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Special Issue

Innovation in Engineering Practice and Technology Education

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Alfonso González González, Alonso Sánchez Ríos, Cayetano José Cruz García and David Rodríguez Salgado	1150–1158	A Proposed Methodology to Evaluate Educational Competences in Engineering Degrees Based on Electronic Devices and Open Access Software

In the new context of the European Higher Education Framework (Bologna Process), the lecturers must cope with the educational achievement assessment and with an appropriate control of the educational process. In this paper, we present the methodology used in the University of Extremadura to evaluate the educational competences in the real time by means of Socrative (by Mastery Connect) launched in smartphones, tablets, laptops, etc. This study has been carried out with the students of two Faculties: the School of Industrial Engineering and the University Centre of Merida, in the framework of an educational innovation project focused on several technical subjects for the mechanical engineering and industrial design degrees. The result shows that the students have improved their competences and their skills, and also the interest in the core syllabus contents, and a great satisfaction with the introduction of this type of activities as a complement to the lectures. Finally, they value this educational experience by means of a surveying, obtaining marks between 83%–85% of the students that consider it as a “positive” or “very positive” experience. The conclusions of this study show that with the use of this tool (Socrative), the students are more motivated and interested in the content of the subjects, with an improvement of their collaborative attitude in the class. It leads to obtain an outstanding performance, with a failure rate that in our case, has been reduced by a 20% from “classical” methodology. In contrast, the implementation of this new technological tool demands a notable effort from lecturers’ coordination, besides a supplementary work.

Keywords: e-learning; educational competences; open access software; online surveying; outstanding achievement

Sarah M. Asio, Jennifer A. Cross and Stephen Ekwaro-Osire	1159–1173	Factors Affecting Innovation in Engineering Design Teams: An Empirical Investigation of Student Team Perceptions
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Innovation is a catalyst for economic growth, competitiveness, and sustainability worldwide. Knowledge has been identified as a key driving force for innovation usually resulting in intellectual property as a reward for creativity. Engineers of today are expected to possess abilities for teamwork, creativity, and innovation in order to meet the challenges and complexities of the 21st century. However, there is insufficient empirical evidence explaining the organizational, social and cognitive processes affecting innovation among engineering student design teams—the engineers of tomorrow. The research addresses the question: What are the factors affecting Innovation in engineering student design teams? The study advances a framework for engineering student team innovation and uses survey data from a representative ABET accredited four-year institution of higher learning involving 709 participants constituting 210 design teams from 40 design sections across nine academic departments at a college of engineering during an academic year. Validity and reliability of the survey instrument were obtained by using pre-existing scales, a pilot test, factor analyses, and scale reliability analysis. Other analyses involved aggregation analysis, ANOVA, correlation, and hierarchical linear modeling. A validated 59-item survey scale was realized. Perceived engineering student team innovation is found to be significantly related to leadership, support for innovation, rewards, team size, communication, task orientation, effort, learning, cohesion, conflict and participative safety at the team level. Most study findings agree with general organization team innovation literature with exceptions of participative safety and support for innovation. Findings from the study have implications for the improvement of engineering design curriculum and provide a framework for endeavors to harness skills for teamwork and innovation among engineering graduates through enhancing or regulating the determinants of innovation. A linear model for assessing team innovation among engineering students is elaborated in the study.

Keywords: innovation; teamwork; engineering design teams; student teams; capstone projects

Hai Chien Pham, Nhu-Ngoc Dao, Akeem Pedro, Quang Tuan Le, Rahat Hussain, Sungrae Cho and Chan Sik Park	1174–1191	Virtual Field Trip for Mobile Construction Safety Education Using 360-Degree Panoramic Virtual Reality
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Construction safety education plays a vital role in equipping students with concrete safety knowledge and promoting safety performance prior to entering construction sites. However, safety topics are not given adequate attention in most construction curricula and traditional pedagogic tools fail to provide practical experience or sufficiently engage students in acquiring safety knowledge. With this regard, this study proposes the Virtual Field Trip System (VIFITS) for mobile construction safety education using a 360-degree panoramic virtual reality. The VIFITS utilizes a state-of-the-art 360-degree panorama-based Virtual Reality technology in order to bring construction field trips to the classroom and provide practical experience to improve students’ safety knowledge. VIFITS consists of three modules: (1) a Safety Information Dissemination module (SID) in which the educator disseminates safety information to the students through mobile learning; (2) a Virtual Field Trip Experience module (FTE) where students experience virtual construction field trips based on their own mobile devices; (3) and a Safety Knowledge Assessment module (SKA) designed for learners to play testing simulation games in order to assess their safety knowledge. The VIFITS prototype is developed and validated with virtual scenarios derived from real construction sites. The results reveal that the VIFITS is a powerful pedagogical method for effectively providing practical experience and safety knowledge for students.

