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Section I

Special Issue

Current Issues in Asia-Pacific Engineering Education

Guest Editor

Pao-Nan Chou – National Pingtung University of Science and Technology, Taiwan

The aim of this study was to investigate the effect of the English Medium Instruction (EMI) model on elementary school students' engineering learning and English proficiency and to examine their EMI learning experiences. Accordingly, a true experimental design with a pretest and posttest was adopted. Thirty elementary school students participating in a winter camp were recruited and randomly assigned to two experimental groups: EMI and semi-EMI. The students in the EMI group received engineering instruction delivered in English; those in the semi-EMI group received only English-based engineering learning materials, but the lectures were in Chinese. The quantitative results revealed that the students' acquisition of engineering (programming and electrical engineering) content knowledge and their English proficiency were significantly improved under the EMI model. In addition, the qualitative results indicated that positive learning attitudes might enable students to excel in EMI learning scenarios.

Keywords: English Medium Instruction; electrical engineering; physical computing; experimental study; educational reform; university social responsibility

Student learning achievement is derived from many configurations between teachers, learners and class environments. Class size is one of the factors that usually consider for the learning ability successive. QUIZIZZ gamified learning teaching is rarely use in engineering calculation subject. Student learning behaviors become an issue that teacher must be suitable adapt. Due to their behaviors gradually change according to the technology and social network interruptions. A diversity of students from large class together with less engagement disrupting from freedom accessible devices are obstacle student learning ability. The GPA class in the past three years rather low between 0.8–1.4. Therefore, the author aims to rise student learning achievement by using appropriate application technology. This is the concept to activate and encourage them to maintain on lesson but still keep using benefit from electronic devices. According to those issues, this study proposes the gamified learning teaching QUIZIZZ application to contribute in this large class which is free accessible that convenient for both teacher and learners. Comparison using QUIZIZZ as active learning with traditional passive learning state that there is significantly improve their academic efficiency by increasing of average mean. Students assess that very high value that QUIZIZZ help to easier understand the lessons and help to improve their summative score. More than 80 percent of the students agree with no further improvement aspects especially they realize that the contents are well planned and prepared, and the learning objectives are clear. Also there is interesting result of student engagement, the 80 percent of student state that QUIZIZZ encourage them to fully participate accordance with the evident from number of student who maintain to study for entire semester. Moreover, the amount of students who success in excellent is increased while students who fail is decreased in significantly level.

Keywords: game base learning; QUIZIZZ application; large engineering class; active learning

With the rapid development and progress of science and technology, in order to help student to meet the everchanging engineering requirements, aiming at the criteria of complex engineering problem solving and continuous improvement established by WA and ABET, this paper proposes a novel course design and assessment method which is applied to the Electrical Engineering (EE) capstone course "Comprehensive Design of Power Electronic Technology" in North China University of Technology. With the introduction of the Hardware in-the-loop simulation phase into the procedure of the capstone course, a "four-dimensional" practical teaching mode including theoretical analysis phase, digital simulation phase, hardware in-the-loop phase and physical experiment phase has been established which allows students to experience more realistic complex engineering problem. And another distinguished feature of the capstone course is the participation of enterprise mentors during the entire designing process. This diversifies the course assessment and consequently a "vectorized" assessment system is accomplished by the participation of group members, course instructors and enterprise mentors. Thus, students' research potential, practical ability and communication & cooperation can be evaluated separately and objectively. On the other hand, a capstone course survey is designed to collect students' feedback from various aspects, and the feedback result analysis and the corresponding course adjustment has been elaborated, thus the continuous improvement of the capstone course is realized.

