

# The International Journal of Engineering Education

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### Contributions in: Women in Engineering, Creativity, Personality Traits, Socio-Emotional Competencies, Student Confidence, Misconceptions, Mathematical Thinking, Final Examination Formats, Intelligent Fuzzy Assessment, Transdisciplinary Practice, Distance Learning, Software Engineering, Professional Practice

- Ahmad Ibrahim** 1 Editorial
- Pao-Nan Chou and Wei-Fan Chen** 2–11 Female Engineering Students' Perceptions of College Learning Experiences: A Qualitative Case Study in Taiwan
- This study investigated female engineering students' perceptions of college learning experiences by using the pipeline theory. One-hour qualitative interviews were conducted to obtain details of female engineering students' learning experiences. Thirty female students of engineering from various engineering majors voluntarily participated in the study. The participants were senior college students from two public universities in Taiwan. Phenomenological qualitative analysis was used to identify five themes in "the motivation for pursuing an engineering major", seven themes in "learning experiences during higher education period", and four themes in "future career development". Overall, most of findings were supported by previous research results.
- Keywords:** women in engineering; gender study; learning minority; pipeline theory; qualitative research
- Chunfang Zhou and Jiannong Shi** 12–22 A Cross-Cultural Perspective to Creativity in Engineering Education in Problem-Based Learning (PBL) between Denmark and China
- This paper takes a cross-cultural perspective to link a study on creativity development in engineering education in a Problem-Based Learning (PBL) in Denmark and its implications for fostering creative engineers in China. The analysis of empirical data, drawn from a Ph.D. study (2008–2012), aims to answer the two research questions: (1) what are the advantages and disadvantages of PBL in fostering creative engineering students in the Danish context? and (2) what are the cross-cultural implications of fostering creativity in engineering education by PBL in Denmark for China? The results suggest that in the Danish context, PBL is helpful for creativity development by stimulating motivation, developing skills such as communication, critical thinking, leadership, etc. But disadvantages exist, such as students having poor conceptualization of creativity and poor confidence in being creative. This has an implication in China: PBL requires that the relationships between teachers and students and between students needs to be reconstructed. To break the Chinese culture's barriers to creativity is the key to reconstructing these relationships.
- Keywords:** creativity; Problem-Based Learning (PBL); engineering education; cross-culture study
- Ju-Sen Lin, Chao-Tung Liang, Wen-Shan Chang and Chaoyun Liang** 23–32 Relation between Personality Traits and Imaginative Capability of Engineering Students
- In this study, we examined the curvilinear effects of personality traits on the imaginative capability of engineering students. The participants in this study consisted of 503 engineering majors. The results indicated that all of the traits assessed exhibited various curvilinear relationships with imaginative capability, except for 'extraversion', which exhibited only a direct effect on initiating imagination. A curvilinear effect of 'openness' for an inverted U-shaped relationship influenced conceiving imagination. 'Neuroticism' exhibited direct and curvilinear relationships for an inverted U-form with conceiving imagination. 'Conscientiousness' exhibited direct and curvilinear effects and an inverted U-shaped relationship with conceiving imagination. In addition, conceiving imagination increased with the 'agreeableness' score, and their association revealed a U-shaped curvilinear relationship. The results of this study are pivotal for student selection and guidance, and crucial for the pre-employment assessments of people seeking jobs in the engineering field.
- Keywords:** curvilinear effects; engineering education; imaginative capability; personality traits
- Daniel López-Fernández, Victoria Lapuerta and M<sup>a</sup> Luisa Casado** 33–41 Socio-Emotional Competences at University: Optimization of Learning and Professional Competitiveness of Engineering Students
- This paper gathers the actions developed in the context of several educational innovation projects carried out at the Technical University of Madrid (UPM) whose aim has been the improvement of the socio-emotional competences of both students and teachers. These competences are very useful for the teacher in class, as they help him or her to create an atmosphere that supports student's learning as well as for the students who can optimize their academic achievement when their emotional world works in their favor. Moreover, when they start their professional career, these socio-emotional competences, as much as technical training, will allow them to increase their competitiveness in companies. Nowadays, in the business world, the ability to establish healthy relationships with oneself and with others with initiative, self confidence, flexibility and other personal qualities directly related to emotional intelligence are increasingly appreciated. This paper is focused on the work related to students.
- Keywords:** transversal competences; emotional competences; emotional intelligence; coaching
- Hyunyi Jung, Heidi A. Diefes-Dux, Aladar K. Horvath, Kelsey Joy Rodgers and Monica E. Cardella** 42–57 Characteristics of Feedback that Influence Student Confidence and Performance during Mathematical Modeling

