several different disciplines, connections between scientific subjects may be difficult to weave. As a consequence, student activities for solving engineering problems were developed. The basic concept is to clearly illustrate how theoretical tools can be used in an activity linked to engineering and more generally to student life.

In addition, future engineers must be acquainted and trained to ethic values, especially those used in team work. During team working, honesty and benevolence are important core values to be encouraged as a basis of trust that has been identified as one of the cornerstones for performing teams. Consequently, the principle of team working for students was adopted and humanities are associated into the project to manage ethical and professional standards.

Thus, the chosen teaching activity is a project-based learning team work that addresses on the one hand application of integration and derivation to expression of needs of consumable supplies and notions around professional ethics on the other hands.

Keywords:

Project based learning, Applied mathematics, Ethics

PAPERS:

ID:

1394

Topic:

Mathematics at the heart of Engineering
Attractiveness of Engineering

Title:

Integrated Programming and Mathematics in Schools - A Solid Foundation for a Future Engineering Education?

Authors:

Berge, Runar L.;
Sæterås, Bjørnar;
Brandsæter, Andreas

Abstract:

The interest in programming in schools has the last decade increased, and many countries have introduced programming as part of the school curriculum. Teaching of programming to students in primary and secondary school is often focused on the computer sciences aspect of programming. The current study is a part of the recently initiated research project "Programming for understanding mathematics" which has a different emphasis; the project investigates how the mathematical competence of the students are affected by actively using programming in mathematics lessons. In this paper, a recognized analytical framework for analysing the cognitive demand of mathematical tasks is presented. We extend the framework to include the analysis of tasks that utilize programming, allowing us to distinguish between tasks that are demanding due to the mathematical content, but the programming aspect of the task is trivial, and tasks that are cognitive demanding due to complex programming, but the mathematics is simple. We use the extended framework to analyse tasks in four mathematics textbooks written for 16-17 year old students by two major publishers in Norway. The results show that the tasks provided in the textbooks mainly focus on elementary programming skills, and the tasks give limited experiences with cognitive demanding programming tasks.

Keywords:

Programming; mathematics; secondary education; computational thinking

PAPERS:**ID:**

1396

Topic:

Fostering Engineering Education Research
Curriculum Development

Title:

Organising evidence-informed innovation

Authors:

Van Den Beemt, Antoine;
Van de Watering, Gerard;
Bots, Michael

Abstract:

Educational innovation often builds on existing practices, and focuses on improvement, rather than a radical change. One current example of educational innovation is Challenge-Based Learning (CBL). At university [blinded] the approach is a curriculum wide implementation of CBL based on a integrated programme that combines implementation of bottom-up innovation projects with research. The result of this research contributes to the translation of CBL to practice, thus helping curriculum designers and teachers in designing and executing their courses. In the process evidence is collected about principles of CBL, learning behaviour, learning outcomes, and didactical aspects of CBL, such as coaching and self-directed learning, assessment, pedagogies, and design of challenges, and facilitating structures.

The goal of this paper is to explore the development of a research agenda, which aligns research and practice, and to contribute to evidence for successful CBL implementation as result. The CBL research agenda shows which topics and aspects of CBL are addressed by research and practice, and which are overlooked. It is a systematic way of collecting strategic and practical problems related to CBL implementation, and how these are translated into research questions, methods, and results. The CBL research agenda leads to dialogue, which in turn guides our CBL programme. This integrated programme, including the research agenda is governed by a Taskforce CBL and supported by programme management, and a university wide research community. This approach enables the curriculum wide implementation and research of CBL as a concept for educating engineers of the future and strengthening on-campus education.

Keywords:

challenge-based learning, curriculum design, evidence-informed, innovation

PAPERS:

ID:

1397

Topic:

Attractiveness of Engineering
Engineering Skills

Title:

🏠 Setting-Up a Research Club for High School Students: an Engineering Educational Concept Based on Increasing Both Interest and Self-Efficacy

Authors:

Al-Kharabsheh, Dina;
Geese, Anne;
Müller, Rainer

Abstract:

In the fall of 2019, the research club changING started as an outreach program in the Cluster of Excellence SE2A. While the cluster deals with interdisciplinary research topics to explore technologies for sustainable and environmentally friendly aviation, the associated research club offers students from the 10th grade onwards the opportunity to gain insights into engineering.

The target group here is primarily young women, who are heavily underrepresented in this career field. The research club is experience-oriented and offers high school students the opportunity to explore engineering, its systems, technologies, applications, and social and cultural significance by participating in different projects at various engineering institutes in the Cluster. During their four years of participation in the club, which is voluntary, students are challenged to discover, create, construct, and solve problems. In the process, students learn different engineering concepts and skills. Currently, three batches (75 high school students) actively participate in the program, accompanied by engineering Bachelor students who serve as mentors.

This paper presents the structure of the research club which is based primarily on theories of the emergence and development of individual interests and self-efficacy expectations. A well-known model depicting the development of individual interests is the four-phase model. This model is considered the basis for the structure of the research club program. In this paper, the most important factors in the set-up of the research club and the expected results as well as the many lessons learned are presented.

Keywords:

Research Club, engineering education, interest development, self-efficacy expectations, project-based learning

PAPERS:**ID:**

1398

Topic:

Artificial Intelligence in Education

Ethics in Engineering Education

Title:

To be fAIr: Ethical and Fair Application of Artificial Intelligence in Virtual Laboratories

Authors:

Caccavale, Fiammetta;

Gargalo, Carina L.;

Gernaey, Krist V.;

Krühne, Ulrich

Abstract:

In 1984, the film “The Terminator” predicted that a hostile Artificial Intelligence (AI) will threaten to extinguish humankind by 2029. Even though the real present is quite far from this post-apocalyptic scenario where AI rebels against its creator, a growing concern about the lack of ethical considerations in the use of AI is rapidly spreading, leading to the current “ethics crisis”. The lack of clear regulations is even more alarming considering that AI is becoming an integral part of new educational platforms. This follows the wave of digital transformation mainly induced by the Fourth Industrial Revolution, with advances in digitalization strategies, and the COVID-19 crisis, which forced education institutions worldwide to switch to e-learning. The appeal of AI is its potential to answer the needs of both educators and learners. For example, it can provide help grading assignments, enable tutoring opportunities, develop smart content, personalize and ultimately boost on-line learning. Although the “AI revolution” has great potential to improve and boost digital education, there are no clear regulations in place to ensure an ethical and fair use of AI. Therefore, this work aims to provide a comprehensive overview of the current concerns regarding fairness, accountability, transparency and ethics in AI applied to education, with specific focus on virtual laboratories. The main aspects that this work aims to discuss, and provide possible suggestions for, are: (i) ethical concerns, fairness, bias, equity, and inclusion; (ii) data transparency and digital rights, including data availability, collection, and protection; and, (iii) collaborative approach between disciplines.

Keywords:

Digital Education, Virtual Labs, Ethics, Artificial Intelligence

PAPERS:

ID:

1399

Topic:

Virtual and Remote Labs
Mathematics at the heart of Engineering

Title:

IT'S YOUR DAY! TAKE ACTION AND CLICK ON THE VIDEO ZONE: UNDERSTANDING, IMAGINING, DOING AND REVIEWING.

Authors:

Carmona, Ángeles;
Claverol, Mercè;
Encinas, Andrés M;
Jiménez, María José;
Martín, Àlvar;
Mas, Albert;
Mitjana, Margarida;
Ruiz, Magda Liliana

Abstract:

This paper summarizes the results obtained in one project conceived to improve remote and face-to-face teaching of Calculus in the fields of industrial and biomedical engineering. The project consists of developing teaching videos that treat key topics of Calculus subject through some engineering problems at a first level university course. We focus on achieving the goal of learning by setting it in the approach and solution of a subject, making it more experiential. This type of practice should be the central focus of activities inside and outside the classroom. In this way we will be able to consolidate the students' mathematical skills, but at the same time acquire other skills that will be vital for their professional and personal development.

The evaluation process must be formative, as the assessment should provide teacher-student feedback in order to adjust teaching or learning based on the information received. We propose two main types of activities: Production of audiovisual material for the improvement of teaching and completion of Wiris questionnaires for self-assessment. The didactic video is very useful in class and has a motivating intention because rather than transmitting exhaustive and systematized information on the subject, it aims to open questions, raise problems, arouse the interest of students, disturb and generate a participatory dynamic. With the elaboration of these videos we promote that students be able to understand through specific problems and with the help of graphic material, a specific problem and then move on to the abstraction of more general situations.

Keywords:

Videos, Self-learning, Lab sessions, Testing progress

PAPERS:

ID:

1400

Topic:

Curriculum Development

Engineering Skills

Title:

🎓 Supporting global competence learning for engineering students: Insights gained and lessons to be learnt

Authors:

Richter, Tanja;

Kjellgren, Björn

Abstract:

Global competence is an essential attribute for engineering graduates working in an interconnected and culturally diverse world, and higher engineering education needs to adapt to ensure that their students will acquire it before entering the labor market. For universities, the only way to ensure comprehensive global competence learning for all students is the holistic integration of related learning outcomes throughout curricula – which requires engineering educators to be able to (re)design their courses and programs accordingly. Considering that most engineering educators are subject experts of their discipline – but lay people when it comes to such competencies – we set out to compile a practical guideline for those wanting to integrate global competence learning within their disciplinary courses.

Following a participatory action research approach, we connected our own insights as global competence educators at a technical university with those of several cohorts of engineering educators and students enrolled in global competence courses. Synthesizing these insights, we could identify four essential lessons for integrated global competence learning: 1) learning opportunities can be found (nearly) everywhere, 2) relevance and authenticity must be emphasized, 3) theory and practice need to be integrated and 4) global competence cannot be taught, but it can be learnt. These lessons are illustrated with practical examples for fostering global competence learning in regular engineering courses.

Keywords:

Global Competence, Competence Integration, Curriculum Development, Teaching and Learning, Comprehensive Internationalization

PAPERS:

ID:

1401

Topic:

Co-creation with students

Teaching methods

Title:

🏠 Broadening personal competence profiles through transdisciplinary project modules

Authors:

Marckwardt, Anja Sophie;

Kühne, Stefan;

Behme, Jonas Friedrich;

Bleszynski, Charlotte Maria;

Bullerdieck, Philip;

Dang, Tra Mi;

Ghazi, Mohamed;

Oberschmidt, Dirk

Abstract:

Engineering education today is often organised in discipline-specific modules. Although it is essential to build up basic knowledge, cross-disciplinary knowledge is fundamental for solving complex problems. Transdisciplinary approaches can provide the necessary hard and soft skills, improve self-determination in education and broaden personal competence profiles.

The experience gained is conveyed using the example of project-based modules on the topics of a) AI applications to minimise racial biasing in medical technology and b) construction of microfluidic systems to avoid animal testing. These were developed over several semesters by interdisciplinary student groups involving industry and research partners. The concept was initially carried out online in an interdisciplinary project module focusing on individual learning objectives, composed of the disciplines "Mechanical Engineering", "Computational Engineering Science", "Physical Engineering Sciences" as well as "Biomedical Engineering" and is being expanded in a hybrid-transdisciplinary manner through gradual additions including systems engineering, philosophy and sustainability in technology, ergonomics and human-machine systems.

Through active participation in researching and solving real challenges, collaboration of transdisciplinary teams over several group generations and setting individual learning goals, profound knowledge and new methodological competences can be acquired beyond engineering disciplines. The integration of non-technical methods and approaches allows students to recognise complex problems and identify the necessary competences in order to realise a successful project. To further expand this approach, a new module concept for interdisciplinary cooperation in production engineering was developed. It takes up the aspects of individual, project-based learning and brings together all the competences of the institute in transdisciplinary exchange.

Keywords:

Transdisciplinarity, project-based learning, hybrid education, competence profiles, individual learning goals

PAPERS:

ID:

1403

Topic:

Challenges of new European Universities
Engineering Skills

Title:

IN THE SEARCH FOR THE FUTURE ENGINEER: THE EELISA DISCIPLINARY
BROADENING WORKSHOP EXPERIENCE

Authors:

Gorgul, Emine (1);
Erden, Hamza Salih (2)

Abstract:

The emerging adhocracy of sustainability in every field of life, do also claims its legacy in the field of education, particularly in the discipline of engineering. Institutions necessitate to adapt their curriculums to the possible changes so that the engineers of the future are ready to address interdisciplinary and evolving challenges in their careers. As a European University Alliance aiming to define and implement a European engineering model, EELISA project has a dedicated work package to explore and propose various approaches to address this challenge by deploying disciplinary broadening workshops. This paper scrutinizes the initial outputs of the first full-day workshop organized by three partner universities of the alliance under the theme of "Cities and Communities" in October 2021, and opens it to a broader discussion.

This paper is structured in four parts while deploying qualitative research methods to analyze the collected data. Initially, it expresses the role of EELISA University, the state-of-the-art skills of today's engineers and the challenges for enriching them to materialize the vision of European engineering, including bridging and expanding disciplinary domains. The second part explains the workshop structure that was organized under four interdisciplinary subtopics related to the theme to increase the involvement of various engineering and non-engineering academics and professionals. Then the workshop outputs, the participants' brainstorm about the skills, competences, proposals to overcome challenges and barriers are conveyed. The final part summarizes the workshop results and introduces valuable inputs to the search for the European engineer profile and the roadmap of the EELISA.

Keywords:

EELISA-European University, Future Engineering Education, Cities and Communities, Disciplinary Broadening, Skills

PAPERS:

ID:

1404

Topic:

Ethics in Engineering Education
Curriculum Development

Title:

A Feasibility Study for inclusion of Ethics and Social issues in Engineering and Design Coursework in Australia

Authors:

Boshuijzen-van Burken, Christine;
Singh, Shreyansh;
Baggiarini, Bianca

Abstract:

In this study we attempt to shed light on the feasibility of including ethics and social issues in the current curriculum in an Australian university. The study has three goals: first, to understand the current status of inclusion (or lack thereof) of ethics and social issues in engineering courses in the school of engineering and information technology. Second, to understand the willingness (or lack thereof) of staff within school of engineering and information technology to include ethics and societal issues in their courses. Third, to understand the opportunities and challenges for inclusion of ethical and societal issues in the coursework.

Our methods include interviews with school staff and subject matter experts as well as analyzing textual artifacts such as course outlines, course readings, assignments that students were given, and accreditation reports. The analysis of textual artifacts runs partially via an automated text analyzer that search for words that have ethical connotation, such as safety, responsibility, privacy, harm, etcetera in the dataset of course materials. A manual (human) analysis of the coursework is done for those courses that do not give any results in the automated text analyzer. We look for opportunities to include ethics and societal issues in the coursework.

The conclusion is that there is general consensus amongst staff that ethics and societal issues deserve more attention in the school. There is worry that including ethics and societal issues takes too much time. There is preference for an integrated way of ethics teaching, rather than one separate engineering ethics course.

Keywords:

engineering ethics, social issues, feasibility study, text analyzer, interviews

PAPERS:**ID:**

1405

Topic:

Sustainability. Sustainable Development Goals

Title:

Challenges to the higher education to ensure sustainable development

Authors:

Szpytko, Janusz

Abstract:

New challenges in the field of digital transformation and content conveyed in the education process, in particular engineering sciences, triggered a discussion on the identification of issues focused on forms of cooperation with recipients using the available tools and taking into account the individual predispositions and knowledge of students related to their soft and hard competences. The subject of the paper is an attempt to identify students' soft competences on the basis of observations during the digital transformation period in 2020-2021.