Keywords: complex engineering problem; continuous improvement; capstone course design; hardware in-the-loop simulation; "vectorized" assessment

Republic of Korea promotes maker education as a policy to enhance learners' engineering experience and problem-solving ability. This study was conducted for the purpose of examining the status of maker education operation and consulting needs of national elementary, middle, and high schools in Korea. To achieve this purpose, the research team operated the supportive group for maker education policy and collected and analyzed related data by conducting online and offline consulting, workshops, and surveys for maker education in all national schools (32 schools in total). The status of maker education is as follows. First, the student participation rate for maker education was high, but the teacher participation rate was relatively low. Second, the makerspace is built with an area of 1.5 to 2 times that of a general classroom, and supports various activities such as

woodworking, digital manufacturing, software, and storytelling. Third, the makerspace is equipped with various equipment to support the activities of learners. Fourth, the maker education is centered on technology, science, and information subjects. Fifth, teachers generally perceive the effect of maker education positively. The consulting requirements of maker education are as follows. First, teachers have difficulties in securing and reorganizing space. Second, teachers have difficulties in purchasing and managing materials, tools, and equipment related to the curriculum. Third, teachers requested various maker education programs that can be applied to the curriculum. Fourth, teachers are paying a lot of attention to the safety issues of makerspaces. Fifth, teachers suggested the need to increase the understanding of maker education among school members. Given the implications of the study, the establishment of a systematic support system for maker education, the preparation of a curriculum for engineering experience, and the development of equipment making tools suitable for schools were recommended.

Keywords: maker education; maker space; consulting needs; K-12; Korea

Investigating Graduates' Feedback for the Implementation of Project-Based Learning in Electrical Engineering Undergraduate Program

332–341

Jinsong Tao, Umair Bacha, Stephen C McClure, Cunhui Zhang and Xishan Wen

In order to evaluate the Integrated Pedagogy for Specialty Courses (IPSC), school of Electrical Engineering and automation of Wuhan University baccalaureate graduates were surveyed through an instant message tool. The former students contributed feedback on the methods, noting ways in which the IPSC pedagogy prepared them for independent literature reviews, project design, and implementation. They believed that project-based learning in particular, was useful and mirrors real world challenges while and the literature review enhances student's ability to integrate information. Furthermore, they indicated that the IPSC pedagogy equipped them with problem solving and critical thinking skills useful throughout both at work and in their larger lives. Survey respondents emphasized the need for more on-site experiments and visits in undergraduate engineering curricula. Our motivation was to provide some kind of evidence to support the implementation of project-based learning and literature review content at all stages of the electrical engineering undergraduate program to make it more relevant and meaningful for students. The analysis of these results, however, does suggest that life-long learning and independent learning abilities must be cultivated at the stage of higher education.

Keywords: lifelong learning; independent learning; graduates' feedback; Integrated Pedagogy for Specialty Courses (IPSC)

Introducing Engineering to High School Curriculum: Effects of an Introductory Engineering Program

342–352

Joosoon Mo and Hyuksoo Kwon

Technology and engineering greatly influence our lives, and global citizenship in technological society should involve a proper understanding of technology and engineering as well as a cultivation of related literacy. Technology education has been implemented in the K-12 education system in the Republic of Korea. Engineering content is included in the national curriculum. The goal of this research was to develop an engineering program for high school students and implement it in technology education classrooms. This study was conducted with a mixture of development and implementation research. This study developed an engineering education program and then investigated its effect on students' attitudes toward engineering and engineering learning using a single group pre-test and post-test design. The program was implemented with 180 first year high school students to evaluate for changes in attitude toward engineering, attitude toward engineering learning, and attitude toward the engineering careers. Results showed statistically significant changes in all three measurements: attitude toward engineering, attitude toward engineering learning, and attitude toward engineering careers. The engineering program not only changed students' attitude toward engineering and but also improved attitude toward engineering learning. In addition, the engineering program affected the career orientation of students toward engineering, increasing the proportion of students wishing to pursue an engineering career. Based on this study, it is necessary to develop engineering education programs in elementary and middle schools and conduct further studies to verify effectiveness.

Keywords: engineering education; technology subject; attitude; engineering career; Republic of Korea

Institutionalizing Engineering Education Research (EER) in China under the Context of New Engineering Education: Departments, Programs, and Research Agenda