This study focuses on characteristics of written feedback that influence students' performance and confidence in addressing the mathematical complexity embedded in a Model-Eliciting Activity (MEA). MEAs are authentic mathematical modeling problems that facilitate students' iterative development of solutions in a realistic context. We analyzed 132 first-year engineering students' confidence levels and mathematical model scores on a MEA (pre and post feedback), along with teaching assistant feedback given to the students. The findings show several examples of affective and cognitive feedback that students reported that they used to

revise their models. Students' performance and confidence in developing mathematical models can be increased when they are in an environment where they iteratively develop models based on effective feedback.

**Keywords:** confidence; feedback; mathematical model; performance

**Farrah Fayyaz, Ruth A. Streveler,  
Ashraf Iqbal and Muhammad Kamran**

58–71 Category Mistakes, Knowledge in Pieces, or Something Else? Problems in Conceptually Learning Signal Analysis

A thorough understanding of signal analysis is important for learning many specialized electrical engineering fields such as communication and digital signal processing. To date there has been a great deal of effort by engineering educators across the world to make this course easy to understand. However, the abstract and complex mathematical nature of the concepts involved in signal analysis and the disconnection of these concepts from daily life continue to pose a challenge in conceptually understanding signal analysis. This study addresses the mistakes and learning hurdles faced by electrical engineering undergraduate students while learning signal analysis and suggests possible reasons for these misconceptions and learning hurdles. The results of this study are established with the difficulties that appeared throughout the development of a detailed concept map of signal analysis using Fourier analysis techniques; during discussions with the experts in signal analysis; and from student responses to the questions in class tests and later during individual interviews. This study identifies the difficulties in conceptually learning signal analysis that arise from insufficient understanding of: (1) the difference between continuous and discrete domains, (2) discrete frequency, (3) units of Fourier series and Fourier transforms, (4) periodic/aperiodic or finite/infinite duration signals, (5) sampling, (6) aliasing and folding, (7) abstract mathematical concepts, and (8) advanced mathematical thinking ability. A few possible explanations for these learning hurdles are various p-prims, ontological miscategorization of discrete and continuous domain signals, and the lack of ability among students for advanced mathematical thinking. The knowledge of difficult concepts and the reasons behind the difficulties in learning signal analysis related topics is necessary for the design of an appropriate pedagogy for signal analysis related courses. While teaching signal analysis, careful attention to these learning hurdles and the possible related explanations will help to establish meaningful learning among students.

**Keywords:** misconceptions; Fourier analysis; p-prims; discrete frequency; advanced mathematical thinking; electrical engineering education; conceptual learning; signal analysis

**Garrick Aden-Buie, Autar Kaw and Ali Yalcin** 72–82 Comparison of Final Examination Formats in a Numerical Methods Course

With decreasing budgets for teaching assistants, large class sizes, and increased teaching loads, it is becoming ever more important to effectively utilize resources without sacrificing best practices of assessment. The objective of this study is to evaluate a hybrid multiple-choice final examination with optional partial credit (MC+PC) as a replacement for the same examination in constructed response (CR) or strict multiple-choice (MC) formats. In the hybrid MC+PC format, students were given multiple-choice options and were also allowed to submit constructed responses that would be graded for partial credit. The three examination formats were utilized once each in three offerings of a Numerical Methods course at the University of South Florida. Multiple linear regression and item analysis of student responses demonstrate that students approach the MC+PC format similarly to a CR exam, and the administrative requirements of the test were significantly reduced. This study finds the hybrid MC+PC format to be equally reliable and appropriate for a comprehensive final examination.

**Keywords:** final examination; examination formats; numerical methods

**Ahmet Fevzi Baba, F. Melis Cin and  
Emre Ordukaya**

83–93 Intelligent Fuzzy Assessment System for English Academic Writing in Engineering Education

This paper aims to address the objectivity and reliability of academic writing assessment through the rule based fuzzy logic assessment system and to show the feasibility of computer assisted assessment in language learning. In this study, first, a user-friendly and rule based intelligent fuzzy writing assessment software (IFWAS) system was developed. The designed IFWAS is based on the Fuzzy Group Decision Support System (FGDSS), which provides a score and diagnostic feedback to students. The system has a flexible database to form written reinforcing feedback addressed both to students' weaknesses and strengths in writing. Secondly, to see the efficacy of software in an educational setting, it was implemented to assess the academic English writing skills of 15 engineering students. The focus group interviews conducted with students and teachers after the empirical research underlined the importance of an objective and transparent assessment in learning; thus indicating that the educational use of software had positive pedagogical implications.