Technology has a significant impact on education, but also human and social factors have a significant impact on shaping the new future of universities, especially those with an engineering profile. The experience of the last 2 years shows the need for an integrated approach to the education process, which should take into account the content provided in combination with a properly selected form of cooperation with recipients using the available tools and taking into account the individual predispositions and knowledge of students (attention should be paid to the so-called soft and hard skills).

Keywords:

digital era, challenges for education, new competences, sustainability

PAPERS:

ID:

1406

Topic:

Sustainability. Sustainable Development Goals
Curriculum Development

Title:

Co-designing a curriculum for a sober techno- and eco-responsible engineering : transition to a new professional identity for a sustainable world

Authors:

Feron, Aurelie (1,2);
Poinsotte, Fanny (1,3);
Jossic, Laurent (1,4)

Abstract:

In a finite world whose limits now seem obvious, future engineers are wondering what their profession will become tomorrow. The global stakes question the young people who would like to give more meaning to their training and future profession. To respond to this strong expectation, the PISTE* curriculum was opened in September 2021: a full semester in the final year of engineering studies at Grenoble INP (France).

The program was co-designed with the students and the different partners. The objective: to enable the students to experiment a new posture and to offer them the tools needed to meet the challenges they will face in a world in transition. A systemic, interdisciplinary approach, taking into account planetary limits and environmental and societal impacts, structures the whole semester.

A group project takes up more than a third of the semester. The subjects are proposed by local authorities, associations and companies. The groups must design, implement and document sustainable solutions and strategies that are accessible to as many people as possible. The courses are designed around the project: they provide useful insights for the students throughout the semester. The assessment of the learning outcomes is based on an individual written and oral reflection of the contributions of each teaching unit to the project.

This paper presents and argues the pedagogical design choices. With a view to continuous improvement, the strengths and areas for improvement are described.

*PISTE : Pour une Ingénierie Sobre Techno- et Éco-responsible (“For a Sober Techno- and Eco-responsible Engineering”)

Keywords:

systemic approach, transition issues, project based learning, co-creation with students, engineering skills

PAPERS:**ID:**

1407

Topic:

Building Communities and Coordination
Teaching methods

Title:

FACTORS OF EFFECTIVE INTERDISCIPLINARY ONLINE TEAM LEARNING

Authors:

Saarikoski, Lotta (1);
Lautamäki, Satu (2)

Abstract:

The pandemic has forced higher education to radically change the teaching format from face-to-face mode into virtual or hybrid format. Also, intensive courses, workshops and seminars have been conducted totally or partly online. These formats include lots of students' teamwork in order to succeed. Starting to work virtually with strangers might be difficult for students. Our paper presents how we developed and conducted two interdisciplinary team learning projects during the academic year 2021-2022 and the results we got. Our projects were implemented in the BSc degree programs of engineering, business administration and nursing at two Finnish UAS and at two foreign partner universities. After the courses we collected qualitative data from students' learning diaries and other reflections and performed content analysis which revealed that there are supportive and hindering factors for virtual teamwork and they should be considered while designing the learning experiences.

Keywords:

interdisciplinary, psychological safety, virtual, team learning

PAPERS:

ID:

1408

Topic:

Engineering Skills
Assessment

Title:

Experiential learning: integrating learning and experience in shaping the future of the engineers

Authors:

Sangwan, Devika;
Singh, Rajni;
Sangwan, Kuldip Singh

Abstract:

A persistent assumption about empowering engineering students to overcome the difficulties and challenges posed by the technically acute environment is that learning through practice and experience is needed to effectively instil a set of essential skills. The challenge is to identify a suitable set of skills to enable the engineering students to make themselves efficient and adaptable to face any kind of challenge. Next, this means understanding the interaction among concepts or variables interrelated in these competencies. To address these challenges, Kolb's theory of experiential learning is used, where engineering theory and application meet in an intensive, 'hands-on' teamwork experience, resulting in an effective learning process that involves the essential skills. It emphasises the importance of preparing engineers to face the challenges of uncertainty posed by a lack of skills and resources. Thus, the study aims to find out the list of skills suitable for engineers. How do these skills work in relation to their application at the workplace? How do these skills benefit engineers? What are the types of experiential learning methods/techniques? How experiential learning enables in developing the skills? The study, qualitative in nature, uses a conceptual research design, focusing on the synthesis of the essential skills in relation to the theory of experiential learning using systematic review. The results show that experiential learning allows engineering students to get a hands-on approach to practise their learned competencies to better understand industrial needs and constraints. Also, it helps in knowing what is learned and what needs to be learnt.

Keywords:

Experiential learning, hands-on approach, engineering education, skills, learning

PAPERS:

ID:

1409

Topic:

Engineering Skills

Lifelong Learning

Title:

21st-century competencies in engineering competencies: initiation, evolution, current, and now whither to

Authors:

Sangwan, Devika;

Sangwan, Kuldip Singh;

Raj, Punita

Abstract:

The fibre of engineering education has evolved from knowledge to competencies. This is a logical consequence of the technologically advanced and multifaceted learning environment where engineers are expected to be technically acute but along with a set of essential non-technical competencies. This change is referred to as a 'paradigm shift' in engineering education. Hence, the vision of learning is to immerse a progressive, learner-centric, continuous, and competency-based learning environment to face the uncertainties of the 21st century. There are various ways to improve the performance of learners by implementing the available competency frameworks, but the need is to initiate a set of essential competencies according to their nature and purpose that can endure across disciplines. In this paper, the evolution of competencies from the essential to the necessary is reviewed. Consequently, the outreach of the competencies is considered considering their implications by the engineers. Finally, the benefits of these competencies in relation to the performance of the engineers are discussed in detail through semi-structured interviews conducted with the engineers. MAXQDA, a qualitative data analysis tool, is used to analyse the data. The findings will be helpful for the learners/engineers in grooming their character and expertise as per the current demands of the industries.

Keywords:

skills; competencies; evolution; 21st-century competencies; engineering education; initiation

PAPERS:

ID:

1411

Topic:

Mathematics at the heart of Engineering
Attractiveness of Engineering

Title:

🏠 Integrated concept for the Enhancement of mathematical competencies at the Transition from high school Student to Freshmen in engineering studies

Authors:

Nasarow, Alexander;
Schmitt, Patrick;
Kreis, Oliver

Abstract:

This concept paper presents the large-scale measures and results that the Faculty of Engineering of the Friedrich-Alexander Universität Erlangen-Nürnberg (FAU) has developed to shape the future of learning and teaching of propaedeutic skills in the field of mathematics as a central basis of engineering subjects and to inspire pupils and young people for engineering studies. Since 2020, the Faculty of Engineering has developed a three-tier, structured voluntary program that is attended by several thousand pupils and freshmen per year:

1. Summer review courses in mathematics for pupils after the 10th and 11th school year during the summer holidays in accordance with the Bavarian school curriculum
2. School leaving exam preparation courses in mathematics shortly before the university-entrance diploma acquired at a secondary school in Germany, the so-called "Abitur"
3. Math review courses for freshmen.

The methodological approach of the article lies in the presentation of the educational measures and in the analysis of the results of systematic student evaluations. This leads to generalizable, transferable recommendations for the future design of such large-scale measures for universities, derived from answering the proposed research questions and evaluation results.

Keywords:

mathematic education, high school, freshmen, study entrance level

PAPERS:**ID:**

1412

Topic:

Mathematics at the heart of Engineering

Title:

Mathematics in Engineering Education: A Shared Responsibility

Authors:

Høyvik, Ida-Marie;

Lundheim, Lars Magne;

Nome, Morten;

Rønning, Frode

Abstract:

This paper reports from a project where future engineers are trained to use mathematical models and concepts based on the principle of contextual learning, with educators from mathematics and applied fields work together. In the paper, we present examples from two applied fields (electronics and chemistry) which have in common that they require the same mathematical knowledge – numerical solutions of systems of first-order non-linear differential equations. The paper also briefly reports from surveys of student perceptions of the relevance of mathematics for their study programme, comparing students within the project with students not in the project.

Keywords:

Mathematics, engineering education, contextual learning

PAPERS:

ID:

1413

Topic:

Student Engagement
Mentorship and Tutorship

Title:

Student perceptions of support services for first-year engineering students

Authors:

Van Dyck, Annelies;
Koppen, Els;
Van den Broeck, Lynn;
Langie, Greet

Abstract:

To help first-year students get accustomed to university, many universities organise intra- and extracurricular support initiatives. During the academic year, student support services at the Faculty of Engineering Technology at KU Leuven offer both course-specific activities as well as initiatives focusing on study career guidance and academic skills. Yet we notice that not all students find their way to these voluntary activities – even if they would benefit from the help.

The purpose of this study is (1) to understand how first-year engineering students perceive the student support services, and (2) to understand how we can reach students who need the support, but do not find their way yet. This will further guide us in the development and communication of support activities.

A small-scale questionnaire was distributed among first-year engineering students, followed by two focus group discussions.

Our findings indicate that support needs are bigger at the start and end of the first semester. Crucial information such as how to study, and communication regarding support activities, should be served more than once, as first-year students still find it hard to filter out the right information. Students prefer course-specific Q&A sessions where they can hear questions of fellow students as well as the answers to those questions. A mentor for study career guidance is well appreciated. Tests and trial exams are important as triggers to start studying. We believe that these findings can inspire colleagues in other institutions.

Keywords:

student support services, first year, student perception, study success

PAPERS:

ID:

1416

Topic:

Student Engagement
Navigating Open Learning Environments

Title:

The teaching involvement of the users, the units and the whole UPC measured through the Moodle indicators of the virtual platform Atenea. An extension proposal of Atenea's BI platform

Authors:

Prat, Joana d'Arc;
Llorens, Ariadna;
Alier, Marc

Abstract:

Atenea is the Moodle virtual platform of the Universitat Politècnica de Catalunya (UPC) with about 31000 users and 5000 active subjects from 16 school centers. Atenea indicators give information on the teaching activity of the users and centers. This is especially relevant when teaching is online, as was the case in the Covid-19 period (1). The UPC already has a Atenea's Business Intelligent platform (BI), which has recently been launched. In this 1st phase the Institute of Science of Education (ICE) has actively participated in the design of the application (2).

Currently it shows basic indicators over a period of time where one can filter or compare by centers or type of users. The paper presents this design and make a proposal for the extension of the BI, for the future, with respect to: 1) the inclusion of key indicators for measuring the online teaching (3), 2) a proposal for a vision of the online activity of a center with their subjects and 3) a proposal for cross-referencing data with academic performance.

(1) Prat, J., Llorens, A., Alier, M., Salvador, F. Amo, D. 2020. Impact of Covid-19 on UPC's Moodle platform and ICE's role. TEEM'20: Eighth International Conference on Technological Ecosystems for Enhancing Multiculturality, Salamanca, Spain (2020), 765–769.

(2) <https://www.ice.upc.edu/ca/butlleti-epicentre/butlleti-epicentre-8>

(3) Prat, J., Llorens, A., Alier, M., Salvador, F. Amo, D. 2021. A methodology to study the university's online teaching activity from virtual platform indicators: the effect of the Covid-19 pandemic at Universitat Politècnica de Catalunya. Sustainability (Switzerland), Vol. 13, 9, 1-19.

Keywords:

Virtual Learning Environment; Learning Management System; Education; Covid-19; 13 Moodle indicators; Engineering education

PAPERS:**ID:**

1417

Topic:

Curriculum Development

Title:

Curriculum Agility at Faculty, Department, Program, and Course Level

Authors:

Brink, Suzanne (1);

Schedin, Staffan (1);

Vikström, Susanne (1);

Mejtoft, Thomas (1);

Sjoer, Ellen (2)

Abstract:

This short paper describes the first prototyping of a self-evaluation process of Curriculum Agility at a Faculty of Technology in Sweden. The process comprises guided, semi-structured, individual interviews at different organisational levels within the faculty, a joint narrative based on those interviews, prioritizing development strategies per level, and jointly mapping them on importance and implementation time. The self-evaluation is part of and based on the research on the principles of Curriculum Agility. The results show the interplay in timely curriculum change for futureproof engineering education between the teaching staff, the systems and the people who control the systems. The self-evaluation brings together the different perspectives and perceptions within the faculty and gives insight in how those affect the willingness towards and occurrence of curriculum development. This work in progress indicates how doing such a qualitative self-evaluation paves the road for transparent strategic dialogues on a holistic level about what to give attention and organize differently.

Keywords:

curriculum agility, curriculum innovation, change management, flexible education, co-creation

PAPERS:**ID:**

1418

Topic:

Mathematics at the heart of Engineering
Co-creation with students

Title:

Authentic application examples in math lectures through peer teaching

Authors:

Hilger, Susanne;
Schmitz, Angela

Abstract:

Engineering students often miss the connection between mathematics and the engineering disciplines. One solution to this problem is to integrate application examples into the math lectures. However, it is challenging for mathematicians to find adequate applications and to present them in an authentic manner.

We describe a concept of integrating application examples through peer teaching: A student who has already completed the mathematics course is involved in the preparation and presentation of such examples. As a result, the examples are very authentic since they are developed and presented by a person knowing the applications, the learners' motivation is high due to peer teaching, and the new material is high-quality owing to the supervision by the lecturer. Surveys conducted for each application example reveal that the concept is well accepted.

The paper describes the steps in the development of application examples of different length and mathematical depth and gives recommendations on how to implement the concept successfully into math lectures.

Keywords:

peer teaching, math lecture for engineers, engineering teaching, student participation

PAPERS:

ID:

1419

Topic:

Student Engagement

Industry and Companies liaison. Regional Involvement and Innovation

Title:

Project Concept Citizen Engagement of Engineering Students and High School Students

Authors:

Sayrol, Elisa (1);

Monteil, Thierry (2);

Arquilué, Inés (3,1);

Pérez, Mar (3,1);

Desjeux, Benoît (4,5);

Bruyère, Nathalie (6);

Julliot, Mélanie (7);

Alarcon, Eduard (1)

Abstract:

The Project seeks to engage the community of citizens made up of 15-23 aged students on the topic of mobility of the future while empowering them to become actors for change who can participate on the development and the evolution of their city.

Led by an European Consortium composed of cities, teaching entities from high school to universities and clusters of companies in the field of mobility, the main objectives of the Project are as follows:

- To make young citizens aware of the context of urban mobility with the expertise of teachers and trainers, city services, and industrialists in the field of mobility.
- To develop their capabilities to become actors of the mobility of the future with the creation of networking between students, city and industry on this topic.
- To be able to highlight the needs and desires of this group of citizens.
- To create a reproducible methodology and an environment to help students from ideation to action for future mobility.

4I4U objectives are achieved by planning a set of seminars, round-tables and brainstorming sessions to raise awareness or understand different aspects of mobility. To go from ideation to action for future mobility, small groups of students design and produce a first ideation allowing to understand and to be able to project oneself into the proposed solution. This activity will be achieved under the mentoring of cities and industrialists while using the means of training institutions.