Keywords: construction safety education; virtual reality; 360-degree panorama; construction field trip

Due to the impact and influence of information technology on the education, computer-assisted language learning is becoming the trend in engineering laboratory based teaching and learning. Furthermore, the interactive computer network allows students to explore the technical information and to conduct the laboratory activities more independently.

In this research, we introduced a multimedia system to the undergraduate lab education in order to transform a traditional lab instruction to the dynamic experiential learning environment. We applied this multimedia method in a number of labs from second-year class to fourth-year class. Then we evaluate the effectiveness of this new lab teaching approach by conducting student survey and lab test. Based on the results of lab test, we will further measure the Course Learning Outcome (CLO) and Program Learning Outcome (PLO) from the classes with or without adopting this method.

Since biotechnology is a discipline of applied science, laboratory application holds high importance in its education. In biotechnology, and other applied science labs, students enhance their learning through seeing, observing, and performing. Our research indicates that this multimedia approach can cultivate the teaching laboratory into more student-centered, active, challenge-based, self-directed learning, and problem based learning environment.

Keywords: mentorship; peer mentorship; peer mentorship; cooperative education; experiential learning; co-curricular education; career preparation; professional skills; engineering technology program

Marjan Golob and Božidar Bratina 1199–1211 Web-Based Control and Process Automation Education and Industry 4.0

The higher education processes of engineering disciplines, especially Industrial Automation, Process Automation, and Mechatronics, face the challenges of the fourth industrial revolution, which is introducing system modelling paradigms, such as the Cyber-Physical Systems, and several new technologies, such as the Internet of Things, Industrial Internet, Cloud-based Manufacturing, Smart Manufacturing, and others. This paper describes how communication and web-based technologies can be used to build an efficient laboratory learning model of the remote and distributed control system and enabled remote access to physical processes. Our experiences are presented with several remote experiments. The user interface of the first experiment is implemented by professional supervision tools and is using web-based SCADA technology. In the second experiment, we discuss the process of developing fault detection and isolation applications for online and remote education by using industrial equipment from the field of Process Technology (batch, continuous) supported by web technologies. Through-out the course, the student can develop and test model-based and data-driven FDI schemes in Matlab/ Simulink remotely by using an industrial communication interface. Next, an improved platform is proposed for web-based remote-control system experiments suitable for control education. Finally, the proposed platform can be assembled quickly as an example of an IIoT system.

Keywords: control engineering education; distributed control systems; remote laboratories; Industry 4.0

Jose-Maria Gutierrez-Martinez, Ana Castillo-Martinez, Juan Aguado-Delgado, Roberto Barchino and Salvador Otón 1212–1222 Innovative Evaluation by Projects for Course with Mixed Computer Science Degrees

This paper explains the evaluation method applied to a specific capstone course, called “Ubiquitous computing”, taught in different Computer Science Degrees of the University of Alcalá (Spain). Along the previous editions of the course several issues have been discovered, which are intended to be solved with the proposed method that was used as evaluation system of the subject in year 2016–2017. The issues are related to the number of students of each degree that compose the group each year, the contents’ deviation, the low marks obtained in previous years, the methodological mismatch in relation with other subjects and the bad alignment of the evaluation method used before. With the idea of obtaining better marks, a closer experience to the real situation in software companies and higher satisfaction level of the students, the learning experience proposed implies teamwork, a project-based learning perspective and a balanced use of the technologies. Taking the results obtained through its implantation along the last academic year, it can be concluded that the evaluation method shown in this document enhances the learning process and the contents are closer to the course initial conception, and students got more involved and obtained better results.

