Volume 41 Number 1 2025 ISSN 0949-149X

Contents

Contributions in: Contributions in: Mentorship, Modelling, Belonging, Argumentation, Simulation, AI, Innovation, Gender, Outreach, Virtual Reality, Health and Safety, Concept Maps, Assessment, STEM, Diversity, PBL, Curriculum Development, Academic Burnout, Learning Outcomes, Computer Science, Aerospace, Electrochemical Cells, Electrical Vehicles, Fluid Mechanics, Energy & Environment

Selective plating serves as a method for locally repairing structural components, offering practicality as technical engineers can apply it directly on-site. However, proper training is essential for operators to perform this process effectively. Mastery of the technique can take months and involves significant chemical and financial expenditures. Recognizing these challenges, virtual reality has emerged as a promising solution for cost-effective training. This study aims to explore the potential of virtual reality in surface manufacturing training and develop a selective plating training program. It was carried out by a group of M-level engineering students. The methodology comprised three phases: exploration, development, and improvement. In the exploration phase, knowledge about both virtual reality and selective plating was gathered. The development phase involved creating a prototype training scenario through collaboration with an industrial expert. Finally, in the improvement phase, 41 engineers in training from diverse backgrounds tried and assessed the educational training, identifying strengths, weaknesses, and potential future improvements. The selective plating training was divided into three parts: a main menu, a learning scenario to familiarize users with functions and controllers, and the selective plating training scenario simulating the deposition of cadmium onto an aircraft landing gear. Positive feedback regarding the benefits of the technical training was received, and suggestions for further enhancements were proposed.

Keywords: aerospace; simulation; programming; education; surface repair

This materials laboratory proposal for undergraduate students focuses on the analysis and optimization of the mechanical properties of continuous fiber-reinforced thermoplastic composites using additive manufacturing. Additive manufacturing is a versatile and useful manufacturing process for complex parts for which using traditional methods would be difficult or impossible to manufacture. Experimental data from mechanical tests, tensile strength, and fatigue will be investigated to characterize these compounds, using nylon as a matrix and different filling patterns and types of reinforcing fibers. Machine Learning will be applied to develop regressions and predict the mechanical behavior of compounds under different process parameters. The results show that machine learning models can accurately predict composite fatigue and have the potential for the design and optimization of composite materials manufactured by additive manufacturing. This lab will provide students with hands-on experience in material characterization, additive manufacturing, and the use of Machine Learning, contributing to the advancement in the field of materials and additive manufacturing for demanding engineering applications.

Keywords: mechanics of materials; fused deposition; reinforced thermoplastic composites; fatigue; artificial intelligence

Postdoctoral training holds an increasingly important position in securing high-impact research and academic positions in engineering and computer science. High-quality mentorship contributes to the success of postdoctoral trainees, but existing literature demonstrates postdocs from outside of the US, women, and racial minorities who experience stereotypes are provided less mentorship, and less successful outcomes than their white and male counterparts. Further, trainees who originate from outside of the US hold more than half of the postdoctoral positions in the US. Increasingly, funding agencies within the US require postdoctoral mentorship plans, but it is unclear to what end and if they are helpful or simply performative. Specifically, to date, no research has investigated the content of mentorship plans, their alignment to theory and existing research, or the needs of postdoctoral trainees particularly those from outside of the US, women, and racial minorities. As part of a larger project investigating postdoctoral mentorship, we analyzed 54 postdoctoral mentoring plans to identify how they align with recommendations from content supported by theory and literature. We find marginal alignment with best practices, with much room for improvement, including tailoring and specificity. From this work, a postdoctoral mentorship blueprint and rubric for plan evaluation are offered as tools to improve the uniqueness, specificity, and utility of mentorship plans.

Keywords: postdoctoral; mentorship; content analysis; engineering; computer science

The study aims to develop and examine the Project-Building Information Modeling (Pro-BIM) instructional strategy in improving BIM literacy for students in the fields of architecture, engineering, and construction. The participants consisted of two industrial BIM practitioners, two CEE instructors and 28 students enrolled in designed course were selected purposively for convenient sampling. This study adopted Design-Based Research (DBR) method. Data collection techniques included: (1) observation, (2) interview, (3) FGD, (4) test, and (5) documentation. Qualitative data analysis techniques were data collection, data presentation, and conclusion while quantitative data analysis techniques included descriptive analysis. The results indicated that: (1) analysis and exploration were literature review, design analysis, cost, and sustainability, (2) design and construction included six steps of Pro-BIM and the increasing of student's BIM literacy, and (3) evaluation and reflection included FGDs producing positive perceptions of students, lecturers, and educational practitioners. This study concludes that the Pro-BIM learning strategy is effective in

improving BIM literacy among AEC students through the integration of BIM technology into relevant courses. The study indicates that the integration of Pro-BIM learning strategies into the AEC higher education curriculum improves student's understanding and skills in applying BIM technology.

