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Contributions in: Accreditation, Belonging, Biomechanics, Civil Engineering, Course Relevance, Design Thinking, Direct Pathways, Engineering Ethics, Entrepreneurship, Faculty Adaptability, First-Year Students, Flipped Classroom, Graduate Education, Innovation, International Students, Learning Outcomes, Legal Skills, Motivation, Personalized Learning, Self-Efficacy, Assessment, Software Engineering, Student Absenteeism, Teaching Evaluation, Team Characteristics

This study examined how students' motivation and learning strategies changed throughout a semester in a flipped laboratory course and how these changes related to learning outcomes and students' perceptions. A flipped learning design was implemented in an electronic engineering laboratory course with 67 undergraduate students, and surveys on learning motivation and strategies were conducted at three stages during the semester. Repeated measures ANOVA results showed significant increases in intrinsic and extrinsic goal orientation, task value, and self-efficacy, while among learning strategies, elaboration increased and peer learning decreased. Regression analyses revealed that increases in task value and self-efficacy significantly predicted the total course score, and changes across all motivational and strategic subscales were positively associated with perceived achievement. The qualitative analysis identified three types of student perceptions – positive, negative, and mixed. Students valued the connection between theory and practice, deeper engagement in experiments, and increased motivation. They also reported challenges such as heavy workload and limited laboratory infrastructure, while perceptions of collaboration reflected both benefits and challenges. These findings suggest that flipped learning serves as an effective instructional strategy for enhancing students' motivation and strategic engagement in laboratory-based engineering education and offer insights that may inform future research and instructional design in experimental learning contexts.

Keywords: flipped learning; flipped laboratory course; laboratory instruction; learning motivation; learning strategies; learning trajectory

Absenteeism is an increasing concern at public universities, yet reliable figures, context-dependent correlations, and effective strategies to reduce it remain scarce. This study, conducted within a teaching innovation project at a large public engineering university in Spain, investigates how context influences absenteeism, whether specific student profiles are more prone to miss lessons, and the role educators play in mitigating the problem through active learning methodologies. A mixed-methods approach was adopted, combining quantitative and qualitative data collected from multiple stakeholders. Quantitative data were obtained through online surveys administered to 2,069 undergraduate engineering students across three academic semesters, attendance monitoring of 23 courses, and surveys completed by 461 faculty members and 82 industry representatives. Qualitative data were gathered through semi-structured interviews with 25 students identified as frequent absentees, educators' self-reflection reports from 11 courses, and a structured compilation of good teaching practices. Data analysis was conducted in two phases: an initial descriptive analysis followed by the development of explanatory models. Results confirm previous findings that passive teaching methodologies are the primary driver of absenteeism, though nuances such as perceived difficulty and limited personalized support also contribute significantly. The findings highlight that while teachers play a crucial – though not exclusive – role in reducing absenteeism, broader contextual factors must also be addressed. Based on these insights, the study proposes a mitigation plan centred on faculty training to adopt active learning strategies in large classes, with the potential for extrapolation to other institutions facing similar challenges.

Keywords: absenteeism; students' and teachers' perceptions; active learning; evidence-based practice; employability skills

This article explores students' descriptions of the challenges they experienced during a first-year engineering programming course. Programming and computational thinking are vital skills for engineering students, and these skills are affected by the context surrounding students while they learn. In this study, we allowed students in focus groups to holistically describe the challenges they experienced while learning MATLAB and reflect on the effects they attributed to those challenging experiences during focus groups. The research team conducted six focus groups with 29 students across two institutions with similar first-year engineering programming courses. Emergent thematic coding identified challenges associated with learning MATLAB itself, working in a social environment of peers with different levels of prior experience, navigating course policies and logistics, and, for some, dealing with gendered expectations and experiences. These challenges informed the ways in which students discussed what it meant to succeed and belong in engineering. This work has implications for the messages that are presented to first-year engineering students to help them feel like they can succeed in engineering.