Keywords: education; collaborative learning; project-based learning (PBL); evaluation methods

L. Belkhir, R. Fleisig and D. K. Potter 1223–1235 Effective Learning of Innovation by Engineering Students in a Multi-Disciplinary Context

The teaching of innovation to engineers is often fraught with challenges and misgivings, as the definition of innovation itself, often confused with invention and research and development, is still a subject of research in the fields of science, engineering and management. In this paper, we offer the results of a novel graduate-level engineering course that attempts to develop among its students the ability to identify, define and manage innovation within a project-based and multi-disciplinary context, and in a manner that is stakeholder-centric. We present in this paper for the first time a Universal Innovation Framework that offers a practical and distinctive approach to the teaching and management of innovation that foregrounds societal impact as opposite to technical prowess. Preliminary results show a significant impact of the course on student understanding and perception of innovation.

Keywords: engineering management; innovation; innovation education; management of innovation; multidisciplinary pedagogy; immersion; project-based learning; problem-based learning; engineering design education; entrepreneurship education; public policy education

Zhen Gao, Tom Wanyama and Ishwar Singh 1236–1249 Practice-Intensive Learning: An Effective Approach to Enhance the Fundamental Skills of PLC Beginners

Programmable logic controller (PLC) is an essential course for the students whose major are automaton related, since this course is highly connected to industry, and many other technical courses have a direct/indirect relationship with PLC. This paper is focused on thoroughly investigating the detailed contents and approaches to achieve the proposed paradigm called Practice-Intensive Learning. It provides a vision about how to re-design the PLC course to strengthen the theoretical knowledge and practical skills of beginners via hands-on and minds-on learning in all modules including interactive lectures, individual laboratories and innovative projects. The way about how to make the three modules fully integrated is also introduced. The evaluation results from the students and the peers have proven the effectiveness of the proposed method. Through the systematic integration of knowledge absorption, simulations, experiments and real-world implementation, beginners confidently and curiously stepped into the world of automaton by using PLC as an effective tool. The proposed methodology is also applicable for other technical courses in undergraduate and graduate levels.

Keywords: practice-intensive learning; hands-on and minds-on learning; integration of lecture and lab; PLC; process automation

Irina Zakharova and Alexander Zakharov 1250–1260 Key Issues of Low-Level Parallel Programming in the Individual Projects for Graduate Students

This paper presents the research project based methodology of teaching parallel programming to master’s students in a High Performance Computing program. The requirements for completing a master’s degree state that all students should be able to develop computer simulation programs using parallel and distributed computing technologies, regardless of students’ background and their preferences for in-depth study of high or low-level programming, administration, and information security. Creating computer simulations based on high-performance computing is impossible without the experience of solving such key issues of low-level parallel programming as the data flow management, synchronization, load balancing and fault tolerance. We believe that the best way to explore these issues is phased implementation of appropriate algorithms in the application, and then carrying out

computational experiments. Therefore, as a main tool for the practical study, we offer the implementation of special project tasks. While developing the course tasks, we have used not only our teaching experience of parallel programming for undergraduate and graduate students, but we also relied on the existing practice of the development of distributed computing systems. In addition to the classic tasks, students explored pairing algorithms, load balancing and fault tolerance through implementation in distributed applications and testing in computational experiments. Our experience has shown that this approach to teaching parallel programming, which includes modeling and simulations, enabled students to proceed gradually from classic tasks to the implementation of full-scale research projects.

Keywords: parallel programming; graduate course; load balancing; fault tolerance; computational experiments

Juan I. Castillo Tello, E. Verdú Pérez 1261–1272 Analysis and Evaluation of Discussion Forums in the Teaching Process of and **J. Javier Rainer Granados** Industrial Organization Engineering

A series of practical on-line classroom using the forums as a tool were developed in different subjects of Industrial Organization during five consecutive years instead of the traditional face to face sessions. The purpose of this paper is to develop an evaluation system and determine whether the qualification of the forums can be considered a substantial part of the overall qualification process of each subject or not. To achieve this objective, it was necessary to analyze in depth the participation of the students in the forums and to establish an evaluation procedure that can be considered objective, realistic, transparent, fair, easy to be implement and feasible to be incorporated as a part of the traditional evaluation process.