353–368

Lina Zheng and Siqing Wei

Engineering Education Research (EER) in the Chinese context has been developed towards a region rather than a discipline with the intertwining of research and practice. The continuous development of dedicated research centers or departments, Ph.D. programs or tracks in China contribute to the increasingly diversified research agenda. By situating China's EER into the global landscape, this study contextualizes the unique mechanisms and characteristics of EER in China since the launch of the *New Engineering Education* initiative. Beginning with reviewing the diverse recognitions of EER and situating it in the global context, we gain insights from the current status of global EER. Bibliometric analysis is used to identify research agenda in order to outline the picture of EER in China. The results reveal that the growing recognition and hybrid structure of EER academic units with ill-defined graduate programs and tracks, and the attempts from diversified EER scholars share unanimous goals to innovate engineering education via all micro-, meso-, and macro-level research agenda. In this regard, we extend Klassen and Case's arguments about the nature of EER and argue that China's EER is a second-order region looking inward towards singulars represented by social sciences, and outward towards both engineering practice and educational policies. Meanwhile, it can be inferred that rather than unifying different claims to reach consensus in EER, the unanimous goals of EER shared by diversified groups of engineering education researchers help facilitating the institutionalizing process of EER in China. This work uncovers the institutionalizing process of China on academic infrastructures and research agenda to contribute to sharing China's EER experiences and status quo, for future potential engagement and dialogs in global EER.

Keywords: engineering education research (EER); China; New Engineering Education

Outcome Based Approach Applied to a Mechanical Engineering Course to Advance the Teaching-Learning Processes

369–375

Rayapati Subbarao

Increasing significance of OBE has made the faculty of engineering programs to move towards preparing course outcomes. Also, they are expected to see how they are attained at the end of the course. Only few works have attempted the aspect of outcomes of a course and its use in the improvement of the program. In this work, an undergraduate course like 'Applied Thermodynamics' related to Mechanical Engineering program is considered, which is similar to any other course taught across India or elsewhere. Suitable action verbs are recommended, based on the topics associated with different modules of the course. These are then compared with the reference bloom's taxonomy table to ascertain their suitability according to the abilities acquainted. Using the appropriate assessment methods, the coverage of COs is presented in a comprehensive way. It is identified that action verbs like understand, estimate, know, analyze and discover are appropriate as per the syllabus. Later, these verbs are compared with the reference taxonomy table, while determining the type of knowledge gained. It is observed that cognitive levels like understand, apply and analyze are covered by the course. The correctness and coverage of respective course outcomes in the assessment processes adapted are also deliberated. Again, CO attainment is calculated, which is based on both internal and external examinations. Results show that the average grade mark for the last two years is same. Also, the CO attainment for the latest year is good. Thus, the present work provides the teaching community, a best way to adapt the OBE approach appropriately, in order to ensure that the overall outcomes of the program are achieved through the course outcomes.

Keywords: outcome based approach; course outcomes; applied thermodynamics; CO attainment

Section II

Contributions in: Manufacturing, Curriculum Design, K-12 Education, Cross-Disciplinary Teams, Control Systems, Remote Experimentation, Newly-Hired Engineers, Aerospace Engineering, Project-Based Learning, Software Analytics, First-Year Students, Student Success

Predicting Engineering Integration in K-12 from the Perspective of Pre-Service Teachers

Pilar Pazos, Francisco Cima, Jennifer Kidd, Kristie Gutierrez, Dorothy Faulkner, Minjung Lee, Krishna Kaipa and Orlando Ayala

The integration of engineering content at the pre-college level is gaining global traction as a strategy to improve learning outcomes and to promote inclusion and diversity in STEM (Science, Technology, Engineering, and Mathematics). Preservice teacher (PST) programs have become natural insertion points for integration efforts by providing future K-12 teachers with the resources and preparation to teach engineering as part of their academic preparation. There is a need to understand the socio-cognitive mechanisms by which teacher preparation programs can help teachers to integrate engineering in their future classrooms. This work examines how an innovative cross-disciplinary program impacted important social-cognitive drivers of engineering integration. We used mediation analysis to understand a successful pathway to engineering integration as a result of exposure to a cross-disciplinary collaboration with engineering students. This study revealed how participation in the program as part of their academic preparation increased PSTs' confidence to teach engineering and their beliefs about the importance of engineering content, which in turn, increased their intention to integrate engineering in the classroom.