Keywords: undergraduate students; challenges; teaming; belonging; programming

To achieve high-quality Internet of Things (IoT) education, Asia-Pacific countries have placed greater demands on engineering students' problem-solving abilities and innovative practices. However, the traditional approach has struggled to satisfy the needs of talent training. To this end, this paper proposes a hybrid teaching model that integrates the semi-flipped classroom and Bridge-in, Objective, Pre-assessment, Participatory learning, Post-assessment, and Summary (BOPPPS) framework. For validation, a quasi-experimental study was conducted with 100 IoT engineering students, who were divided into a control group (n = 50) receiving traditional lecture-based instruction and an experimental group (n = 50) undergoing the hybrid teaching model. Data were collected through psychometrically validated satisfaction surveys (Cronbach's α = 0.938) and pre-test/post-test assessments across ten instructional modules. Quantitative analysis employed independent-samples t-tests and chi-square tests (significance threshold: $p < 0.05$). The evaluation results demonstrate that over 90% of students are satisfied with the teaching method, content design, and equipment resources. Meanwhile, the student approval rating regarding learning interest, professional ability, and classroom participation has exceeded 90%. Furthermore, the comparison of pre-test and post-test accuracy in the experimental group shows an improvement of approximately 20%, with statistically significant differences favoring the experimental group. Such impressive performances reveal that the hybrid teaching model not only enhances students' engineering innovation abilities and learning initiative but also holds significant value for improving the quality of related programs in engineering education.

Keywords: IoT; semi-flipped classroom; BOPPPS; teaching model; hardware technology; engineering education

Challenges continue to exist for engineering faculty to adopt and scale research-based pedagogies and interventions. Using qualitative research design, we address the question of "How do faculty respond to curricular change, as exhibited in their activities of planning, adjusting, and reflecting during change?" In this work, faculty adaptability is conceptualized as self-regulation during curricular change. Faculty participants were recruited from two divergent curricular change contexts: one that is prescribed with interdependence while the other is emergent with uncertainty. We found that the *willingness* of faculty to adapt during curricular change is nuanced and can be described along six dimensions. Specifically, faculty *willingness for planning* is shown to have different levels of (1) forming an intention to change and (2) allocating time and effort for change. Also, faculty *willingness for*

adjusting is demonstrated as (3) willingness to change one's behavior and (4) the willingness to catalyze efforts for change. In addition, faculty *willingness for reflecting* is characterized as (5) observing one's performance and (6) monitoring task-context relationship. Furthermore, and most importantly, we found that the relationship among these adaptability phases is hierarchical: the more a faculty member is involved in the different phases, the more awareness they are showing for adaptability for change. This work contributes to our understanding of the enablers and barriers for engineering faculty to adapt during curricular change.

Keywords: adaptability; curricular change; faculty roles; self-regulation

Intelligent Tutoring Systems (ITS) are increasingly used in higher education to provide adaptive instruction, real-time feedback, and individualized learning support. This scoping review examines how ITS influence student engagement and learning outcomes in engineering education and closely related technical disciplines, and identifies barriers to adoption and ethical concerns. A rigorous search strategy was employed to identify studies on ITS in higher education from databases including Web of Science, Scopus, and IEEE Xplore., Data from relevant studies were extracted and analyzed using thematic analysis. Following the screening process, 31 studies were included in the review. Across these studies, 22 tutoring systems were synthesized (12 ITS and 10 affective tutoring systems). The findings indicate that ITS are most effective in structured, problem-solving–intensive domains such as programming and electrical engineering, where adaptive feedback, mastery progression, and knowledge tracing align with well-defined solution pathways. Affective tutoring systems show consistent benefits for motivation, engagement, and emotional regulation in high-load learning contexts, although performance gains are more variable and depend on task structure and cognitive scaffolding. Key barriers to broader implementation include scalability across disciplines, development and maintenance demands, instructor trust and transparency, and ethical issues related to data privacy and algorithmic bias. Overall, ITS offer strong potential to support engineering learning when integrated as complementary tools that enhance cognitive and affective dimensions of student learning.

Keywords: intelligent tutoring systems; personalized learning; affective tutoring systems (ATS); higher education; engineering education; student engagement; learner performance

Some graduate engineering students, called direct pathway students, go directly into their graduate education after completing their undergraduate degree or complete these degrees alongside one another. Other graduate engineering students, called returners, spend a significant amount of time in industry before returning to school. The focus of this study was to compare and contrast these two demographics in regard to information retention, recovery of lost information, and learning of new information. All students forget similar amounts and types of information. Retention is based in initial mindset, interest in the topic, and frequency of use; fundamental information and concepts also tend to be retained. Twenty direct pathway and twenty-one returner graduate engineering students were interviewed in person. Differences were found in how students learn new information. Returners attempt to fit information in with what they already know, whereas direct pathway students spend more time searching for applications for new information. Returners were also found to have many advantages due to their work experience, whereas direct pathway students were found to have the advantage of more flexible life circumstances.