Keywords: project-building information modeling (PRO-BIM); building information modeling literacy; instructional strategy; project-based learning; design-based study

The COVID-19 pandemic caused numerous universities to conduct classes in Fall 2020 in remote formats, which may impact student's sense of belonging differently depending on their identity, especially since belonging is a construct largely comprised of feelings of social connectedness. This study explored how underrepresented groups in first-year engineering perceived their sense of belonging during these involuntary remote/hybrid courses. Quantitative data from a survey administered to the COVID cohort were compared to 3 prior pre-COVID cohorts to investigate COVID impacts, supplemented by several open-ended questions. Results showed that female engineering students had a significantly lower sense of belonging during COVID than their counterparts, and reported significantly more negative social experiences than men. Sense of belonging and positive/negative social experiences did not differ for students of different race or income, but the trending patterns suggested that there may have been differences that our measurements were not sensitive enough to fully capture. The online COVID experience also decreased the gap in sense of belonging between high- and low-income engineering students by diminishing sense of belonging for students from a high-income background compared to pre-COVID years.

Keywords: sense of belonging; first year engineering; COVID hybrid course; undergraduate students; social experiences

The Next Generation Science Standards (NGSS), Standards for K-12 Engineering Education, A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas, the National Center for Assessment in Higher Education (QIYAS) and the Saudi Council of Engineers (SCE), and Standards for Technological and Engineering Literacy (STEL) emphasize the importance of scientific discourse and argumentation in student learning, particularly through the scientific and engineering practices of engaging in argument from evidence. This paper analyzes trends in scientific argumentation research by reviewing studies from the ESERA conference proceedings between 2011 and 2021 using quantitative and qualitative approaches. The findings reveal that articles on argumentation and discourse constituted 3.8% to 6.6% of total publications, peaking at 6.6% in 2017. While no consistent patterns emerged in keyword usage, common themes included classroom discourse, argumentation, context, and learning processes. Over 60% of the articles focused on topics such as discourse analysis and student understanding, with qualitative methods dominating, accounting for about 75% of the studies. These results highlight the increasing significance of research in discourse and argumentation, aligning with contemporary trends emphasizing evidence-based practices, and suggest a continuing need to prioritize argumentation in science, technology, engineering, and mathematics (STEM) education to enhance student engagement and comprehension.

Keywords: argumentation; scientific discourse; science education; research trends; engineering education; systematic analysis

Social innovation is an approach to problem solving and design that focuses on increasing social value and minimizing suffering of marginalized groups. We report on a three-year effort to establish social innovation as a core professional competency among a small group of undergraduate engineers who are passionate about social justice issues. In this illustrative case study, multiple data sources are analyzed to understand the extent to which students view social innovation as accountable disciplinary knowledge for their future careers as engineers. Students perceived that engineers should make connections between their work and society by (1) identifying issues that cause marginalization, (2) working with communities experiencing marginalization in designing solutions, and (3) understanding policy. These findings indicate that exposure to social innovation could provide undergraduates an important opportunity to re-evaluate the knowledge required for professional engineers to have a positive impact on society.

Keywords: social innovation; social entrepreneurship; human-centered design

The reasons for the lack of gender diversity in computer science and engineering (CS&E) fields are nebulous, and past research has shown that disparities in spatial skills that predict pursuit of CS&E careers begin to develop in childhood. Because playing with spatial toys in childhood has been correlated with higher spatial skills, childhood toys have been hypothesized to influence career choice. To investigate correlations between childhood toy usage and career choice of adults, 960 participants were surveyed to collect information on career choice and retrospective childhood toy usage. When controlling for gender, there was not a significant correlation between playing with spatial toys and working in a CS&E career, in part due to the strong gender-stereotyping of both spatial toys and CS&E careers as masculine. The prevalence of masculine-stereotyped spatial toys highlights the importance of targeting K-12 STEM intervention and outreach toward a diverse range of students. From the gender-stereotype perspective, a significant correlation was found between women who played with more masculine-stereotyped toys as a child and women who do not work in feminine-stereotyped career fields, indicating a correlation between breaking gender stereotypes in toy usage as a girl and career selection as a woman. These findings justify the need for inclusivity in the marketing of toys and STEM outreach, as well as encouragement of breaking gender stereotypes in childhood play by parents and educators.

Keywords: gender stereotypes; CS&E career choice; K-12 outreach; toys; gender gap

This study examined an impedance learning methodology applicable to electrochemical cells using Microsoft (MS) Excel Software. MS Excel, a tool commonly used by practitioners in chemical engineering, can provide an educational platform for analysing and understanding the complex impedance characteristics of electrochemical cells. The impedance learning method using MS Excel aims to increase the efficiency of impedance education by providing a user-friendly interface for beginners and experts in electrochemistry. This paper proposes using the MS Excel functions to simplify data input, processing, and interpretation for each component within the various impedance circuit patterns in electrochemical cells. This information caters to students aspiring to engage in the research and development of next-generation electrochemical cells, serving as an educational resource for grasping the concept of impedance with ease. This study will also be helpful to researchers in various application fields, including the development of electrochemical sensors and energy storage systems.

Keywords: impedance learning; electrochemical cell; Microsoft Excel; simulation

also recognized. Ultimately, the study advocates for transformative practices to improve the quality of STEM education, emphasizing the need for evidence-based methodologies in curriculum development, such as teacher preparation. In this context, the success of an educational system is shaped by the quality of its teachers.

Keywords: expert teachers' perspectives; STEM activities; phenomenology study; science education