Keywords:

Innovation, Entrepreneurship, International Education, Citizen Engagement, Urban Mobility

PAPERS:**ID:**

1420

Topic:

Physics and Engineering Education

Teaching methods

Title:

Development and Application of Simulation Games for Model-based Systems Engineering

Authors:

Schumacher, Thomas;

Ammersdörfer, Theresa;

Inkermann, David

Abstract:

Model-based Systems Engineering aims at increasing consistency of information in complex engineering processes that involve different engineering domains. A major challenge when introducing Model-based Systems Engineering is to highlight the interactions of different process activities, like requirement definition, specific methods and available tools as well as roles. These interactions have to be demonstrated to members of the engineering team in order to induce awareness for potential hurdles within the implementation process and to increase acceptance for required changes of processes, methods and tools. Simulation games present a promising approach to generate awareness as well as the needed expertise for successful implementation of Model-based Systems Engineering, in both teaching of students and training of experienced engineers. In this contribution a development process and essential aspects for the game design of simulation games are proposed. The structured process and its specific steps are illustrated by the development of the simulation game MbSys.

Keywords:

simulation game, engineering education, model-based systems engineering

PAPERS:

ID:

1422

Topic:

Ethics in Engineering Education
Cooperation for Development

Title:

🏠 The Berlin Ethics Certificate: Conceptualizing Interdisciplinarity as a Core Building Block of Ethics in Engineering Education

Authors:

Ammon, Sabine;
Kljagin, Alexandra;
Rettschlag, Juliane;
Vortel, Martina

Abstract:

To address the need for more responsible research and innovation, there is a growing call to integrate ethics education across the science and engineering curriculum. Accordingly, ethics education must not be limited to the avoidance of scientific misconduct but rather be oriented toward addressing the complexity of planetary challenges and realizing social good. Designing curricula to accommodate the ambition of integrated ethics, however, remains a great institutional and epistemic challenge. In this paper, we introduce the Berlin Ethics Certificate (BEC) at the Technical University of Berlin, to demonstrate how this challenge can be addressed by using interdisciplinarity as a core building block of integrated ethics education. The BEC's unique approach to ethics education enables the positioning of ethical issues in all study programs within the university by designing future-oriented interdisciplinary courses open to all students, be they from the humanities, natural or engineering sciences. The paper outlines the BEC's conceptualization of interdisciplinarity, ultimately arguing that interdisciplinary ethics education must be built upon the epistemic practice of situating knowledge. Methodologically, we show how the BEC integrates interdisciplinarity into ethics education through three iterative steps: 1) acquiring disciplinary and non-disciplinary self-knowledge in relation to other forms of knowledge (by focusing on multidisciplinary learning experiences), 2) establishing a common epistemic practice of collaboration (by focusing on interdisciplinary learning experiences), and 3) addressing real-world problems by engaging with stakeholders (by focusing on transdisciplinary learning experiences). Examples of how the BEC implements this methodology are shown, which may serve as suggestions of best practices in integrated ethics education.

Keywords:

Interdisciplinary Education, Engineering Ethics, Integrated Ethics, Situated Knowledge, Curriculum Development

PAPERS:

ID:

1423

Topic:

Entrepreneurship Education

Engineering Skills

Title:

Online vs in-person: flipped classroom approaches to a 3rd Year Electrical and electronic engineering project management module

Authors:

Perea Borobio, Esther (1);

Gotham, Simon (2)

Abstract:

Managing Engineering Projects is a 3rd Year module of the 4-year MEng in Electrical and Electronic Engineering with Management degree. Its purpose is to provide students with innovation and project management skills in the context of engineering practice.

The format was modified during the 2020-21 academic year to include more elements of student-centred learning to increase engagement given the online delivery format due to Covid. The module comprised 10 x 2-hour weekly sessions. Students were sent the material for each of the sessions ahead of time, with the first hour being devoted to discussing relevant aspects or issues raised by the students. The second hour focused on a related case study or activity, where students were allocated to break out rooms on Teams for group work, then coming together for some general discussion and conclusions. Alternatively, guest industrial speakers would share their professional experiences to illustrate the theory covered in the first hour. There was also an opportunity for questions and general project management discussion.

The module was delivered in person this academic year, retaining the same flipped classroom format, case studies and industrial speakers.

This paper compares the feedback and insights gathered through questionnaires from the online and in-person cohorts. Initial evidence shows that both groups found the flipped classroom, practical group work, and guest talks more engaging than traditional lectures. However, the in-person cohort showed higher rates of attendance and students were more engaged in group activities.

Keywords:

Engineering Project Management, Professional Practice, Flipped Classroom, Student Centred Learning

PAPERS:**ID:**

1424

Topic:

Sustainability. Sustainable Development Goals
Teaching methods

Title:

D4i: A FRAMEWORK FOR TEACHING SUSTAINABILITY IN ENGINEERING DESIGN

Authors:

Kunrath, Kamila;
Beliatis, Michail

Abstract:

Sustainability has become an integrative part of engineering education once it is not possible to discuss sustainable development without also talking about innovation capability. Political and environmental frameworks request a drastic change in the industry landscape and so in the way design is carried out. This paradigm change forces new approaches to education that align with the prospects of the industry and also embed considerations related to the Triple Bottom Line (i.e. economic, ecological, socio-cultural elements). Addressing the complexity of sustainability requires innovative practices for teaching and learning, leading to new methodologies that aim to develop the broad sets of competencies required from the students. In Engineering Design, theories and methods related to sustainability have been mainly focused on the Design for X elements, material circularity, and product lifecycle leaving behind the importance of contextualized knowledge of regulations, or human-related aspects that motivates the students to tackle the challenges. Therefore, this study proposes a holistic approach that encompasses a broader understanding of what educators can exploit for capacitating future engineers in sustainability-related complex problem-solving. The framework highlights three main areas to be considered when teaching sustainability for Design Engineers: i) Context & Resources, ii) Human factors & Competencies, and iii) The D4i design process. A simplified version of this framework in class as a lecture-workshop format is presented and discussed along with multiple directions for future research.

Keywords:

Sustainability, Engineering education, Teaching Framework, Innovation

PAPERS:

ID:

1425

Topic:

Sustainability. Sustainable Development Goals
Cooperation for Development

Title:

🏠 Experiences of mining engineering students in cooperation for development

Authors:

Sidki-Rius, Nor (1);
Alfonso, Pura (1);
Martinez, Arnau (1);
Gaona, Roger (1);
Sendros, Miquel (1);
Bel, Guillem (1);
Bascompta, Marc (1);
Anticoi, Hernan (2);
Yubero, Maria Teresa (1);
Jimenez-Franco, Abigail (3)

Abstract:

Future engineers, in addition to technical knowledge, should incorporate in their academic curricula aspects that contribute to do mining a sustainable activity. This will change the concept that society has about mining and this activity be socially accepted by the surrounding communities. In the studies of Mining Engineering at the Universitat Politècnica de Catalunya (UPC), students have the opportunity to develop cooperation activities together with professors and other workers from the area of Mining Engineering. They all together collaborate with artisanal miners from different countries, mainly from Latin America, and contribute to making mining more environmentally friendly. Moreover, they have the opportunity to acquire a social sensitivity that can be of great importance during the development of their professional activity. The Center for Cooperation for Development of the UPC contributes to the training and awareness of future engineers and manages all the projects in cooperation for development. This study presents some experiences of undergraduate, master and doctoral students in cooperation activities in mining. The projects were developed as a collaboration between UPC and universities or NOGs in Latin America. The activities have been carried out in underdeveloped areas where mining is practised with a high environmental impact and poor use of resources and, therefore, they need to take a long way to achieve sustainable development.

Keywords:

Sustainability, Environment, Artisanal Mining Cooperation for Development, Engineering Education, Sustainable Development Goals

PAPERS:

ID:

1429

Topic:

Sustainability. Sustainable Development Goals
Cooperation for Development

Title:

UNIVERSITY ACTIVITIES AND DEVELOPMENT COOPERATION IN THE AGRI-FOOD
FIELD: KITEGA CC CASE

Authors:

Collado López, M. Francisca (1);
Albors Sorolla, Ana María (1);
Gutiérrez Chávez, Jesús Anthony (1);
Clemy, David (2)

Abstract:

The connection between the activities carried out by universities and cooperation projects for development is of great interest to achieve the Sustainable Development Goals and the 2030 Agenda.

This work shows the activities developed by the Universitat Politècnica de València (UPV) in terms of human development and international cooperation in the agri-food field. It starts from a description of the experiences and internships by the research staff, students, and technical staff of the UPV in a rural community of Uganda (Kitega) where it has been possible to connect two projects. The first one is related to the improvement of agricultural systems and the second project is on food conservation and processing techniques, both intending to develop sustainable agri-food and always based on actions that have repercussions on the needs of the most vulnerable groups.

Agricultural production in rural areas allows food to be obtained for self-consumption, while surplus production is offered for sale without any conservation or transformation system during its useful life. In addition, the narrow variety and low quality of the products sometimes do not allow to cover the nutritional needs of the families. Poverty and lack of technical knowledge are largely causes of food unsafety and malnutrition.

The conclusions obtained point to the importance of students, researchers, and staff from universities in development cooperation projects to achieve a transition towards fairer societies in a sustainable and lasting environment.

Keywords:

Cooperation, agri-food, food conservation, agriculture, development

PAPERS:

ID:

1430

Topic:

Sustainability. Sustainable Development Goals
Engineering Skills

Title:

Integrating Green Competencies and Skills in the Hungarian Environmental Engineering Education

Authors:

Barna, Orsolya;
Szalmáné Csete, Mária

Abstract:

Engineering plays a crucial part in responding to the biggest challenges of our era, including the transition toward a green economy by meeting the Sustainable Development Goals by 2030 and by achieving net-zero carbon emissions by 2050. Engineering education could be the leading actor to prepare engineers for these complex tasks and spread the necessary green knowledge, interdisciplinary skills, and competencies essential in the pursuit of a sustainable future.

Considering the Central Eastern European region, Hungary's education system has improved significantly in the last decade. A new national higher education strategy in 2014 set new directions for its development in many aspects, including an emphasis on soft skill development in the curricula. The Hungarian higher education system was characterized for decades by memorizing facts and figures; therefore, the effective integration of soft skill development is a slow process.

In our study, we first provide a systematic review of the international and national literature to identify fundamental sustainability skills and competencies for engineering. We also examine the Hungarian higher education frameworks and the skill-related output requirements in the environmental engineering programs. In the second part of the research, we present a qualitative study of in-depth interviews with Hungarian experts with different academic profiles and a focus group study with environmental engineering students about their views on green skills.

Our results show that the concept of green skills is slowly spreading in university communities; however, the effective implementation into the curricula will require some more time and work.

Keywords:

sustainability competencies, green skills, engineering education, environmental engineering, Hungary

PAPERS:

ID:

1431

Topic:

Curriculum Development

Title:

📖 An analysis of Engineering Educators' understanding of Complementary Studies Courses using the Repertory Grid Technique

Authors:

Tendayi, Tinashe George (1);

Shaw, Corrinne (2);

Wolmarans, Nicky (2)

Abstract:

Accreditation bodies such as the Engineering Council of South Africa and the Canadian Engineering Accreditation Board have a group of courses that fall under the umbrella of Complementary Studies. This term is used to describe a set of engineering courses that include knowledge areas other than the more common mathematics, natural sciences, engineering sciences etc. Studies have shown that engineering educators sometimes view these courses in a negative light. They have been thought of as distracting and taking the focus of the students away from the so-called technical courses, which the educators feel are more important. This paper reports on a research study that explored the way that engineering educators construe, that is make sense of, complementary studies courses within an industrial engineering curriculum. The repertory grid technique was used to elicit the educators' construal of a number of complementary courses when compared to other engineering courses within the same curriculum. The relationships between elements and constructs in the grids were analysed using principle component and cluster analysis. A number of important observations are made which reveal how industrial engineering educators construe complementary courses when comparing them to the more traditional engineering courses. The findings from this study mark an important step in understanding complementary studies and how industrial engineering educators can better engage with them. This study is part of a larger research project focused on understanding how educators and students construe complementary studies in the engineering curriculum as a whole.

Keywords:

complementary studies, industrial engineering, repertory grid technique

PAPERS:

ID:

1432

Topic:

Student Engagement
Engineering Skills

Title:

Empowering master students to solve real-world engineering problems

Authors:

Kraft, Volker (1);
Marco-Almagro, Lluís (2)

Abstract:

In engineering, the importance of multi-disciplinarity and the need to “think outside the box” are obvious. However, subjects in engineering education are often treated in an isolated fashion. The kind of problems solved in these subjects are often just simplified artificial exercises. To ensure employability of new engineers, students need to practice how to “convert a mess into a problem”, and then use the scientific method in context to solve it. Good data skills (including data collection, exploration, and modeling) are essential to solve problems. These data skills are the “backbone” of the scientific method. The use of real data (coming, for example, from real applications in industry) can be motivating in teaching and stimulating to connect engineering topics.

This talk will present experiences from master courses taught in various engineering fields at Universitat Politècnica de Catalunya · BarcelonaTech (UPC). Several teaching tools and resources to improve student employability will be discussed. We will also share testimonials from several former UPC engineering students who are now working in industry and consultancy.

Keywords:

Problem-solving, data skills, employability

PAPERS:**ID:**

1433

Topic:

Student Engagement

Title:

Coping in pandemic times: bricolage employed by first-generation engineering students

Authors:

Smit, Renee (1,2);

Junck, Leah (3,2)

Abstract:

First-generation students have been a focus in higher education research over the past ten years. However, limited attention has been paid to engineering students who are the first in their generation to enter university. The paper reports on data collected as part of a longitudinal study of first-generation engineering students at a South African university during the early stages of the pandemic. First-generation students, who already face multiple difficulties in their educational journey, were confronted with a juxtaposition during the lockdown. As engineering students, they are inducted into technical approaches to problem-solving via systematic and analytical exploration. Levi-Strauss contrasts this notion of the *ingenieur*, grounded in the Enlightenment belief in the superiority of rational scientific reasoning, with the *bricoleur*, who finds solutions by “doing things with whatever is at hand”. With the lockdown period being less amenable to structured problem-solving, students often had to resort to more improvised approaches to accommodate their studies and their shifted precarious everyday routines. The study not only adds to literature on first-generation engineering students, but also provides insight into the ways in which these students cope with obstacles over which they have little control. In the process a picture of resilient agency emerges that challenges a narrow deficit view of students with limited resources.

Keywords:

first-generation students, bricolage, coping, engineering students, COVID-19

PAPERS:

ID:

1434

Topic:

Student Engagement
Physics and Engineering Education

Title:

Evolution of Guided Activities in the Teaching of Analog Electronics in Bachelor's Degree in Industrial and Automatic Electronic Engineering to Increase the Students' Motivation

Authors:

Martínez-García, Herminio;
García-Vílchez, Encarna

Abstract:

Despite the indisputable progress and development of electronics and digital systems, it is quite true that analog electronics, and especially that which directly affects the operational amplifier and its applications, is one of the fundamental pillars on which they establish the modern curricula for electronics students in different fields of engineering (industrial, telecommunications, etc.).

Within the offer of core courses of the Degree in Engineering in Industrial Electronics and Automation (EIA) of the Eastern Barcelona School Engineering (EEBE) of the Technical University of Catalonia (UPC), which appeared as a result of the current undergraduate study plan, within the European Higher Education Area (EHEA), there is a course, Analog Electronics (EAEIA), which allows the Electronic Engineering student to delve into the knowledge of this content. The present communication exposes the philosophy of this course, in such a way that it analyzes the orientation that is intended to be given, especially within the new framework of subjects offered at the EEBE where, in addition to the hours of theory, problems and laboratory, there must be room for to the guided activities that the new plan contemplates.