Keywords: Engineering education; engineering integration; K-12 education; cross-disciplinary teams

Teaching System Identification by Remote Access to a Networked Control System Laboratory

Tangming Guan, Guo-Ping Liu and Wenshan Hu

Remote experiment courses can expand the boundaries of the classroom, allowing students to conduct experiments anytime and anywhere. This paper takes the system identification experimentation as an example to introduce how to use the remote laboratory to carry out online experiments for system identification. The physical equipment is deployed into the Networked Control System Laboratory (NCSLab) and is used to conduct remote experiments, and the corresponding input/output signal data are collected for parameter identification. The experiment course discussed in this paper combines system identification models, classical identification methods, least squares method, offline identification, online identification, and other theories to provide a thorough experimental design and experimental processes. To validate the effectiveness, the proposed method has been applied to an undergraduate system identification course at Wuhan University. The results show that the remote experiment course has positive application effects and is of great significance to the reform of the existing experimental teaching system.

Keywords: system identification; remote experimentation; least squares method; engineering education in control; experimental design

Actions Recent Engineering Graduates Undertake to Integrate into the Workplace – A Case Study from the Aerospace Industry

Benjamin Ahn, Yun Dong and Secil Akinci-Ceylan

This study extends the literature on organizational socialization by examining newly-hired engineers' proactive actions to integrate into the workplace, relating them to the four primary socialization task domains – task mastery, role clarification, acculturation, and social integration. The study conducts semi-structured interviews with 26 newly-hired engineers in aerospace companies. The results identify 16 proactive actions of newly-hired engineers during their socialization period. The most crucial actions during the onboarding period are interacting with coworkers, using available resources and tutorials, participating in training opportunities, learning through hands-on experience, seeking opportunities to learn and solve problems independently, and possessing self-belief to meet commitments. The study's findings provide valuable practical implications for engineering students, newly-hired engineers, engineering managers and organizations, and engineering educators concerning the use of specific actions to improve newly-hired engineers' socialization period.

Keywords: workplace socialization; workforce development; newly-hired engineers; proactive actions; aerospace engineering

Applying Project-Based Learning to Teach Software Analytics and Best Practices in Data Science

Silverio Martínez-Fernández, Cristina Gómez and Valentina Lenarduzzi

Due to recent industry needs, synergies between data science and software engineering are starting to be present in data science and engineering academic programs. Two synergies are: applying data science to manage the quality of the software (software analytics) and applying software engineering best practices in data science projects to ensure quality attributes such as maintainability and reproducibility. The lack of these synergies on academic programs have been argued to be an educational problem. Hence, it becomes necessary to explore how to teach software analytics and software engineering best practices in data science programs. In this context, we provide hands-on for conducting laboratories applying project-based learning in order to teach software analytics and software engineering best practices to data science students. We aim at improving the software engineering skills of data science students in order to produce software of higher quality by software analytics. We focus in two skills: following a process and software engineering best practices. We apply project-based learning as main teaching methodology to reach the intended outcomes. This teaching experience shows the introduction of project-based learning in a laboratory, where students applied data science and best software engineering practices to analyze and detect improvements in software quality. We carried out a case study in two academic semesters with 63 data science bachelor students. The students found the synergies of the project positive for their learning. In the project, they highlighted both utility of using a CRISP-DM data mining process and best software engineering practices like a software project structure convention applied to a data science project.

Keywords: project-based learning; software analytics; software quality; data science; software engineering

Investigating the Relationship between the Initial English Reading Skills of Newly Enrolled Engineering Undergraduates and their Academic Success – A Case Study

Avshalom Danoch, Roman Michaelan, Revital Danoch and Neta Kela-Madar

With an ever-growing influence of the English language in the realm of higher education of non-English-speaking countries, various questions have been raised regarding the relationship between students' proficiency in the language and their academic performance. The present study was conducted at Shamoon College of Engineering with the aim of shedding further light on the relationship and investigating whether an initial level of English language proficiency of newly enrolled students, specifically their reading comprehension skills, prior to embarking upon academic courses is influential on the students' academic achievements. The collected data encompassed 1973 students who started their studies in the academic years 2015–2016 at the college. Drawing on the results obtained, there is a significant relationship between the students' academic performance, as well as their commutative GPA, and their beginning level of English proficiency throughout the first academic year. The paper concludes that students' English proficiency level, mainly reading comprehension skills on entry to the college, plays a significant role in their subsequent academic performance.

Keywords: English proficiency; engineering undergraduates; first year students; student success

Guide for Authors