Keywords: asynchronous discussion forum; case method; collaborative learning; text mining; discussion behaviors

Silvia De La Flor, Alberto Belmonte and **Albert Fabregat-Sanjuán** 1273–1284 Improving Students' Engagement and Performance Through New e-Learning Tools in Laboratory Subjects in Mechanical Engineering

In this paper we present the design, development, implementation and evaluation of a new assessment methodology for the subject *Laboratory of Elasticity and Strength of Materials* of the degree in Mechanical Engineering in order to improve learning outcomes while simultaneously engaging students in their learning process. This set of different assessment methods is based on e-learning tools in combination with traditional face-to-face practical training, and carefully balances **formative assessments** (to improve instruction and student learning) and **summative assessments** (to evaluate individual academic achievement) within a well-designed time-distributed program. The results of an anonymous student satisfaction survey show that these improvements have been very well received. 73% of the students polled are very satisfied with the quality and usefulness of the method and 86% of the students think that the assessment feedback is sufficiently detailed to enable them to identify their own particular weaknesses. Regarding the fairness of the grading process, more than 60% of the students polled considered two of the four assessment methods to be extremely fair. The results from academic outputs show a significant improvement after this methodology is applied. Comparing the grades obtained in the last five academic years we can conclude that the dropout rate has been reduced from 41% in 2011/12 to 18% in 2015/16 as has the number of failed students (from 20% to 11%). Regarding the number of students achieving good grades (above 7/10), it has increased noticeably from 3% in 2011/12 to 26% in 2015/16. Correlating the students' final grades with the individual grade of each e-tool, we can conclude that self-assessment tasks before laboratory sessions are a great assistance in understanding what we consider essential for the successful completion of each session and self-assessment tasks after laboratory sessions are a good guidance for students to know which their level of knowledge before the exams is. It also confirms that students with higher marks on self-assessment tasks are also the ones with higher marks on the exams, which indicates that self-assessment tasks are useful to prepare the partial test exam as well as the final oral exam. We can conclude that this comprehensive assessment program contributes to improving academic outcomes, ensuring that students acquire the adaptive and autonomous learning characteristics necessary for enhanced engagement with the learning process and a subsequent successful performance.

Keywords: formative assessment; summative assessment; learning outcomes; student satisfaction; student engagement

I. Ortigosa 1285–1288 An Experience with Varied Teaching Methodologies at Mechanical Engineering Program

This article presents an experience of teaching a course in the second year of a Mechanical Engineering program. Namely, Strength of Materials which is a course of 6 ECTS points. The objective is to improve the learning process, to develop students' competences and skills and to create opportunities for interaction among students and lecturers. Several active learning strategies have been applied in the course. Numerous approaches have been incorporated in the lectures, making use of varied teaching methodologies such as master class, active learning (AL) and problem-based learning (PBL). The actions introduced in the practical lectures are focused in program specific and professional competences related to the academic discipline, it aimed also to train core and cross-cultural competences such as management of information, team work and development of technical reports. At the end of the course a questionnaire was administered in order to analyse which of these activities is the one students believe has the greatest influence on the learning process.

Keywords: teaching engineering; active learning; problem-based learning

Section II

Contributions in: Teamwork, Engineering Design, Evaluation, Faculty Development, Project Management, Innovation, Critical Thinking, Social Networking, e-Learning, Learning Competency, International Students, Academia and Industry, Project-Based Learning, Learning Physics

Kali Prasad Nepal 1289–1298 A Relative Relevance Approach to Refine Inconsistent Peer- and Self-Assessment Scores in Teamwork Assessment

This study proposes an extended approach to refine inconsistent peer- and self-assessment scores in teamwork assessment. These refined scores are commonly used to estimate individual contribution factors, also referred in some literature as individual weighting factors. The individual contribution factors are then multiplied by team mark to convert team mark into individual marks, provided the scores are valid (the degree to which the scores measure the true contributions) and reliable (the extent to which the scores are consistent). However, not all peer- and self-assessment scores are valid and reliable. Although the validity is as equally, if not more, important as reliability, this study focuses on the reliability. Anecdotal and literature evidence suggests that there are several cases of inconsistencies in students' peer- and self-assessment scores. Creative accounting scores (over-rating to self and under-rating to peers) by some minority team members are commonly encountered cases of inconsistencies, which are addressed by the proposed extension. To discuss the characteristics of the extended approach, mathematical equations and computations are presented and discussed with the help of typical inconsistent peer- and self-assessment scores. The analysis clearly shows that relative relevance approach based on standard normal probability can be a viable option in order to refine creative accounting cases of inconsistencies.