In this course guided activity, the professor introduces a series of titles to the students (for example, audio amplifiers and equalizers, the control of a small DC motor, etc.). The students, usually in groups of two or three people, work together, cooperatively, according to the puzzle technique, to design, simulate, assemble, solder and test in the laboratory the circuit proposed that fulfills the design specifications.

Keywords:

Guided activity, puzzle technique, PBL

PAPERS:

ID:

1435

Topic:

Sustainability. Sustainable Development Goals

Title:

Demonstrating the Engineering School's commitment to the achievement of the SDGs: The ALCAEUS Evaluation Programme / Agenda 2030. A case study

Authors:

Yagüe Fabra, José Antonio (1);
Murillo Esteban, María Benita (1);
García Ramos, Francisco Javier (2);
Martín Ramos, Pablo (2);
Serrano González, Antonio (3);
Ortega Pardos, Ana Isabel (3)

Abstract:

ALCAEUS is a voluntary evaluation scheme developed by the Spanish agency ACPUA, designed to provide visibility to institutions and centers that demonstrate commitment and contribute to the achievement of the UN Sustainable Development Goals (SDGs) / 2030 Agenda. It is a pioneering international external evaluation program within the European Higher Education Area, open to faculties and schools that have successfully undergone an IQAS certification review (institutional accreditation). The ALCAEUS pilot program was carried out last year and two Engineering Schools (Escuela de Ingeniería y Arquitectura and Escuela Politécnica Superior) of the University of Zaragoza (Spain) participated in it. The evaluation was based on a site visit conducted by an international review team. The two schools demonstrated a firm commitment to SDGs and were awarded a 2030 Agenda quality label valid for 6 years.

Keywords:

Sustainable Development Goals (SDGs), Evaluation

PAPERS:

ID:

1436

Topic:

Sustainability. Sustainable Development Goals
Teaching methods

Title:

Developing future working life competencies with earth-centered design

Authors:

Väätäjä, Heli;
Tihinen, Maarit

Abstract:

Integration of sustainability in the curriculum of higher education creates a demand for bringing the theme into concrete development projects. Sustainable and proactive development have been identified in Finland as key generic competences in higher education. Capability to innovate and create sustainable solutions and services for future are key skills in producing novel sustainable solutions. We experimented with master's level students the use of a novel design method, Planet Centric Design (PCD), to create sustainable system and service concepts for the future. The trialed method combines systems thinking with service design to solve sustainability related challenges. It has been developed by a software company to support practical sustainable solution development jointly with their customers. Companies have recently been active in developing their own approaches to support design related activities. Trialing, benchmarking, and learning the use of the topical industry-lead methods during their studies, provides students practical hands-on experiences of using the methods and confidence to use the methods. The participating students found using an industry-developed design method valuable. Learning about sustainability was perceived to be applicable both for working and personal life and have impact in both areas. In the student's self-reflection reports on their learning and experiences, the collaborative teamwork in multidisciplinary teams and the creative confidence gained through the learning to use a novel design approach, were the most most often described positive themes.

Keywords:

sustainability, earth-centered design, systems thinking, design thinking, working life skills

PAPERS:

ID:

1441

Topic:

Fostering Engineering Education Research
Sustainability. Sustainable Development Goals

Title:

Sustainable Engineering Education in Research and Practice

Authors:

Block, Brit-Maren;
Guerne, Marie Gillian

Abstract:

Sustainability and responsible use of the resources at our disposal are among the most important goals of our time. Employees are looking for next-generation employees with ever more skills. To ideally foster these in engineering and prepare them for future challenges, the integration of education for sustainable development (ESD) with a linkage of technical and sustainability-oriented issues in the curriculum is essential. This paper takes up two points: (1) An analysis of the research landscape in engineering education research (EER) on the topic of "sustainability" is undertaken. For this purpose, more than 3500 conference papers of EDUCON and FIE of the years 2014 to 2018 as well as 2021 (Educon only) are evaluated. The methodology of the analysis as well as the set of main and sub categories (among them "sustainability") will be presented at SEFI 2022. The results of the analysis of the research landscape (1) show that the topic of sustainability has so far played a negligible role in the conference contributions. In (2), the focus is on the implementation process and the linking of technical and sustainability-oriented issues. The study programme concept of the X offers two options for sustainable technical education by combining major and minor study programmes. The interdisciplinary combinations are presented and explained using module examples. The paper proves in a research-based manner that the topic of sustainability has so far been underrepresented in the engineering sciences, which is why evidence-based interdisciplinary implementation procedures such as those presented in (2) are highly relevant.

Keywords:

sustainable engineering education, engineering education, sustainability in engineering degrees, sustainability competencies

PAPERS:

ID:

1443

Topic:

Mathematics at the heart of Engineering
Physics and Engineering Education

Title:

Studying mathematics students' learning experiences in Challenge-based education

Authors:

Kilic, Ayse;
Salinas-Hernández, Ulises;
Kock, Zeger-jan;
Pepin, Birgit

Abstract:

This paper is of methodological nature. We present the empirical research methodology of a study that focuses on student learning experiences, in particular of mathematics students in an innovative learning environment, such as Challenge-based Education (CBE) at a Dutch university of technology. In this study, we present the case study of CBE in an innovative mathematics course on modelling, the mathematics ``Modelling Week``. We draw attention to the methodology used to study this modelling course, where we investigated students' learning experiences in a monodisciplinary CBE-oriented master course. We explain the design of the study and the associated data collection strategies regarding students' use of resources (Schematic Representation of Resource system-SRRS) and their learning processes. In the poster presentation, we will show selected results that come from the different instruments to help us understand student learning experiences in innovative/CBE related mathematics courses.

Keywords:

Student learning experiences, challenge-based education, applied mathematics, modelling course

PAPERS:

ID:

1444

Topic:

Attractiveness of Engineering
Gender and Diversity

Title:

Efforts to Improve Attractiveness of Lower Level Engineering Education

Authors:

Cronhjort, Mikael;
Nobuoka, Jakob;
Ängskog, Per;
Haga, Andreas;
Mårtensson, Gunilla

Abstract:

There are nine study programmes awarding the degree bachelor in engineering (högskoleingenjör) at the University of Xxxx. Some of these have only a few applicants, even though the graduates are appreciated by a relatively large regional primary and secondary sector industry.

A major revision of the programmes is planned. One objective is to increase the attractiveness of the programmes. In the revised programmes, students are proposed to study most courses together during the first year of study, even if they belong to different engineering specializations. This is intended to improve the study environment. Students in programmes with low numbers of applicants will become part of a richer and livelier student collective. However, the attractiveness could further be problematized by asking to whom higher education is attractive. A special focus will be on increasing the admission of students from groups in society that have been underrepresented in higher education. More specifically this may be linked to individual factors such as the educational level of parents, family income, immigrational background and geography. There may also be societal explanations in traditions of gendered professions. Engineering programmes, and especially some of the specializations at the university, are dominated by male students. This study focuses on how universitys can take action to further increase the attractiveness of the engineering programmes, with a special regard to groups that are known to be underrepresented among the students.

Keywords:

Bachelor in engineering, gender, broadening participation

PAPERS:

ID:

1445

Topic:

Navigating Open Learning Environments
Mathematics at the heart of Engineering

Title:

The engagement of students using the virtual platform tools. A successful case in a required subject of 1st year in mathematics in engineering (UPC)

Authors:

Prat, Joana d'Arc;
Massana, Immaculada

Abstract:

Fonaments matemàtics is a required 1st year subject in engineering career at the university EPSEVG (UPC), with approximately 300 students enrolled each semestre, that traditionally it had a low pass rate.

Over the last 4 years we have introduced gradual changes in the teaching planning of it with the idea of achieving:

- the engagement of the students throughout the course,
- leveling knowledge,
- reduce the number of students not presented to any exam.

The changes have been implemented and corrected based on our feedback from students (engagement, grades, acceptance and survey assessments). The introduction of the calculator, laptops and tablets in everyday life and the use of the tools of the UPC virtual platform have been key.

In this contribution, we present the strategies used and the very good results obtained.

Keywords:

PAPERS:**ID:**

1446

Topic:

Mathematics at the heart of Engineering
Teaching methods

Title:

PROMOTING CONCEPTUAL UNDERSTANDING OF DIFFERENTIAL EQUATIONS
THROUGH INQUIRY TASKS

Authors:

Rogovchenko, Yuriy;
Rogovchenko, Svitlana

Abstract:

Teaching mathematics to future engineers is challenging; it requires a correct balance between theoretical knowledge and techniques for solving applied problems. Research often points towards the lack of students' conceptual understanding and the tendency of engineering students to take an instrumental approach to their studies even though both educators and students acknowledge the importance of abstract mathematical thinking and unique opportunities in its development offered by mathematical disciplines. Courses in Ordinary Differential Equations (ODEs) have been an important part of engineering education for many years. However, students experience difficulties with the understanding of the main concepts including differential equation itself and different types of solutions (general, particular, stationary, etc.). In this paper, we discuss how the work on non-standard problems on the Existence and Uniqueness Theorems (EUTs) helps students to make sense of differential equations and relate the concepts of particular and general solutions.

We designed the set of non-standard problems on EUTs to engage students more deeply with important theoretical results focusing on the development of conceptual understanding rather than procedural skills. Our aim was to explore how non-standard questions can be used to challenge students, develop their analytical skills, and contribute to conceptual understanding of important notions and ideas in an ODE course for engineering students. Furthermore, introducing the small group work in the project, we analyse to what extent individual work and group discussions contributed to students' conceptual understanding of EUTs and influenced their individual solutions submitted for final assessment.

Keywords:

ordinary differential equations; conceptual understanding; non-standard problems; small group work

PAPERS:

ID:

1448

Topic:

Teaching methods

Digitalisation & Hybrid models

Title:

Interactive courseware to support blended learning

Authors:

De Laet, Tinne

Abstract:

Covid-19 has been a game-changer in engineering education at the higher education level. Even beyond the pandemic, blended learning is there to stay. The design, execution, and delivery of blended learning can be supported by a plethora of fast-developing educational technology.

In this paper we share the experience of the evolution of one engineering course "Uncertainty in Artificial Intelligence" from a rather traditional design strongly relying on face-to-face interaction to a fully blended technology-supported course.

In particular, we share the experience of how an interactive courseware platform called "Nextbook", which allows students and teacher to directly interact on the course material, supported the design, implementation, and delivery. Student experiences measured using a questionnaire are supplemented with teacher experiences to present the following "lessons learnt": A well-chosen platform can help students find clear structure in a mix of types of material, and social annotation features make it possible to connect discussion and questions and answers directly to the course material. Further efforts are needed for engaging students to actively use the features of interactive courseware platforms.

Keywords:

PAPERS:

ID:

1450

Topic:

Mathematics at the heart of Engineering
Assessment

Title:

Is the engineering students' self-assessment accurate? Analysing midterm tests in terms of self-assessment accuracy

Authors:

Kulcsár, Nárcisz

Abstract:

There is a high drop-out rate in engineering higher education, the reasons can be grouped into four categories: economic explanations, individual pedagogical-psychological, learning-related reasons, socio-cultural influences. This paper discusses the problem of the accuracy of self-assessment among the individual pedagogical and psychological reasons.

During the maths midterm tests, students self-assessed on each task, which was compared with the points given by the teacher. More than 80% of students overestimated their actual performance in all midterms, and this overestimation was moderate. Based on the relationship between accuracy scores and test results, students who achieved better results in the midterms gave more accurate self-assessments than those who performed poorly, which confirms the Dunning-Kruger effect in engineering education. Feedback based on their performance may affect the accuracy of self-assessment. Feedback from the midterm caused a significant improvement in self-assessment for students who met mid-term requirements, while those who did not showed no such improvement. Thus, underperforming students did not benefit enough from the feedback from the first midterm, and the accuracy of their self-assessment did not improve.

The fact that there is a significant difference in the accuracy of self-assessment between students who fulfilled mid-term requirements and those who did not. The self-assessments of the former was closer to the teacher's evaluation than those of the latter. This may be problematic because weaker students are less aware of their deficiencies due to their inaccurate self-assessment, and thus they may stop their preparation short of what is necessary, and may not ask for help when needed.

Keywords:

self-assessment accuracy, Dunning-Kruger effect, feedback, drop-out

PAPERS:

ID:

1451

Topic:

Mathematics at the heart of Engineering
Teaching methods

Title:

Promoting engineering students' learning with mathematical modelling projects

Authors:

Rogovchenko, Svitlana;
Rogovchenko, Yuriy

Abstract:

Mathematics constitutes an important component in the engineering education. Engineering students are usually offered a number of mathematics courses which provide the knowledge needed at the workplace. Unfortunately, quite a few students view mathematics as one of the main obstacles on their way to the engineering degree and often perceive it as a discipline that teaches mostly procedures not relevant to their future careers. Introducing university students to mathematical modelling (MM), a powerful strategy for solving real-life problems, we contribute to the development of their mathematical competencies, motivate their interest to mathematics, promote the use of advanced mathematical thinking, methods of applied mathematics, and digital computational tools.

In this paper, we discuss how MM projects were introduced in a Differential Equations course for graduate students in mechatronics. The first author modified the traditional course curriculum including small group project work with MM tasks offered in the format of graded course projects counting towards the final grade. Engaging students into solving applied problems relevant for engineering, we connect their knowledge gained in mathematics, physics and engineering courses. Furthermore, our MM projects promote students' conceptual understanding of differential equations and show how abstract mathematical ideas can be efficiently combined with the possibilities offered by the modern computer algebra systems. The organisation of students' work in small groups introduces important elements of collaborative learning and enhances students' social skills. Last but not least, the use of graded projects in the assessment distributes students' work more evenly reducing the exam stress.

Keywords:

Mathematical modelling, assessment, ordinary differential equations, mechatronics students, projects

PAPERS:

ID:

1452

Topic:

Sustainability. Sustainable Development Goals
Co-Teaching

Title:

Seminar as a way to educate engineering students on environmental challenges in the textile industry

Authors:

Benkirane, Romain (1);
Perwuelz, Anne (1);
Pruvost, Sophie (2);
Thomassey, Sébastien (1);
Ternynck, Elise (1)

Abstract:

The Ecole Nationale Supérieure des Arts et Industries Textiles (ENSAIT) is one of the few schools specialising in materials for the textile industry. Each year it graduates around 110 engineers whose role is to meet the challenges of the sector while respecting the values of the companies and environmental standards. The ENSAIT engineer's course takes place over three years. From the first year of the engineering cycle, a seminar on sustainable development is offered. It is held in the second semester and lasts two full days. The first objective is to make them aware of CSR issues in companies. The second is to build on the knowledge acquired during the last 6 months to develop the life cycle of a garment and understand the associated impacts. Finally, it is to highlight the different possible strategies based on eco-design, fair trade, taking into account the regulatory constraints. This seminar is based on active pedagogy, where students work in teams and compare their results with each other. It also aims to provide the minimum tools to understand ecodesign strategies and to be an informed fashion consumer, and to become a textile engineer capable of participating in and technically supporting companies' CSR initiatives.