Keywords: direct pathway; graduate engineering education; returner

ABET has established a globally recognized framework for assuring the quality of undergraduate and master's programs in engineering, computing, and technology. However, no equivalent accreditation model exists for doctoral programs, despite the increasing importance of research-based education, interdisciplinarity, and societal impact. This paper explores the feasibility and potential framework for extending ABET accreditation to PhD programs in engineering. It analyzes current ABET criteria, contrasts them with existing doctoral-level quality assurance models (e.g., EUR-ACE, QAA, and national qualification frameworks), and proposes a new set of Doctoral Student Outcomes (DSOs) emphasizing originality, ethical research practice, leadership, innovation, and global impact. A conceptual "Doctoral Program Accreditation Framework" (DPAF) is presented, outlining governance, assessment mechanisms, and integration pathways with ABET's continuous improvement model. The paper concludes by discussing challenges, implementation strategies, and implications for global engineering education reform.

Keywords: ABET accreditation; PhD; quality assurance; engineering education; outcome-based framework; research impact

Engineering ethics education in China has gradually but significantly evolved in response to national policies and the demands of industrialization. This study uses a mixed-methods case study design to investigate a decade-long reform initiative at a university in Shanghai. Enrollment records and course evaluation surveys collected between 2014 and 2024 – encompassing data from approximately 7,500 students and 850 survey responses – were analyzed, and this quantitative analysis was supplemented with qualitative thematic analysis of institutional and pedagogical documents. The transition period of engineering ethics was traced from its beginnings as an elective course to a mandatory general-education course when the key reforms were implemented. Before and after the curriculum reform, questionnaires were administered to students during class sessions to collect feedback. Comparative analysis revealed that students' in-class participation had doubled over the course of the reform. Enrollment figures increased dramatically to more than 1,000 students annually once engineering ethics education became a requirement of the national engineering education standard. Additionally, a faculty pool was established, including both industrial experts and academic faculty, to solve constraints related to teaching resources. The "Shanghai Case" exemplifies a successful model for engineering ethics education that effectively synergizes policy mandates with pedagogical innovation and collaboration between academia and industry. This approach successfully bridged the gap between theory and practice, providing a replicable framework model for engineering ethics education in other countries or regions undergoing rapid development.

Keywords: engineering ethics; education reform; case teaching; policy coordination; industry-education integration

The presented study validates an engineering-entrepreneurial self-efficacy (E-ESE) instrument among engineering students. Although several survey instruments have been developed to measure entrepreneurship outcomes, they have been developed for and validated with business school students and nascent entrepreneurs, leading to a lack of validated instruments to measure entrepreneurship outcomes in engineering education. The study aims to answer two research questions: First, what is the latent factor structure of an Engineering Entrepreneurial Self-Efficacy (E-ESE) instrument for engineering students? And second, what are the psychometric properties (validity and reliability) of the E-ESE instrument? The analysis was conducted in three phases, with data collected from two institutes in the United States. The first phase involved a review of existing survey instruments and revising the items based on pilot exploratory factor analysis (EFA) results and stakeholder feedback. The second phase includes data

collection at Institute 1 (85 responses) and conducting an EFA to identify the latent factor structure. The third phase includes performing a confirmatory factor analysis using data from two institutes (212 responses) to verify the underlying structure of the five latent variables (searching, planning, marshaling, implementing people, and implementing finance), and evaluating reliability using Cronbach's alpha. The findings reveal a five-factor solution for the E-ESE instrument that is refined for engineering education with psychometric properties (validity and reliability) meeting requisite standards. The study discusses the implications of the results for engineering entrepreneurship education and provides guidance for future work.