Keywords: teamwork; peer-assessment; self-assessment; reliability; relative relevance

Mahender Mandala, Christian Schunn, Steven Dow, Mary Goldberg, Jon Pearlman, William Clark and Irene Mena 1299–1313 Impact of Collaborative Team Peer Review on the Quality of Feedback in Engineering Design Projects

Increasing classroom sizes and decreasing financial and human resources have encouraged educators to seek innovative strategies to manage large classrooms. Several instructors have begun using web-based peer reviews as a way to increase open-ended feedback. Recent work in design-based classes has revealed that students struggle to provide meaningful peer feedback. Furthermore, it remains unclear how best to increase student motivation and engagement with the process. In a sophomore mechanical engineering class, we investigated the effect of a collaborative team of reviewers (a team of reviewers generating a single review) on the quality of feedback generated and on student perception of the process. Feedback generated by 117 students on their peers' design projects over two assignments was analyzed using a mixed-methods approach. We found that collaborative team of reviewers produced higher quality feedback than did individual reviewers. Students spent more time on reviews in teams but found the process engaging and more fun than with individual reviews. Furthermore, students perceived individual and team review tasks as requiring similar levels of effort. Our findings indicate that team review approach could help reviewers provide better feedback in engineering design reviews. Additionally, collaboration improved student engagement in the process. Over the past two decades, peer reviews have remained a solitary endeavor—this study is the first group process implementation of peer review and provides a basis for future exploration of the topic.

Keywords: peer review; team based learning; design; cooperative/collaborative learning; design evaluation

Mahender Mandala, Christian Schunn, Steven Dow, Mary Goldberg and Jon Pearlman 1314–1324 Uncovering the Practices, Challenges, and Incentives for Engineering Design Faculty

Design, a cornerstone of engineering education, necessarily involves a practical training approach, which often requires educators to navigate non-traditional learning environments. Ambiguity in design is the result of the existence of multiple solutions to a given problem, and the need to find an optimal solution most often based on incomplete information. Research in design education over the years has showcased the importance of providing feedback, coaching over teaching, and including several hands-on activities with clear learning objectives. It is unclear whether this research knowledge has transcended into actual design classrooms, and whether there exists barriers or facilitators in teaching design. In a qualitative interview study with 38 design educators and administrators, we examined the practices and attitudes on teaching design, and any barriers or facilitators they faced, across a sample of schools within the United States. Additionally, we examined the use and faculty attitude on peer review, a potentially scalable approach for providing timely feedback on design. We found that the time faculty spend on teaching is significantly affected by incentives (and requirements) devised by their institutions. The recent growth in classroom sizes has resulted in reduced formative assessments. Faculty expressed concerns about low student engagement, poor communication skills, and their capacity to remain creative while taking risks. Furthermore, instructors supported use of peer learning activities, but they found implementing these activities challenging with respect to the technical needs and student motivation.

Keywords: engineering design; design teaching; teaching strategies; barriers; faculty incentives

Matt DeMonbrun, Julia Kerst, Hanna Pfershy and Cynthia J. Finelli 1325–1334 The Long-Term Impact of a Faculty Development Program on Student Evaluations of Teaching

Although participation in faculty development programs has been linked to improvements in teaching and positive outcomes in student learning, prior research has yet to uncover how these outcomes might lead to increases in student evaluation of teaching scores. Student evaluation of teaching scores are frequently used in tenure and promotion decisions, and prior research has found that these scores often decline over time. Thus, it is important to better understand how faculty development programs might work to improve these scores. In this study, we examine whether student evaluations of teaching scores do decline over time, and the potential impact of a faculty development program on these evaluations.

Keywords: student evaluations of teaching; faculty development programs; longitudinal studies; quasi-experimental research

Adriana Rojas-Molina, Manuel Toledano-Ayala, Juvenal Rodriguez Reséndiz, Edgar Rivas-Araiza and Gilberto Herrera-Ruiz 1335–1346 Project Management in Higher Education Institutions in Mexico: A Case Study

Project management (PM) is considered a determining factor in the success of collaborative innovation and technological development projects carried out by universities and private companies. This work presents the findings of a study carried out in the Faculty of Engineering of the Autonomous University of Querétaro (FIUAQ) that aimed to determine the level of maturity in project management of the faculty members. Their level of maturity is also linked with the perception of success (in terms of satisfaction level) of the companies that collaborated with the FIUAQ in research and innovation projects. Knowing the level of maturity in project management of its members is important for the FIUAQ, since it aims to incorporate a Project-Based Learning Model (PBL) in the curriculum of undergraduate and graduate students, encouraging their participation in collaborative projects between academia and industry. The conclusions section describes some factors that may hinder an organization such as the FIUAQ in its aim to increase the level of maturity in project management of its members.