Keywords:

engineer education; seminar; CSR; LCA

PAPERS:**ID:**

1453

Topic:Engineering Skills
Assessment**Title:**

Cheating in engineering education: Modern methods and potential counter measures

Authors:Cooke, Neil;
Hawwash, Kamel**Abstract:**

Engineers must engender trust in order to collaborate successfully to produce solutions that the world needs. As part of building this confidence, students with an accredited degree must meet learning outcomes i.e. demonstrate skills to an acceptable standard. Cheating during such assessments reduces professional integrity and future work quality. Through careful assessment practice and encouraging a professional culture with ethics, we may minimise student's opportunity and motivation to take short-cuts. With this in mind, it is useful to understand which technical and professional skills are most affected. Cheating is evolving, with more collaborative online opportunities. Previous research suggests a majority of student's admit to dishonesty at least once, and that there are several motivations, including individual, demographic, institutional, and societal. We describe today's engineering education environment in terms of how it affords cheating behaviours and their methods, including the popularity of online services such as Chegg. By analysing potential cheating methods against a current agreed inventory of contemporary engineering skills, we highlight where educators might focus efforts to reduce bad learning practices. We also consider how the covid pandemic with more online and remote studying amplifies the situation.

Keywords:

academic dishonesty, cheating, integrity, ethics, assessment, skills

PAPERS:

ID:

1454

Topic:

Mathematics at the heart of Engineering
Co-creation with students

Title:

AN INTRODUCTION TO SLIDING MODE CONTROL FOR INTERDISCIPLINARY
EDUCATION

Authors:

Block, Brit-Maren;
Haus, Benedikt;
Schitz, Philipp;
Dethmann, Jannis;
van Rossum, Felix Malte;
Mercorelli, Paolo

Abstract:

This paper proposes a new lecture structure for an introduction to Sliding Mode Control (SMC) for a wider audience of undergraduate students. In particular, the intuitive derivation of the sliding variable and choice of the sliding surface is emphasized in order to obtain an intuitive understanding in a gradual manner. The structure of the lecture is conceived in an inclusive way, considering only the common mathematical high school background and basic knowledge about simple differential equations and their solutions. In this sense, SMC can represent a possible application of the already acquired knowledge and in the meantime provide contact with one of the most important control techniques in theory and application. The paper intends to give a possible structure of an interdisciplinary lecture in SMC for teachers and students (in particular, non-technical students). By presenting the research-based approach and the results of the implementation, the paper contributes to the discourse on interdisciplinary education in engineering.

Keywords:

Interdisciplinary engineering education, theory-based engineering course, design for non-engineering students, practice-based learning concepts

PAPERS:

ID:

1456

Topic:

Social and Service Learning
Cooperation for Development

Title:

Service-Learning in Engineering: analysis of students' experiences in development cooperation

Authors:

Alsina, Montserrat;
Alfonso, Pura;
Sidki-Rius, Nor;
Bel, Guillem;
Gaona, Roger

Abstract:

For several years, engineering students from the Escola Politècnica Superior d'Enginyeria de Manresa have been participating in development cooperation projects as activities of the non-governmental Organization Mining for Development, with the support of the Center for Development Cooperation of the UPC. Activities were carried out in several mining sites in South American countries, mainly in Bolivia and Peru. Although the motivation for the students may have been initially a desire for adventure and volunteering, the experience turned into meaningful learning, as intended by the faculty leading the project.

This paper presents the findings of a study carried out to analyze how these experiences contributed to the learning of engineering students, within the framework of what is known as service-learning. The study is based on the reports written by the students at the end of the experience and interviews conducted afterwards, when the experience had been fully internalized.

The characteristic elements of service-learning have been identified. In addition, the analysis revealed how the experiences had a significant impact on subsequent learning, beyond the initially intended objectives.

Keywords:

service-learning, cooperation, development, skills

PAPERS:

ID:

1457

Topic:

Mathematics at the heart of Engineering
Co-creation with students

Title:

🏠 AN INTRODUCTORY LECTURE ON CHAOTIC SYSTEMS THROUGH LORENZ ATTRACTOR AND FORCED LOTKA-VOLTERRA EQUATION FOR INTERDISCIPLINARY EDUCATION

Authors:

Kim, Geunjeong;
Haus, Benedikt;
Block, Brit-Maren;
Mercorelli, Paolo

Abstract:

Is it possible to predict the future? How accurate is the prediction for the future? These questions are fascinating and intriguing ones in particular for young generations who look at their future with curiosity. For a long time, many have tried to quantitatively predict future behavior of systems more accurately with techniques such as time series analysis and derived dynamical models based on observed data. The paper proposes a lecture structure in which elements of chaos, which greatly impacts the predictive capabilities of dynamical models, are introduced through two classical examples of nonlinear dynamical systems, namely Lorenz attractor and Lotka-Volterra equations. In a possible lecture, these two structures are introduced in a basic and intuitive way, followed by equilibria analyses and Lyapunov control approaches. The paper intends to give a possible structure of an interdisciplinary lecture in chaotic systems, for all students in general and non-engineering students in particular, to kindle students' interest in challenging ideas and models. By presenting an intuitive learning-based approach and the results of the implementation, the paper contributes to the discourse on interdisciplinary education. The lecture is a part of a course within a Complementary Study at Leuphana University of Lüneburg. The material which inspired the proposed lecture structure is taken from the scripts of the Master Complementary Course titled Modelling and Control of Dynamical Systems using Linear and Nonlinear Differential Equations held at Leuphana University of Lüneburg.

Keywords:

Interdisciplinary engineering education, theory-based engineering course, design for non-engineering students, practice-based learning concepts

PAPERS:**ID:**

1458

Topic:

Student Engagement
Social and Service Learning

Title:

Service-learning experience through outreach and engagement with science and technology museums

Authors:

Alsina, Montserrat (1);
Gaona, Roger (1);
Bel, Guillem (1);
Fornell, David (2);
Ventura, Pau (3)

Abstract:

The paper describes and analyzes the service-learning experiences of various engineering students in two science and technology museums, over the years 2020, 2021 and 2022. The experience was based on the design and implementation of education and outreach activities and scaffolding material was provided.

Student learning was significant not only in terms of content but also in terms of generic and transversal competences. In addition, this service-learning model shows a good potential to address some of the problems in engineering today, such as the declining interest in engineering among school students. Thus, it can be a win-win model for all the agents involved: museums, university, the student himself and society in general.

Keywords:

service-learning, skills, engagement

PAPERS:**ID:**

1463

Topic:

Industry and Companies liaison. Regional Involvement and Innovation

Title:

COMPASS addressing the challenge of DigitalSkills skilling from the Regional Ecosystem Perspective

Authors:

Vilanova, Ramon (1);

Ariño, Xavier (2);

Palou, Laura (2);

Gali, Mireia (2);

Palma, Julia (3)

Abstract:

COMPASS is an initiative initiated from to face actual challenges on the labour market related to the digital skills mismatch. Today we are experiencing the Fourth Industrial or Industry 4.0 Revolution, in which digitalisation is one of its most important pillars. However, are companies prepared for this twin transition? What enablers they need?

COMPASS goal can be stated as the development of a regional ecosystem-based training platform and associated methodologies for effective and efficient skilling pathways.

COMPASS as a platform is conceived as integrated by two key elements: a) skills guiding tool and b) a learning training tool. COMPASS as a skills guiding tool will be elaborated incorporating industrial activity, sector-based skills taxonomy and introducing technological trends as a source for pointing at the near future needs. COMPASS guiding tool is conceived to a) guide individuals and companies to get a closer idea of the skills-gap they need to cover, as well as to b) Help universities as training providers to elaborate their offer on the basis of the detected regional needs. This will definitively make the overall ecosystem more efficient. On the other hand, COMPASS is also conceived as a learning & training environment, in the sense of a) Dynamic micro-learning environment providing easy and mobile interaction between the learners and the content and b) Micro-credential system linked to the achieved skills.

This communication shares the approach and roadmap to simultaneously face the skilling problem and enhance the role of the university as a regional ecosystem key player.

Keywords:

Digital Skills, Regional Ecosystem, LifeLong Learning

PAPERS:

ID:

1476

Topic:

Engineering Skills

Digitalisation & Hybrid models

Title:

Is “digital education” the right way forward? – Or is, maybe, postdigital education what is needed!

Authors:

Bernhard, Jonte (1);

Ryberg, Thomas (2);

Daidsen, Jacob Gorm (2)

Abstract:

The use of “digital tools” have usually played an important role in the transformation to “emergency remote teaching” during the pandemic. However, even before the pandemic there has been a strong pressure that education should become more “digital”.

Nevertheless, we see several problems associated with the present discourse related to “digitalisation” of education. 1) It often unclear what is meant with “digital education”, 2) very narrow view of “digital tools” too mainly be tools for information and communication neglecting other uses of digital technology, 3) unbalanced focus on “digital tools” there other tools are either neglected or seen as inherently inferior and “old-fashioned”, 4) conflation between “digital” and “distance”, 5) adherence to either a technological determinism or a pedagogical determinism (technology is a neutral tool).

Engineering students’ courses of action have been videorecorded in design projects and in electronics labs at two universities. It can be seen that students’ use a wealth of bodily-material resources that are an integral and seamless part of students’ interactions. They use bodily resources, concrete materials, “low-tech” inscriptions as well as “high-tech” (“digital”) inscription devices. Our results challenge that by hand – by computer and analogue tools – digital tools should be seen as dichotomies. Our empirical evidence suggests that students should be trained to not only be trained to work with “digital” tools but with a multitude of tools and resources. We, thus, advocate that a postdigital perspective should be taken in education where the digital makes up part of an integrated totality.

Keywords:

postdigital education, digital education, digital tools, labs, design projects

WORKSHOPS:

ID:

464

Topic:

Student Engagement
Engineering Skills
Teaching methods

Title:

Emerging professional skills: Insights and methods

Authors:

Cooke, Neil (1);
Wint, Natalie (2);
Johannsen, Thies (3);
Manzini, Raffaella (4);
Thomson, Gareth (5);
Wood, Gary (6);
Hawwash, Kamel (1);
Hadgraft, Roger (7)

Abstract:

In this workshop run by the Engineering skills SIG, you'll learn about emerging professional competencies, and strategies to overcome teaching barriers. The workshop format is "world cafe" with several tables for small groups to informally discuss these strategies within a time limit. Each table will focus on an emerging skill and you'll have the opportunity to visit several tables.

The session is informed by the engineering skills survey taken by SEFI 2021 conference attendees. It gave us views on new competencies, barriers to teaching them, and illustrations of good practice. The results highlight several emerging professional abilities including emotional intelligence, lifelong learning, cultural awareness, responsibility, ethics, and enterprise/entrepreneurship. Obstacles to teaching them include motivation, legitimacy, overloaded curriculums, student resistance, resource constraints, and pedagogical understandings. Ideally skills should be learned by students in contexts where they're used. While many technical competencies are primarily developed in engineering practice, professional/soft abilities are often not. As a result, there ought to be some opportunity for the student to transfer, adapt and (re)learn them in an engineering degree.

Attendees should take away insights and methods for describing and introducing emerging professional skills into their practice.

Common questions and prompts for every table include:

- What do you think the skill is, how would you define it, what does it include?
- Why is this skill important for engineers?
- How is it taught at your institution?
- How is it assessed?
- Are there any good textbooks or papers to recommend?
- What are the challenges and barriers to teaching and developing this skill in students?

The tables in our world cafe are:

Teamwork, Project Management and Leadership

At this table skills associated with Teamwork, Project Management and Leadership will be discussed. Currently, there is wide debate about the skills needed to work successfully in a team and to be a future leader, which are rather different to being a good project manager. New skill sets like self-awareness, empathy, cultural awareness as well as the commonly

known ones like communication, collaboration, conflict management will be discussed, as well as a relatively new focus on how to help students create psychological safety and trust in their teams.

Innovation and Entrepreneurial Mindset

In this table we will discuss why it is so important for engineers, in all fields of specialisation, to develop an attitude towards innovation, which implies an entrepreneurial mindset. We will also discuss how to help students develop this attitude: what innovation management tools can be exploited, what learning approaches are most suitable to be effective. Some examples will be also illustrated and discussed.

Communications

On this table we will discuss the various ways in which engineers communicate, whether this be verbally, graphically or in written form, as well as the need for students to develop active listening skills. Particular emphasis will be placed on the increasing need for the ability to communicate across disciplinary boundaries and international borders, and there will be opportunities to discuss the development of communication skills in students with non visible disabilities.

Other tables include System complexity, and Transdisciplinarity.

Keywords:

professional skills

WORKSHOPS:

ID:

1466

Topic:

Ethics in Engineering Education
Social and Service Learning
Co-creation with students

Title:

How can you contribute to the social responsibility of your university's education?

Authors:

Bombaerts, Gunter (1);
Kovacs, Helena (2);
Martin, Diana (1);
Tormey, Roland (2)

Abstract:

In this SEFI ethics SIG workshop, we will actively engage with the question: "How can you contribute to the social responsibility of your university's education?"

This is an important question for university staff.

First, universities become (and see themselves) as increasingly important players to contribute to the sustainable development goals. Their missions broaden to more research, entrepreneurship and social responsibility. From the perspective of being recognized as important actors in the quintuple helix of innovation (Carayannis et al., 2012), (technical) university eco-system collaborations become increasingly co-creative, including complex interactions between political, economic, and education systems, natural environment and knowledge creation. The technical universities' education also becomes increasingly intertwined with the eco-system partners, resulting in new formats such as research-based, community-based or challenge-based learning.

Second, in this transition, teachers change inevitably from purely internal staff to societal actors. Willingly or unwillingly, you as an individual teacher get a more pronounced societal role, as an agent of social change (e.g. Bourn, 2016). This means a growing realization that, in the language of Paulo Freire, "Education is politics...when a teacher realizes that he or she is a politician too, the teacher has to ask, What kind of politics am I doing in the classroom? That is, in favor of whom am I being a teacher?" (Shor and Freire, 1987:46).

If we approach this from the responsibility angle, Whitbeck's definition "exercise of judgment and care to achieve or maintain a desirable state of affairs" (2011:159) can be a starting point here. As Fore and Hess note while introducing their five-sided framework of ethical becoming, "rules and codes found in discipline-specific standards are undoubtedly important, [but] insufficient by themselves for moral inquiry and ethical judgement" (2019:1355). The reflection of the impact of education to the university's responsibility then requires a broader perspective on all involved (students, teachers, university, eco-system).

For the session, we propose the following agenda:

Short introduction of the context of the workshop

Break-out groups

What is your role in the university? (Ethics) teacher? (Educational) manager?

What do you care about? What do you want to change or influence? Do you focus on the classroom activities? Or do you reflect on how your activities (teaching, research, ...) have a broader impact?

How do you judge things as a desirable state of affairs? How does ethics come into play?

What can you “exercise”? What can you do? What is your agency or influence? How is it limited (university, other contexts)? Do you want more influence?

Who can or should you involve in co-constructing the educational agenda and reaching educational goals?

How do you evaluate your influence? Student satisfaction or student learning? Do you also use input from other partners?

Plenum discussion, in which we bring together the different inputs and have an overall discussion.

Keywords:

responsibility, ethics, teacher, university, eco-system

WORKSHOPS:

ID:

1467

Topic:

Building Communities and Coordination
Navigating Open Learning Environments
Co-creation with students

Title:

Are We Open to Being Open? Discussing the role of Open Educational Resources in post-secondary education

Authors:

de los Arcos, Bea (1);
Gomez Puente, Sonia (2);
Rans, Calvin David (1)

Abstract:

What is open education and what does it offer academic institutions?