Keywords: entrepreneurship education; instrument development; entrepreneurial self-efficacy; engineering education

This study investigates the effects of traditional teaching and competency-based teaching on the development of managerial competencies among first-year engineering students, examining if and how those effects are moderated by individual characteristics such as achievement motivation and student engagement. The competencies examined were self-awareness, effective teamwork, leading positive change, and supportive communication. The experimental design included a control group exposed to traditional teaching methods and an experimental to competency-based, with 25 participants in each group. Instruction lasted five weeks and included four structured training sessions, with data collected pre- and post-intervention. Results revealed no significant differences between the two groups, indicating that the teaching method itself did not determine competencies development. However, student engagement showed a significant positive correlation with competencies gains, highlighting its role as a key factor in fostering managerial skill development. The study contributes empirical evidence on the conditions that support the early integration of managerial competencies in engineering education and emphasizes the importance of fostering student engagement as a driver of learning outcomes.

Keywords: engineering education; managerial competencies; competency-based instruction; achievement motivation; student engagement; experimental study

This study investigates the integration of Generative Artificial Intelligence (GenAI) into programming education and its impact on students' learning outcomes, motivation, and algorithmic thinking. The objective is to develop and empirically evaluate a digital assessment framework that supports the responsible use of AI tools while preserving independent cognitive processes. The research is based on a pedagogical experiment involving 365 participants, including students and instructors from higher education institutions. Data were collected through a structured survey and analyzed using descriptive statistical methods and content analysis. The results indicate that a significant proportion of students actively use GenAI tools, with ChatGPT being the most dominant platform. Approximately 63% of students reported a positive impact of AI on their programming skills, while 83.5% expressed high satisfaction with practical tasks implemented in a digital assessment environment. At the same time, the findings reveal concerns regarding overreliance on AI, which may reduce independent problem-solving abilities and weaken algorithmic thinking. The study proposes a pedagogically grounded framework and structured strategies for integrating AI into programming education, balancing technological support with the development of critical and analytical skills. The results contribute to the design of effective digital assessment environments in the era of AI-driven education.

Keywords: GenAI; programming knowledge assessment; algorithmic thinking; feedback; programming knowledge control

This study examines 25 teaching evaluation policy documents issued by engineering-advantaged universities in China through a two-dimensional analytical framework integrating policy instruments and evaluation elements. The analysis reveals that existing policies are characterized by an overreliance on mandates, an imbalanced alignment of evaluation elements, and a systematic misalignment between policy instruments and evaluation elements. These features indicate a policy design logic predominantly shaped by managerialism, accountability-driven governance, and an emphasis on administrative efficiency. Therefore, the refinement of teaching evaluation policies in China's engineering education should focus on optimizing the structure of policy instruments to better balance faculty teaching autonomy and institutional constraints, improving the scientific design of evaluation elements to promote development-oriented teaching evaluation, and strengthening the alignment between policy instruments and evaluation elements to enhance the effectiveness of teaching evaluation. From a policy perspective, this study contributes to research on teaching evaluation in engineering education and offers empirically grounded insights for improving policy design in support of high-quality engineering education.

Keywords: engineering education; teaching evaluation; policy preferences; China

The rapid advancement of artificial intelligence (AI) is profoundly reshaping the landscape of engineering education, driving significant transformations in teaching paradigms, disciplinary structures, and competency development. To systematically explore the intellectual structure and evolutionary trends of AI-driven innovation in engineering education, this study conducts a scientometric analysis based on 884 publications retrieved from the Web of Science Core Collection spanning 1998 to 2025. A four-stage analytical framework integrating bibliometric analysis, Latent Dirichlet Allocation (LDA) topic modeling, and regression analysis is employed to reveal the knowledge structure, thematic evolution, and developmental trajectory of the research field. The results demonstrate a marked and accelerating growth in AI-related engineering education research, particularly after 2020, reflecting the growing integration of AI technologies in educational contexts. Bibliometric mapping identifies key contributors, collaborative networks, and influential journals that shape the domain. LDA modeling further uncovers eight major research topics, which are consolidated into three higher-order dimensions: technological innovation in teaching and learning environments, disciplinary reconstruction through interdisciplinary integration, and systemic transformation of educational governance and assessment mechanisms. Regression analysis confirms a statistically significant upward trend in research attention across these thematic clusters. This study not only provides a comprehensive overview of the global research landscape of AI-enabled engineering education, but also offers a structured analytical framework for understanding its evolution. The findings deliver practical insights for educators, curriculum designers, and policymakers seeking to strategically integrate AI into engineering education, supporting the development of future-oriented competencies and resilient educational systems.

Keywords: artificial intelligence; engineering education; scientometric analysis; LDA topic modeling; educational innovation