**Keywords:** multi-criteria fuzzy assessment; writing feedback; academic writing assessment; intelligent assessment

**Atila Ertas, Kellilynn M. Frias,  
Derrick Tate and Susan M. Back**

94–105 Shifting Engineering Education from Disciplinary to Transdisciplinary Practice

This paper examines current global challenges and the ways in which engineering education must adapt. In particular, the paper argues the need for a transdisciplinary approach to engineering education in which the methods, tools, concepts, and theories from multiple disciplines are integrated in a holistic manner to achieve a common understanding of complex issues, questions, or problems that incorporates both academic and non-academic knowledge. The paper contrasts interdisciplinary and transdisciplinary approaches based on experience at the undergraduate and graduate level in the College of Engineering at Texas Tech University. Based on successes with the graduate transdisciplinary program and student feedback, an outline for extending transdisciplinary education to undergraduate engineering programs is proposed, and questions for further research are identified. Two survey results on transdisciplinary education are also reported in this paper.

**Keywords:** transdisciplinary; interdisciplinary; engineering education

**Jafar Saniie, Erdal Oruklu,  
Richard Hanley, Vijay Anand  
and Tricha Anjali**

106–120 Transforming Computer Engineering Laboratory Courses for Distance Learning and Collaboration

Distance learning extends classroom access to students who are not physically present in the classroom. There are additional challenges when distance learning is applied in a laboratory environment. These challenges come from two broad categories: the ways in which students collaborate/communicate and the ways to virtualize the devices they use. In this investigation, a real-time collaborative educational framework is presented to address both the technical and ambient challenges. Multiple senior level laboratory design courses in computer engineering are included in the test trials. Analysis of how well students perform in the collaborative remote laboratory environment is given. Iterative refinement is discussed in order to ensure that remote laboratories do not negatively impact students' learning experience. Experimental trials suggest that there is a change in social dynamic that students work in when conducting experiments in a laboratory. A carefully designed social component is needed to create a successful team based learning experience in the laboratory.

**Keywords:** collaborative learning; computer and information science education; distance learning

**Hsiu-Ping Yueh, Yi-Lin Liu and  
Chaoyun Liang**

121–126 Impact of Distance Teaching Implementation, Online Material Guidance, and Teaching Effectiveness on Learning Outcomes

This study examined the influence of distance teaching implementation, online material guidance, and teaching effectiveness on student learning outcomes. The results indicated that both distance teaching implementation and online material guidance positively affect learning outcomes. These results supported the conclusion that the relationship between teaching effectiveness and

learning outcomes is curvilinear. The results also indicated that a competent instructor plays a crucial role in improving student learning outcomes in the distance learning context and revealed that the adoption of quality online materials should be based on the specific instructional objectives and learning strategies of each course. Furthermore, the interactive distance learning environment can reduce alienation and increase enrollment through videoconferencing.

**Keywords:** blended learning; distance teaching; engineering education; learning outcomes; online material; teaching effectiveness

**Goran Sekulić Ilija Antović, Siniša Vlajić, 127–140 Conceptual Model of Software Architecture in Instruction Java Web  
Saša Lazarević, Dušan Savić, Vojislav Frameworks  
Stanojević and Miloš Milić**

The purpose of this research is to determine appropriate methods for efficient learning and adoption of new software technologies. We considered Expert Modeling (EM) and Self Guided Modeling (SGM) approaches of Model Centered Instruction applied to learning Java Web Application frameworks. As a conceptual model we focused on software architecture, and thereby provided integral (expert) meta-model represented in 3D learning environment. To evaluate this approach, we conducted an experiment with two groups of students using the two different instruction approaches. Finally, we used statistical methods to determine whether there was an observable effect of the instructional approach that used the integral metamodel JSP Model 2 software architecture. Although the number of participants in the experiment was limited, our findings confirmed that the use of different Model Centered Instructions has significant impact on learning efficiency. Our experience shows that application of EM in learning Java Web application frameworks gives better results compared to those obtained by applying SGM.