UNESCO defines Open Educational Resources (OER) as teaching, learning and research materials in any form, e.g. digital or otherwise, that are made public so that this material can be reused by different educational parties under certain conditions (Definition by UNESCO, 2019).

Some of the advantages of using OER in our universities are, for instance, the increase access to education for students to assess and plan their education choices; to convert students exploring options into fee-paying enrolments; to accelerate learning by providing educational resources for just-in-time, direct, informal use by both students and self-directed learners, that can be continually improved; to reduce faculty preparation time; and, to generate innovation through collaboration.. However, working with OER is not necessarily plain-sailing; concerns have been raised that bring to the fore questions regarding the quality of resources, their sustainability and the way technology and intellectual property issues may affect creation and use.

As you can see, even these answers to the initial question are subject to some interpretation and possible argumentation. For this reason, this workshop aims to discuss this definition of open education as well as the challenges which arise from OER and open practices. During the workshop we will address several questions, including:

- What are the boundary conditions of “open” and can institutions afford to be open?
 - What is the value proposition for academic institutions and individuals? for contributing to open education?
 - How can the OER landscape be transformed from a data dump of resources into a community of creation, co-creation, revision, and improvement of educational resources?
- Participants will also be given the opportunity to raise additional questions related to OER relevant to themselves and their own institutions to add to the conversation. The desired outcome for the workshop is to identify points of concern and interest related to open education that will be used to define and steer activities with the Open and Online Education SIG for the coming year.

Keywords:

Open Education Resources, community building, co-creation

WORKSHOPS:

ID:

1468

Topic:

Ethics in Engineering Education
Social and Service Learning
Curriculum Development

Title:

Responsible Innovation as a vehicle for teaching ethical and social dimensions of technology

Authors:

Roach, Kate;
Tilley, Emanuela;
Nyamapfene, Abel;
Seren Smith, Matthew;
Hughes, Stephen

Abstract:

This session is designed for anyone with an interest in teaching ethics, Responsible Innovation (RI) or both. We aim for a lively session in which participants leave with new ideas on how they might embed RI in their modules or curricula. The session will be of interest both to those who involved in teaching modules and to those who are responsible for higher level curriculum design.

Workshop leads are also interested in understanding more about how members of the engineering education community are using RI in their programmes and we hope that this will a forum for the exchange of ideas all round. Is RI (or elements of it) part of an already existing curriculum or module that you run. From our experience, RI seems to crop up most often in areas of the curriculum where sustainability is considered and the two endeavours do have synergies, which will be discussed in the workshop.

Background and relevance?

Over the past two decades there has been a growing emphasis on incorporating social and ethical perspectives in engineering education, and at the same time the concept of Responsible Innovation (RI) has emerged in the UK and Europe as a way of ensuring new technologies align with societal needs. The outcome is that RI frameworks are growing in popularity as a vehicle for teaching ethical and societal dimensions of technical innovation. At its most fundamental, RI holds that moral values can be embedded in technologies and that normative deliberation should be part of all stages of technological innovation [1]. RI is an ethical construct. Indeed, many educators treat it as a special case of ethics [2] but here we present our own on-going experience of using RI and its practice as a tool for teaching and addressing curriculum development. Using a framework that is widely used in the UK (AREA) we will demonstrate how we can map curricula and modules in search of opportunities to embed RI within our engineering modules and student projects.

One advantage of using RI frameworks over teaching classical ethics is that RI is explicitly future oriented. Where ethics classes often focus on retrospective case studies, RI can be used in real-time in design projects. The AREA framework prompts practitioners to ask questions that will help to anticipate the impacts of research and innovation before they occur [3]. It encourages the engineer to understand how it is possible to innovate with and for society and it creates opportunities both for response to social pushback and for co-creation. RI is especially helpful in the upstream phases of project development but is also used in iteration, downstream where it can it is useful in assessing technological impacts.

RI has become associated with a set of tools and techniques that enable engineers to probe the social world.

What is RI? And what is RI for you?

RI is often criticised for its vagueness, but this mistakes its purpose. RI is not a theory or a discipline and as such it does not have

Keywords:

Responsible Innovation. Ethics. Social Responsibility.

WORKSHOPS:

ID:

1470

Topic:

Lifelong Learning

Title:

A Panoramic View of Strategy, Organisation and Practice in Continuing Engineering Education

Authors:

Nørgaard, Bente

Abstract:

Introduction

For decades, life-long learning has been a well-known concept which has gradually grown in importance as we move away from (just) front-loading education to e.g., continuing training of professionals. Nowadays, industries as well as individuals, including professional engineers, are increasingly requesting new skills and competences also at an academic level. To some extent, the continuing education programmes offered by universities meet these needs, but increasing demand for tailored and flexible programmes and micro-credentialing is pressing for new responses in meeting these demands.

WORKSHOP FOCUS

Continuing Engineering Education (CEE) is often referred to as universities' third mission or outreach activity. However, CEE activities are most often part of university strategies aiming at e.g., interacting with society; cross-collaboration with companies; research collaboration; knowledge exchange etc. Many universities offer CEE programmes, but the programmes offered differ greatly, and in general, collaboration with public and private companies is a relatively new and limited 'business' for most universities. In recent years, however, new methods and paradigms for continuing education (knowledge flow) have been developing at European universities. These are initiated by EU and national programmes and aim at upgrading the workforce e.g., to meet the skills and competence requirements derived from the SDGs and Industry 4.0.

This workshop is based on research conducted in a Strategic Partnership funded by the Erasmus+ programme. The project 'STEM skills and competences for the new generation of Nordic engineers' (Nordic engineers) in the period 2018 to 2021[1].

With inspiration from the Nordic engineers, this workshop will facilitate the participants in conceptualizing and sharing their knowledge of CEE and will contribute to building a strong community in the SEFI SIG for CEE and LLL [2].

DURING THE WORKSHOP

This workshop aims to gather researchers, administrators and practitioners in the field of continuing engineering education and lifelong learning to brainstorm on several paths for the future practice, organization and strategies of CEE.

The 60-minute workshop will be divided into six sections:

Presentation of the current situation of CEE in a Scandinavian context.

Brainstorming discussions in groups and the conceptualization of CEE

Scouting and presentation on concept mapping

Knowledge sharing sessions in groups on CEE practice and CEE strategies

Presentation by each group

A list of work to be done by the participants, as the workshop outcomes are summarized.

AFTER THE WORKSHOP

Participants are expected to experience the following outcomes:

An elaborated understanding of the CEE concept

Knowledge of how CEE is practised and organised at various universities

Knowledge of different CEE strategies

A framework developed by the participants themselves on CEE and a network of CEE interested colleagues

Based on the workshop outcomes and group presentations, we will explore the possibility to write and submit a proposal (paper, project etc.) together with the participating attendees of the workshop.

References

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<https://nordicengineers.org/>

[2]

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Keywords:

Continuing engineering education (CEE); CEE practice; CEE strategies

WORKSHOPS:

ID:

1471

Topic:

Fostering Engineering Education Research
Engineering Skills

Title:

🏠 Teaching soft skills for engineers of the future by using projects

Authors:

Mikhridinova, Nargiza (1,3);
Ngereja, Bertha Joseph (2);
Wolff, Carsten (3);
Van Petegem, Wim (1)

Abstract:

Title: Teaching soft skills for engineers of the future by using projects

Workshop rationale: Engineers work in projects and need certain soft skills to succeed in this work environment. Teaching soft skills to engineering students can be supported by creating project situations which generate a relevant learning experience. The workshop is intended for participants who want to look deeper into how to create such project situations in student projects.

Learning outcomes: During the one-hour workshop “Teaching soft skills for engineers of the future by using projects” participants will learn:

- How to plan, prepare and conduct agile cross-border projects with industry involvement for educational purposes
- How to select a relevant project case
- How to build the teams for project assignment
- Participants will be provided with:

Template and example of the course concept with learning activities’ plan

Template and example of the case study description

Working template for the self-evaluation for roles identification

Concept and engagement scenarios: The workshop will have 3 parts:

- Part 1: project-based learning and agile cross-border projects,
- Part 2: roles and soft skills model, team formation and relevant exercises
- Part 3: discussion and feedback from industry partners

Part 1 description:

An introduction to the concept of agile cross-border projects [1] will be provided, including results of the ongoing research from students’ and trainers’/lecturers’ perspectives. During the session, participants get familiar with the course concept including the intended learning outcomes and the learning activity plan.

Part 2 description:

Introduction to the project case development [2] and know-how to refine and tailor a project case with companies for training soft skills [3, 4], as well as roles definition and team formation models and processes. Participants of the workshop will perform a role identification exercise based on Belbin's team roles [5]. After exercise the discussion will follow about matching their results with the Scrum roles.

Part 3 description:

a) Discussion between industry partners and the workshop participants on impact of soft skills in ongoing projects, training strategies to develop soft skills of employees, as well as perspective of the industry on skills of “fresh” engineering graduates.

b) Feedback and discussion about soft skills and personality traits [6] in order to train a desired set of soft skills.

Participants will be asked to assess and evaluate the concept; the workshop materials will be made available to all participants after the workshop (via cloud storage).

The workshop is organised in frames of Erasmus+ KA2 Knowledge Alliance project 621745-EPP-1-2020-1-DE-EPPKA2-KA “ProDiT- Projects for the Digital Transformation”.

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Keywords:

engineering education, project team, soft skills

WORKSHOPS:

ID:

1472

Topic:

Student Engagement

Teaching methods

Assessment

Title:

Promoting Active Learning in STEM Subjects

Authors:

Rinneheimo, Kirsi-Maria (1);

Kinnari-Korpela, Hanna (1);

Velichová, Daniela (2);

L. Dias Rasteiro, Deolinda (3)

Abstract:

Literature doesn't provide a universal definition of active learning. Bonwell & Eison (1991) defined active learning as "instructional activities that involve students in doing things and thinking about the things they are doing". Active learning can be considered as anything but passively listening to a lecture. Most typically the concept of active learning encapsulates methods that activate students during in-class sessions (Prince, 2004). Several research studies have advocated active learning methods in teaching/learning STEM subjects (e.g. Freeman et al. (2014), Theobald et al. (2020)). Many benefits of active learning have also been highlighted. Meta-analysis of Freeman et al. (2014) revealed increased course scores and passing rates in STEM courses under active learning. The effects seemed to be greatest with small group sizes (under 50) even though active learning methods appeared to work across all group sizes.

The drop-out rates are high in the field of engineering throughout Europe. In Finnish UASes the percentage of graduates in ICT engineering after 5 years of studying is 40% and in engineering 48% (Vipunen). These figures are quite low. Engaging students in their learning process seems to promote retention rates. One way to engage students in their studies is using active learning methods.

The objective of this proposed workshop is to enhance educators' competence that improves students' active learning. The workshop aims to promote digital/pedagogical competence of engineering educators by introducing methods and tools for promoting active learning. By increasing such competences of educators, it gives them tools and knowledge to redesign their teaching and implement digital resources and activities (e.g. TPACK, active learning, self-regulated learning, digital languaging and assessment).

The content of the proposed workshop will be twofold. On one hand, it presents DigiSTEM project results, and on the other one, participants will share their experiences/expertises related to using digital tools/pedagogy in STEM education. The session itself utilizes active learning methods. Participants will keep small pitches of their best pedagogical practices in teaching/learning of STEM subjects and participate in group working. In the group working will be focused on the following issues:

Forms of assessment

Learning technology/digital tools

Active learning methods

As a result of the workshop, a collection of best practices, examples of using digital tools, pedagogical solutions and summary of workshop ideas will be created and sent to the session participants. Aim is to create a collection that include elements among others e.g.

innovative pedagogies, utilizing digital assessment, promoting self-regulated learning and using online resources for STEM subjects' learning purposes. This collection seeks to support pedagogical and digital learning methods that activate students and promote self-regulated learning.

The workshop focuses on the pedagogical issues and also on concrete actions and examples of usability of technology. At the end of the workshop participants are expected to experience the following outcomes:

Reflect on how their courses support pedagogical and digital learning methods that activate students.

Share concrete actions and examples of usability of technological/pedagogical solutions in STEM education.

Discuss how using digital tools/pedagogy in STEM education could be designed to optimize learning outcomes in engineering studies.

Keywords:

active learning, assessment, digital tools, learning and pedagogical technologies

WORKSHOPS:

ID:

1474

Topic:

Student Engagement
Mathematics at the heart of Engineering

Title:

Hands-on workshop: active teaching and learning made real in MATLAB

Authors:

Sanchis, Carlos (1);
Susin Sanchez, Antonio (2)

Abstract:

Please, join MathWorks in this MATLAB workshop on resources that support lecturers to motivate and engage students.

Participants will leave the session with a working knowledge about how to:

Access MATLAB resources for active teaching and learning

Create engaging lectures that combine explanatory text, mathematical equations, code, results and examples

Create live scripts to build assignments that let students explore and learn on their own

Deliver automatically graded assessments from MATLAB in a LMS

Keywords:

mathematics, sponsor, matlabs, cloud, moodle

WORKSHOPS:

ID:

1477

Topic:

Niche & Novel

Title:

Engineering More Time for your Research

Authors:

Sheahan, Garry (1);
Mulvihill, John (2)

Abstract:

Forming a true partnership and delivering the right course solution based on your teaching and learning needs is what makes McGraw Hill stand out. We have the content and technology to support your teaching goals, but it is our service and commitment to driving success that separates us from the pack.

During this session John Mulvihill, from the Bernal Institute and School of Engineering at the University of Limerick in Ireland will explore how he uses the McGraw Hill Connect platform to optimise his teaching time and free up time for his research.

John needed to increase the complexity and level of his large Engineering Science module without sacrificing engagement. He wanted his students to engage more with the content outside of the lectures and the lecture slides. Working closely with Garry Sheahan from McGraw Hill, John introduced a new digital platform to help him run his course.

John found that Connect offered him: consistent data on the engagement of his students, better module structure and consistency and an ability to increase the number of assignments set. It has answered his students' need for structure and consistency and offered a different approach to learning engineering.

With Connect, students have access to a more personalised experience and can spend their study time more efficiently. This means that for Instructors, when you use Connect for your classes, you have the opportunity to save time and effort on lesson planning. So, with this extra time that you save with using Connect, you can focus on teaching, creating engaging courses, and improving student outcomes. The advanced features within Connect also simplify assignment management, allowing you to teach your way. Connect provides customisable reports on student performance, learning outcomes and identifies at-risk students. It also integrates easily with LMS gradebooks. Connect Insights data analytics tool has a series of visual data displays each framed by an intuitive question. It provides 'at-a-glance' information on how your individual students are doing, and the class as a whole, so you can see who the at-risk students are and intervene when necessary.

SmartBook is an adaptive learning tool integrated within Connect that creates a personalised learning path based on a student's strengths and weaknesses. It identifies gaps in knowledge and focuses on areas needing reinforcement, helping students to study smarter, instead of harder. SmartBook's insightful report features highlight student progress or topic areas that need more work, assisting instructors in shaping their teaching strategies.

Designed from the ground up by engineering and physics educators, the Free-Body Diagramming Tool provides students with immediate feedback on their drawing comprehension and gives information on where they need improvement the most.

Process Oriented Problems are designed to help students approach and understand complex engineering problems. Students practice how to identify the system, recognise the symmetry of the system and calculate physical properties. Hear more about how this all works in practice directly from John during this interactive session. John and Garry will also be happy to answer your questions.

Keywords:

sponsor, mcgraw-hill

WORKSHOPS:

ID:

391

Topic:

Engineering Skills
Teaching methods

Title:

Teaching analytics skills in Engineering: A hands-on introduction using JMP

Authors:

Kraft, Volker

Abstract:

Engineering curricula often require students to learn a range of analytics skills, which are critical for all practitioners who want to learn from data. With the right software, learning these skills can be hands-on and engaging, allowing students to explore and analyze realistic data without struggling with a clunky or tedious statistics tool. JMP is interactive and powerful point-and-click software for solving real-world engineering problems. It is ideal for engaging, hands-on teaching of relevant data skills in engineering and is also used by scientists and engineers at leading companies across the globe.

While the fundamental skills addressed in this session include understanding variation and uncertainty, we will also look at applications like data modeling, designing experiments and quality management – all from a student's perspective.

This interactive session will demonstrate how JMP can help to engage students' curiosity and teach engineering data skills which are most in-demand in industry today. We'll guide you through a series of brief demonstrations, so that you can directly experience the difference JMP can make for your course. Participants will receive a free trial license before the workshop, and the presenters will provide sample data and lead you through several hands-on examples in JMP. We will also discuss best practices and share resources to support integration into engineering courses.

Keywords:

Teaching tools, real-world problem-solving, active learning

WORKSHOPS:

ID:

1172

Topic:

Attractiveness of Engineering
Engineering Skills

Title:

Key principles of integrated STEM: cross-fertilization between Engineering and secondary STEM education

Authors:

Deprez, Hanne (1);
Spikic, Sascha (1);
Møller, Maria (2);
Rubeck Stenz, Ian (2);
Rasmussen Mølgaard Lunde, Søren (2);
Kersánszki, Tamás (3);
Sanda, István Dániel (3);
Holik, Ildikó (3);
Mettouris, Christos (4);
Vanezi, Evangelia (4);
Petsa, Katerina (4);

Abstract:

Secondary STEM education and engineering higher education: a match made in heaven? Highly educated STEM professionals, and engineers in particular, increasingly top the lists of most wanted profiles on the European labour market (European Commission, 2020). For higher STEM education to be able to deliver the required number of STEM graduates, a sufficiently high number of students should be enrolled at the start. However, by the end of secondary education (SE), a large share of pupils who were initially enrolled in a STEM programme, opt out of STEM when enrolling in higher education (HE) (De Meester et al., 2020; Kersanszki & Simonics, 2022). From the pupils who do enroll in a HE STEM programme, an alarmingly high proportion lacks the attitude and skills necessary to successfully complete their first year (Broos et al., 2021). Moreover, pre- and in-service teachers lack sophisticated Nature of Engineering (NoE) views (Kaya, 2020), inhibiting transfer of the NoE to their pupils. This insufficient preparedness and lack of understanding of the NoE urges a new, integrated approach to STEM SE (European Committee of the Regions, 2019), that can be inspired by practices in the first years of HE engineering programmes (Engberg & Wolniak, 2013). In turn, SE practices in integrated STEM (iSTEM) can also inform HE engineering programmes. In summary: HE engineering programmes and iSTEM SE share two common goals: (1) motivating students for STEM studies/careers, and (2) preparing students for these studies and careers. This workshop aims to enhance cross-fertilization between iSTEM SE and engineering HE, in the pursuit of these goals.

A guideline for designing qualitative integrated STEM projects in six key principles
Six key principles form the basis of iSTEM education that helps pupils develop competences required in engineering and science programmes as well as in future STEM careers (Thibaut et al., 2018; Flemish Government, 2015). These principles are: (1) problem-centered learning and problem solving, (2) integration of learning contents from different STEM subjects, (3) modeling, (4) inquiry-based learning, (5) design-based

learning, and (6) cooperative learning. In an ERASMUS+ partnership project launched in 2021, five European HE institutions joined forces with the primary goal to embed these principles in (i)STEM teacher education programmes in a sustainable and effective manner (CiSTEM², 2021). Through an online training that immerses student teachers in each of the six key principles, the partner institutions aim to prepare these future (i)STEM teachers to incorporate the principles in their own classroom practices.

Finding common ground through interactive group discussions

In this workshop we want to exchange good practices and stumbling blocks with respect to each of the six key principles of high-quality iSTEM education. Two central questions will be addressed: (1) How are the six iSTEM key principles embedded in HE engineering programmes (e.g., projects in the bachelor programme, theoretical courses, interdisciplinary courses...)? (2) What can (i)STEM teacher education and engineering HE learn from each other regarding these key principles to achieve their two common goals? Small group discussions and interactive media (PollEverywhere, padlet, lucidchart, ...) will be used to gather input from the public and summarize participant take-away. Via the interactive workshop activities outlined below, we want to enable participants in identifying actions and good practices for their education practice (specifically in assessing project quality, implementation and student competence training and evaluation) based on the iSTEM key principles.

- (1) We open the workshop by presenting the six key principles and their implementation in STEM SE and (i)STEM teacher education.
- (2) Together with the participants, we derive indicators of successful classroom implementation of each of these principles. The participants are invited to share specific examples from their practice in engineering HE to enrich the meaning of these indicators.
- (3) We reflect upon the implementation in current SE and HE STEM programmes: which principles are strongly integrated, and which deserve more attention? Do SE and HE STEM implementations encounter the same struggles and opportunities? Can we get to a common understanding of practices underpinning qualitative STEM education?
- (4) Additionally, we will focus on how to evaluate students' competences related to the iSTEM key principles.
- (5) Finally, we want to introduce a tool to train STEM teachers and secondary school pupils in some of the iSTEM key principles. With the participants, we reflect on the usefulness of this tool for iSTEM SE and for their own HE STEM practices.
- (6) We ask the participants to identify two action points for their HE engineering programme as well as for STEM teacher education with respect to the iSTEM key principles and with the aim of creating truly inspiring, competence-oriented integrated STEM education.

The conclusions presented in the wrap-up will also be disseminated in the conference proceedings.

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Keywords:

integrated STEM, key principles, STEM pipeline

WORKSHOPS:

ID:

1237

Topic:

Ethics in Engineering Education
Digitalisation & Hybrid models

Title:

A canvas for the ethical design of learning experiences with digital tools

Authors:

Hardebolle, Cécile (1);
Jermann, Patrick (1);
Tormey, Roland (1);
Dehler Zufferey, Jessica (1);
Gillet, Denis (1);
Holzer, Adrian (2);
Felber, Pascal (2);
Bentel, Katrin (3);
Brändel, Urs (3);
Kortemeyer, Gerd (3)

Abstract:

The use of digital tools has drastically increased in engineering education, accelerated by the COVID-19 pandemic. These tools generate important ethical issues, in particular in terms of privacy and fairness. However, very few teacher training programmes address those topics, which means that teachers are often left to figure out by themselves how to address these issues when they want (or have) to use digital tools in their teaching. In this workshop, participants will be introduced to a pragmatic approach to the ethical design of learning experiences that involve digital tools using a visual thinking guide called a 'canvas'. Applied and hands-on, this workshop will help participants to develop a practical understanding of the specific ethical issues related to the use of digital tools in teaching and to integrate ethical reflection into design processes when digital technology is involved.

Keywords:

Digital tools, Ethics, Responsible design, Teacher training

WORKSHOPS:

ID:

1244

Topic:

Student Engagement

Teaching methods

Title:

Game-based Learning in Computer Engineering: A Workshop

Authors:

Farreras Esclusa, Montserrat;

Bofill, Pau;

Armengol, Jesus;

Hernandez, Angels

Abstract:

In the introduction to this workshop we first make a distinction between gamification and game-based learning (GBL). See, for instance, [Dave Eng, 2019]. An example of gamification is a contest where students get points for solving the usual exercises of the subject matter. An example of game-based learning is an escape room where students get involved in studying and solving subject matter problems to get the required hints to continue the game. In this sense, game-based learning is an instance of problem-based learning (PBL) [Lima, 2017]. An interesting reflection on GBL can be found in [Valero, 2018].

The main objective of game-based learning is to provide an active learning environment, where students need to learn and apply the subject matter in order to participate and eventually solve the game. Compared with frontal lectures, active learning has been shown to provide higher motivation and deeper learning [Call, 2021] [Lopez-Fernandez, 2021].

From a general point of view, we can say that learning takes place in five stages [Bofill, 2007]. Namely: motivation, information retrieval, understanding, application (or practice) and feed-back. GBL, then, reinforces the autonomous realization of each of these stages. An escape room is a game where players must solve different puzzles and riddles in order to finish the game (in order to escape from the room). Escape rooms have been used extensively in education, since they allow for the organization of subject matter exercises in a pleasant way [Veldamp, 2020].

The workshop we propose includes the following steps:

an introduction, where GBL and gamification are introduced and compared,

an actual example of an escape room, where participants to the workshop play the game, by solving simple computer programming challenges,

a reflection in small groups on the potential benefits of introducing escape rooms in their own courses,

a full group discussion on the benefits of GBL

and conclusions.

We hope that this workshop will inspire participants and, maybe, engage them in proposing GBL activities for their own students.

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Call, T., Fox, E. and Sprint, G. Gamifying Software Engineering Tools to Motivate Computer Science Students to Start and Finish Programming Assignments Earlier. IEEE TRANSACTIONS ON EDUCATION, 64, 4, 423, 2021.

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Valero, M.

<https://personals.ac.upc.edu/miguel/materiales/docencia/articulos/Gamificacion.pdf>

Veldkamp, A. van de Grint, I. et al. Escape education: A systematic review on escape rooms in education, Educational Research Review, 31, 2020, 100364. <https://doi.org/10.1016/j.edurev.2020.100364>.

Participants are expected to bring their own laptop to the workshop

Keywords:

Escape room, Game-based Learning, Design of Student Activities, Active Learning

WORKSHOPS:

ID:

1278

Topic:

Engineering Skills

Lifelong Learning

Title:

Shaping the embedding of reflection in engineering education

Authors:

Hermesen, Pleun;

Van Dommelen, Sjoerd;

Hueso Espinosa, Paula

Abstract:

Imagine a world where reflection is not allowed: what could possibly go wrong?

Probably too much to contemplate.

Reflection is widely considered as an essential step in (deeper) learning. Reflection helps professionals understand, learn about, appreciate, and grow their own impact in their lives, their work and in the world.

Today's and tomorrow's networked society requires engineers to be able to deal with uncertainties, be able to work with any other discipline, understand stakeholders of all walks of life, to be open and critical towards new and different insights and to deal with wicked problems.

At our university we want to educate those engineers of the future, for whom we believe reflection is an essential professional attribute. With our university-wide program called reflective engineer, we grow, foster, and embed reflection as a core practice in our disciplinary education and organization.

Reflection and context

Literature on reflection has a multitude of definitions of the word 'reflection'. (Marshall 2019). Next to that, based on a qualitative exploration in our university we learned that reflection is deeply context dependent. First of all, the domain of reflection is great in its variety (e.g. reflection on yourself, collaboration, the design or work process or the (intended) impact of your work), besides there is also a cultural factor in reflection: the role and habit of reflection can be different between departments in the same institute, between institutes, let alone between countries or other distinctive factors. It might be completely normal to share your mistakes in one department and be frowned upon in the next.

In short, we spot a *couleur locale* in relevance and habit of reflection. If we want to design education to stimulate reflection, how do we deal with these varieties?

Implementation

Research on educational innovations shows that implementation is easier said than done. Brilliant ideas from literature don't survive the translation to teaching practice; the application of seemingly clear-cut concepts or best practices mismatch with the messy reality of a new context. Longevity and fidelity of educational change (Hamza & Regehr 2021) is challenging. (Coppoolse 2018, VanLommel 2021)

Implementing educational innovation on a subject that is so broad and context dependent as reflection requires a particular focus and attention on implementation. Our guide in this innovation process is the model by Hamza & Regehr on eco-normalization, that describes the interaction between the innovation, the system where it is embedded, and the people doing the work.

To align this interaction and to embed couleur locale we use co-creation in the reflective engineer as one of our main tools.

Workshop

In this workshop, together we (I) deconstruct the couleur locale of participants' contexts and we (II) analyze the stimulating and limiting interactions between system, innovation and people doing the work. (III) We ground this in theory and share an example to illustrate how we manage that in our own messy reality. This allows participants to apply these insights to their own contexts. This workshop will ask an active role of participants and will stimulate interaction.

Keywords:

Reflection, implementation, co-creation, local embedding, longevity

WORKSHOPS:

ID:

1283

Topic:

Artificial Intelligence in Education

Ethics in Engineering Education

Title:

A game-based approach to develop engineering students' awareness about artificial intelligence ethical challenges

Authors:

Hardebolle, Cécile;

Kovacs, Helena;

Simkova, Ester;

Pinazza, Alexandre;

Di Vincenzo, Maria Carla;

Jermann, Patrick;

Tormey, Roland;

Dehler Zufferey, Jessica

Abstract:

The past few decades have seen important efforts to introduce more ethics into engineering education programs around the world, while adapting to the evolution of ethical concerns, notably in relation to digital technology and artificial intelligence. Even if pedagogical approaches based on the use of case studies or code of ethics remain among the most popular, other less well known techniques such as game-based approaches have also been identified as effective. The goal of this workshop is to offer participants an opportunity to explore how games can be used as learning experiences to develop students' ethical knowledge and skills. Participants will first get to play an online game which focuses on ethical issues in the domain of artificial intelligence, before reflecting on their experience and discussing the potential of game-based approaches for engineering ethics education.

Keywords:

Ethics education, Game-based learning, Artificial Intelligence

WORKSHOPS:

ID:

1340

Topic:

Niche & Novel

Fostering Engineering Education Research

Title:

Mapping Engineering Education Research in Europe

Authors:

Wint, Natalie (2);

Williams, Bill (1,3);

Murphy, Mike (3);

Valentine, Andrew (4)

Abstract:

Context

The growth of Engineering Education Research (EER) has led to claims about it becoming a globally connected field of inquiry. Following from this, recent studies have employed scientometric data drawn from SCOPUS to provide insights into the research careers of EER practitioners in parts of Europe: Portugal, Spain and the Nordic countries. Within the SEFI EER SIG, ongoing work by the workshop organisers is studying how national contexts influence the EER output in different European countries.

Workshop Aims

to share with participants scientometric data on EER publication output and research careers across Europe;

to guide participants to situate this scientometric data in the light of their knowledge of their own institutional and national context and to compare international contexts;

to learn from participants new insights that broaden the base of relevant EER data from across Europe.

Workshop structure

Participant introduction activity

Plenary session: presentation of scientometric data on EER publications and careers in European countries

Group activity: participants work in international breakout groups to compare and contrast the EER landscapes in their own countries

Plenary session: report back from group activity

Wrap-up, including discussion on any follow-up to workshop

References

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Keywords:

Mapping, Engineering Education Research, Europe

WORKSHOPS:

ID:

1366

Topic:

Cooperation for Development
Engineering Skills

Title:

MONDRAGON ZTIM HUB: thematic challenges to promote STEM vocations among students

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Vivar Simon, María (6)

Abstract:

The term STEM is one of the most commonly heard concepts in both education and business when talking about the needs of the future (Li et al., 2020). One of the challenges facing our society is the lack of motivation and interest in STEM disciplines and careers by young people, especially girls (McKinsey Global Institute analysis, 2020). The traditional approach and the use of expository strategies (Hernández-Serrano & Muñoz-Rodríguez, 2020) and the instruction in these subjects, organized toward more complex topics, (Rosenzweig & Wigfield, 2020) are factors that create loss of interest toward STEM disciplines.