**Keywords:** JSP Model 2 software architecture; conceptual models; 3D learning environments; mental models; model-centered instruction.

**Muhammad Rashid 141–153 System Level Approach for Computer Engineering Education**

The capstone design course is a culminating course that offers opportunities for students to acquire technical and soft skills in the context of a design project. Conventional curricula and lecture-based teaching methodologies are facing problems to address the challenges posed by industry-oriented projects. Consequently, this paper proposes a system level approach to the curriculum and integrates content-based learning with problem-based learning. Content-based learning consists of coherent delivery of core concepts and systematic laboratory sessions. Problem-based learning addresses the technical skills (such as problem formulation and system design) as well as the soft skills (such as communication skills, working in teams, lifelong learning and ethical/professional responsibility). The Digital System Design course in the Computer Engineering discipline serves as a case study. Assessment through student feedback and the analysis of quantitative data shows a significant improvement in student outcomes.

**Keywords:** system model; coherency of contents; systematic laboratory sessions; problem-based learning; soft skills

**Mark Steiner, Junichi Kanai, Cheng Hsu, 154–164 Preparing Engineering Students for Professional Practice: Using Capstone  
Eric H. Ledet, Jeff Morris, Mark Anderson, to Drive Continuous Improvement  
Scott Miller, Kurt Anderson and  
Bharat Bagepalli**

In this paper, we take the viewpoint and provide a framework to show that capstone is a proving ground for students to demonstrate that they are prepared for professional practice, and accordingly address the important problem of how capstone can provide feedback to the engineering curriculum and thereby continuously make improvements to it. A progressive model for hierarchically prioritizing ABET student outcomes and mapping them to direct metrics related to the curriculum is presented as a main mechanism for generating feedback. The model is shown to be able to highlight areas of engineering education where significant opportunities exist for improving the preparedness of our students for capstone and ultimately for professional practice. As such, capstone becomes a window on our curriculum for driving continuous improvement.

**Keywords:** multidisciplinary; design; engineering education; capstone; culminating experience; ABET; continuous improvement

**Yu Wang, Ying Yu, Ming Chen, Xiaoyang 165–173 Simulating Industry: A Holistic Approach for Bridging the Gap between  
Zhang, Hans Wiedmann and Xiao Feng Engineering Education and Industry. Part I: A Conceptual Framework  
and Methodology**

Many attempts have been made around the world to search for models to reform existing engineering education to better respond to the industry's needs. This paper proposes a systematic and holistic approach, based on simulating industry (SI) philosophy, for bridging the gap between university and industry. In addition to a multidisciplinary, multi-lingual, multicultural environment, the key elements of this SI-based model include: (1) an integrated 'T' type curriculum model, (2) project based learning and design-centric engineering education, (3) vertically integrated practical teaching, (4) industry best-practice oriented laboratories, and (5) university-industry partnership. Although the individual element in this model may not be totally novel, it is a holistic view to integrate all related aspects from curriculum design, laboratory planning to practice-oriented teaching to focus on narrowing the existing gap. The 10-year practice at the Chinese-German school of applied sciences (Chinesisch-Deutsche Hochschule fuer Angewandte Wissenschaften, CDHAW) of Tongji University has proved that it is pedagogically sound, effective and transferable. The experiences gained and the challenges faced are also shared in this paper.

**Keywords:** simulating industry; engineering education; project based learning; active learning; design based learning

**Yu Wang, Ying Zhu, Ying Yu, 174–180 Simulating Industry: A Holistic Approach for Bridging the Gap between  
Xiaoyang Zhang and Chun Xie Engineering Education and Industry. Part II: Practice in Mechatronics  
Engineering**

Mechatronics engineering is a new discipline area where multidisciplinary synthesis, teamwork and communication, hands-on and laboratory experiences, open ended problem formulation and solving, and examples of 'best practices' from industry are emphasized. This paper presented how the 'philosophy of simulating industry (SI)' was realized in mechatronics engineering education at the Chinese-German school of applied sciences (Chinesisch-Deutsche Hochschule fuer Angewandte Wissenschaften, CDHAW) of Tongji University. The key elements include: (1) integrated knowledge network, (2) integrated PBL and DBL methodology, (3) integrated industry-based internship and bachelor thesis. The results of this exploration and practice are encouraging and promising, and experiences are shared.

**Keywords:** simulating industry; mechatronics engineering; knowledge network; project based learning; design based learning