Moreover, the implementation of STEM initiatives in education is not easy due to the need for change that is required with respect to the current dynamics in the classroom. In order to achieve greater interest in these disciplines, it is necessary to employ a practical and constructivist approach to learning through interdisciplinarity, the development of practice contexts, and new and adapted teaching materials (Valero-Matas & Coca-Jiménez, 2021). For this reason, it is necessary to generate initiatives to help schools implement STEM activities. In this sense, the MONDRAGON ZTIM HUB project has been set up to promote STEM vocations. The main aim is to promote STEM vocations among young people as a tool for providing scientific-technological solutions to the different challenges facing our society. It is a network of interconnected agents, schools, socio-economic agents and town councils that work at a local level to develop STEM activities in both curricular and extracurricular areas.

The aim of the workshop is to present one of the activities developed as part of the MONDRAGON ZTIM HUB initiative. The activity, based on thematic challenges, targets secondary school students. In this case, four challenges have been proposed, each one designed, ad-hoc, for each of the four academic years.

In order to design the activity, it is of prime importance to take into account the curriculum associated with the academic year chosen, such as the area of renewable energies in the second year of high school. All of them cover skills related to mathematics, science and technology but also aim to promote transversal skills such as teamwork, creativity, problem solving or communication.

These thematic challenges are designed taking into account the Challenged based learning (CBL) methodology (Nichols et al., 2016) and specifically the ETHAZI model (TEKNIKA, 2020), which is organized around collaborative learning based on challenges,

this being the central element. The main value contribution of the challenges is the participation of external agents through pills or parallel actions to the challenge that allow students to acquire the knowledge or inspiration necessary to face the challenge. These will provide context and tools for their development. In short, the purpose is to bring the reality of the professions to generate solutions to a challenge in a collaborative way. This will facilitate the transition and approach to the world of the STEM professions, improving their professional development through the acquisition of technical and specifically engineering skills and improving their future employability.

Key words: STEM education, Challenge based learning, STEM projects, Secondary Education.

Keywords:

STEM education, Challenge based learning, STEM projects, Secondary Education

WORKSHOPS:

ID:

1369

Topic:

Digitalisation & Hybrid models
Assessment

Title:

Using Peer Assessment in Inclusive Digital Education

Authors:

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van Helden, Gitte (1,3);
van der Werf, Vivian (2,3);
Specht, Marcus (1,2,3)

Abstract:

This workshop is part of the ERASMUS+ project: RAPIDE: on Relevant Assessment and pedagogies for Inclusive Digital Education (<https://rapide-project.eu>) and is open to anyone who is interested in implementing or improving peer assessment in their courses. At the end of the workshop, participants will be able to make an informed decision on a suitable form of Peer Assessment for their courses.

Over the past few years, many of us have faced operating in a frequently changing teaching environment which has made evaluating and assessing students' learning outcomes and more importantly giving students feedback on their learning much more complicated.

One pedagogical tool that has been increasingly used is that of peer assessments where students give each other feedback and assess each other's work.

In this workshop, participants will be introduced to many different types of peer assessment that can be used in engineering education, such as peer reviewing (each other's work), peer grading (continuous feedback on mastery), and peer evaluation (group work) whether face-to-face, hybrid or in a fully online environment and how to do so in an inclusive way thus maintaining the important safe place that education should be.

Participants will then in small groups discuss what types of peer evaluations they use or want to use in their courses and brainstorm on ideas for implementation in their own specific case or for one of the general cases that the facilitators will have available.

At the end of the workshop participants will present their main findings back to the whole group so that they may also learn from each other. We aim for participants to leave feeling inspired at the end of the workshop to implement or improve peer assessment in their own courses.

The aggregated main findings and ideas contrived in the workshop on how to implement peer assessment will also be shared with a wider audience through the conference proceedings and the RAPIDE project website.

Keywords:

Peer assessment, Peer Evaluation, Hybrid Learning, Blended Learning

WORKSHOPS:

ID:

1410

Topic:

Lifelong Learning

Title:

The role of lecturers in engineering students' personal development process and the promotion of lifelong learning competencies

Authors:

Naukkarinen, Johanna (1);

Van Den Broeck, Lynn (2);

Craps, Sofie (2);

Beagon, Una (3)

Abstract:

Professional engineers need to continuously update and up-skill their competencies, to keep pace with the changing technology and shifting requirements of the labour market (European Commission 2019). Educating resilient students requires a university setting that makes them aware of their professional identity and trains them in continuously re-inventing themselves (Knapper and Cropley 2000). Hence, the educational challenge is not only to prepare students for a specific career but also to build foundations for a lifetime of learning (Kamp 2016). Although teaching staff often acknowledge the importance of Life Long Learning (LLL) competencies they do not necessarily feel adequately prepared to support students' personal development and lifelong learning skills. However, to support students and prepare them for a life of LLL, lecturers need to be more systematically and explicitly engaged in the students' personal development process.

Lecturers' ability to support students' career development is related to academics' attitudes and beliefs, teaching and learning approaches, as well as the challenges met by the staff (Amiet et al. 2021). In the contemporary rapidly changing world, engineering graduates emphasize the need for generalist competence, interpersonal skills, and constant learning over formal credentials and specific technical competencies in securing employment (Nilsson 2010). Academics also perceive that enhancing students' general skills supports their career development more than focusing on specific careers (Amiet et al. 2011).

Research has shown that different pedagogical approaches influence engineering students' development of self-regulated learning and, by extension, lifelong learning skills differently. Problem- and project-based learning tend to promote metacognitive self-regulation, critical thinking, and help-seeking, whereas lectures with active learning activities promote more effective use of time and study environment. (Lord et al. 2012.)

Some assessment and grading approaches even seem to undermine the types of goals associated with self-directed learning (Stolk et al. 2014) and may thus even inhibit the development of LLL competencies.

Although many academics recognize that they have a role in students' career development, they also call for the responsibility to be shared among students, lecturers, and professional staff. Lecturers with limited work experience outside university especially felt that they lacked confidence in supporting students' career development. Many academics also felt guilty for not being able to meet the students' expectations for support. They suggested that the responsibility for supporting students' career development should be better acknowledged in academic job descriptions and promotional guidelines, as well as being supported with faculty and university-level resources. (Amiet et al. 2011.)

This workshop launches the Erasmus+ TRAINeng -PDP project which focusses on how we can help students develop LLL competencies and support lecturers by designing and creating appropriate training materials. To begin, we must first collect and discuss a wide array of perceptions regarding the role, responsibilities, resources, opportunities, and challenges of engineering lecturers to support the students' personal development process and a lifelong learning attitude. Hence, we call the SEFI community for assistance.

The workshop consists of a short introduction to the topic followed by collaborative work and discussion in groups in the form of learning café. The discussions will address questions like: What are the roles and responsibilities of lecturers in supporting the development of engineering students' LLL competencies?, Which forms of instruction and assessment have been used to promote LLL competencies?, What kind of resources do lecturers have/need to sufficiently support students' LLL competencies? No prior knowledge of LLL is required. We welcome workshop attendants from all engineering disciplines and all levels of engineering education.

The results of the workshop will inform the pilot projects, attitudinal survey, and training materials which will form the outcome of this project. Workshop participants will come away with a better understanding of the challenges and the opportunities that lecturers have in supporting students in developing the competencies required for a successful future.

The key findings from the workshop will be included in the conference proceedings. All workshop participants will receive a summary report after the conference highlighting the findings from the discussions including best practice examples.

References

Amiet, D., Choate, J., Hoskin, J., and J. Dart (2021) Exploring attitudes, beliefs, and practices of academic staff towards undergraduate career development in non-vocational courses, *Higher Education Research & Development* 40:5, 885–900, DOI: 10.1080/07294360.2020.1799952

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Stolk, J, Martello, R., Koehler, K., Chen K.C., and R. Herter (2014) Well, That Didn't Work. A Troubled Attempt to Quantitatively Measure Engineering Students' Lifelong Learning Development Over Two Years of College. *Proceedings of the IEEE Frontiers in Education Conference*, Madrid 22-25 October 2014.

Keywords:

personal development process, lifelong learning, role of faculty

WORKSHOPS:

ID:

1428

Topic:

Building Communities and Coordination
Mentorship and Tutorship

Title:

Career Development Workshop for Education-focussed Academics

Authors:

Nyamapfene, Abel (1);
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Tilley, Emanuela (1);
Mitchell, John (1)

Abstract:

Career Development Workshop for Education-focused Academics Overview

The workshop will give an overview of recent developments in education-focused academic career pathways, with specific reference to engineering disciplines. Workshop participants will discuss strategies for developing their academic careers through teaching excellence, Engineering Education Research (EER) and SOTL (Scholarship of Teaching and Learning), and leadership in Engineering Education. The workshop will also discuss how engineering schools can improve the support they offer to their education-focused academics.

Background and rationale

The number of academics in the UK (United Kingdom) employed on education/teaching-only contracts (as opposed to joint research and teaching contracts) has increased steadily since the turn of the century. In 2020/21, 32 percent of all UK academics were on teaching-only contracts [1]. The growth in the number of academics on teaching-only contracts appears to be part of an international trend within Europe, Northern America, and Australia driven by changes in the higher education environment such as the massification of higher education, cuts to higher education funding, research funding selectivity, and marketisation of higher education. These changes have led to institutions restructuring and adopting new strategies to ensure survival, including the increased casualisation of academic staff, and the introduction of separate academic contracts for research, education, and research and education [2].

The introduction of teaching-only academic contracts has led to the development of education-focused career pathways with opportunities for promotion to senior academic roles based on teaching excellence, scholarship, professional practice, and education leadership. However, the newness of such pathways means that there is a shortage of education-focused senior academics to provide role models and mentoring for junior academics seeking promotion to senior grades. This is further compounded by uncertainty and lack of consensus on what counts as evidence of good education practice, particularly when considering promotion to senior grades [3, 4].

The SEFI conference brings together academics of all levels and contracts with an interest in Engineering Education, including academics on education-focused career pathways. The workshop seeks to take advantage of this by bringing together these individuals, with those among us who hold senior leadership roles, to discuss and share ideas, experiences, and insights into developing successful education-focused academic careers. It is hoped

that this workshop will help participants to establish supportive networks that will continue to exist beyond the conference.

Audience

Engineering academics on education-focused career pathways, and senior academics with line management for such academics and/or educational leadership and career promotion responsibilities within higher education institutions.

Timeline

Education-focused Academic Career Pathways – 10 minutes

Content outline:

Discuss the unbundling of the academic role into specialised functions focussing on research, education (teaching and learning) and service (to include a brief overview of the underlying factors driving this change).

Identify the emergence of education-focused distinct academic career pathways in individual universities

Highlight the challenges and opportunities for establishing an equitable career progression for education-focused academics in different universities and countries.

Discuss similarities and difference of the academic profession in various countries.

Career Progression through Excellence in Education Practice - 10 minutes

Content outline:

Discuss the contested concept of teaching/education excellence in higher education

Discuss national frameworks for recognising teaching/education excellence, e.g., the UK Professional Standards Framework (UKPSF).

Discuss the use of teaching/education excellence frameworks in developing institutional teaching-based promotion criteria for academic staff

Establishing an EER and Scholarship Career – Strategies, Challenges & Opportunities - 10 minutes

Content outline:

Discuss how EER (and SOTL) is defined and supported within individual higher education institutions and national higher education systems

Identify and discuss challenges in developing and supporting EER (and SOTL) for promotion and recognition

Discuss and propose strategies for evidencing EER attainments in institutional promotional criteria

Establishing an Education Leadership Career- Strategies, Challenges & Opportunities - 10 minutes

Discuss the extent to which education (teaching and learning) leadership is recognised as a valid form of academic leadership within higher education institutions, and within engineering disciplines

Discuss current institutional promotion policies and criteria with respect to promoting and rewarding those who teach and lead on education

Discuss emerging “good practices” in relation to promoting and rewarding education leaders within higher education institutions, and, specifically, within engineering disciplines

How Engineering Schools can support education-focused academics – 10 minutes

Discuss institutional and departmental policies and practices that support career development, promotion, and recognition for education-focused academics, including:

Fostering an inclusive academic culture that supports and encourages academics to play to their own strengths

Continuing professional development opportunities for education-focused academics

Promoting parity of esteem at all levels of the career ladder between education-focused academics and mainstream (research and teaching track) academics.

Wrap-up and closing comments – 10 minutes

Acknowledge emerging good practice in promoting and rewarding education-focused academics and identifying areas for collaborative research in this area.

Workshop organisation

The workshop will be organised as an interactive session in which participants are invited to actively contribute their experiences and insights in all the workshop segments. The workshop is intended to stimulate discussion amongst the workshop participants, with the hope of initiating collaborative research on academic careers and practices within engineering education.

References

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Keywords:

education-focussed academics, academic career framework, teaching-focussed academics, education-focussed career pathway

WORKSHOPS:

ID:

1475

Topic:

Mentorship and Tutorship
Curriculum Development

Title:

Reviewing Manuscripts in Engineering Education Research Journals: fairly, constructively, effectively

Authors:

Edström, Kristina (1);
Mitchell, John (2);
Male, Sally (3);
Bernhard, Jonte (4);
Chance, Shannon (5);
Nikolic, Sasha (6);
Roach, Kate (2);
Beagon, Una (5)

Abstract:

This session focuses on the peer review of journal manuscripts in the field of engineering education research. To the workshop we invite both experienced and new reviewers, and especially doctoral students in engineering education research.

The function of the peer review process is first to support fair decisions by helping journal editors identify which manuscripts most deserve to be published. The task is further to constructively support the authors in improving their manuscript before publication. It is through this process of selection and enhancement that the quality of the journal papers is safeguarded. By extension, this is how the whole research field can establish and maintain respect. Therefore, reviewers play a vital role – without peer review there can be no respected field.

It is a rewarding task to review manuscripts, as a lot can be learned from it. Not least when taking one's own manuscript from submission to successful publication, it is helpful to have experience of the editorial process also from the inside. However, reviewing can also be time consuming, making it a wise investment to improve one's skills to do it effectively.

After the workshop, participants will be able to:

Explain different quality criteria for scholarship in engineering education, and how to apply them

Highlight particular aspects of a manuscript that a reviewer should consider

Discuss how to support editors in making fair decisions and authors in improving their manuscripts

Consider how reviewers can spend their own time wisely

The workshop is facilitated by a team of editors of the leading journals:

European Journal of Engineering Education (SEFI)

IEEE Transactions on Education (IEEE)

Australasian Journal of Engineering Education (AAEE)

Workshop outline

Introductions

Brief introductions: participants and session leaders. [5 minutes]

The journals: aims and scope, review criteria and review process. [15 minutes]

Group activity

Make a poster in groups of four: “Advice for reviewers”. [30 minutes]

Vernissage (hanging the posters).

Synthesis

Plenary discussion of results. Editors’ picks. Collected wisdom and conclusions. [30 minutes]

Participants can sign up to receive documentation from the session, and to volunteer as reviewers for the journals.

Keywords:

sponsor, reviews, peer-reviewed, research, journal