Keywords: project management; level of maturity; academia-industry relationships; research and innovation projects

Kerrie A. Douglas, Todd Fernandez, Shenay Purzer, Michael Fosmire and Amy Van Epps 1347–1362 The Critical-Thinking Engineering Information Literacy Test (CELT): A Validation Study for Fair Use Among Diverse Students

Information literacy and lifelong learning are essential for engineers as they constantly renew and expand their knowledge and skills to keep abreast with the development of new technologies. However, the lack of validated information literacy assessments relevant for engineering students makes it difficult to determine how well those students are acquiring needed information literacy skills. We describe validity evidence for the Critical-Thinking Engineering Information Literacy Test (CELT), an instrument designed to assess students' information literacy associated with critical thinking in an engineering context. By examining psychometric properties of CELT through Rasch modeling applications, we present evidence of appropriate and fair use of CELT among first-year engineering student populations. From our analysis, we find that CELT is appropriate for use in the classroom to assess information skills associated with critical thinking among first-year engineering students, when students' experience with English language is part of their score interpretation. We discuss specific recommendations for use with students who have little experience learning in an English language environment.

Keywords: Assessment; information literacy; instrument development; Rasch model

Ugljesa Marjanovic, Nenad Simeunovic, Milan Delić, Zeljka Bojanic and Bojan Lalic 1363–1375 Assessing the Success of University Social Networking Sites: Engineering Students' Perspective

In the higher education industry, web-based marketing has already been widely applied to service current students, as well as to attract new ones. All major universities in the world have incorporated their websites with social networking sites (SNSs), but it is likely that a significantly larger proportion has no clear knowledge of how successful their SNSs are. Accordingly, this study proposes an integrated model for evaluating the effectiveness of SNSs from an engineering student point of view. This model is based on the DeLone and McLean IS success theory coupled with the socio-demographic conditions perspective. The model was

tested by using data collected from 638 engineering students. The results show that seven hypothesized relationships between seven success variables were significantly supported and two socio-demographic characteristics were significantly related to SNSs use. Our analysis showed that all three quality dimensions (i.e., information quality, system quality, service quality) had a positive impact on user satisfaction, and that only information quality had a significant effect on SNSs use. User satisfaction had positive and direct effects on SNSs use. Female students and self-funding students tend to use SNSs (i.e., Facebook, Instagram, Twitter) more than male students and students with government scholarships. Therefore, gender and funding options should be considered as significant characteristics, since as control variables play significant role in the model. Engineering academic institutions can use the results of this research to assess the success of their SNSs implementation from their students' perspective.

Keywords: social networking site; D&M model; engineering students; SEM

Hsiu-Ping Yueh, Chaoyun Liang and Yi-Lin Liu 1376–1383 Influences of Learning Competency and e-Learning Implementation on Learning Outcomes of Engineering Students

This study examined the combined effects of student learning competency and e-learning implementation on the learning outcomes of engineering students from a series of blended distance education courses. A total of 1,323 valid questionnaire responses were analysed to determine the effects. The results indicated that learning competency comprised two factors, namely scientific literacy and self-regulated learning; e-learning implementation comprised two factors, namely online material guidance and distance teaching quality; and learning outcome also consisted of two factors, namely multidisciplinary learning outcome and fundamental learning outcome. The results also suggested that the scientific literacy and self-regulated learning factors positively predicted the multidisciplinary and fundamental learning outcome factors through the mediators of online material guidance and distance teaching quality. The effects of self-regulated learning and online material guidance on both types of learning outcomes were greater than those that resulted from scientific literacy and distance teaching quality.

Keywords: distance teaching quality; fundamental learning outcome; multidisciplinary learning outcome; online material guidance; scientific literacy; self-regulated learning

Prasad KDV Yarlagadda, Jyoti Sharma, Pujitha Silva, Karen Woodman, Jegar Pitchforth and Kerrie Mengersen 1384–1399 Factors Influencing the Success of Culturally and Linguistically Diverse Students in Engineering and Information Technology

The perception of supervisors who supervise culturally and linguistically diverse (CALD) higher Degree research students (HDR) in Engineering and IT was analysed to identify, operationalise and quantify factors which could influence outcomes related to successful completion of HDR studies. A large study was conducted from three Australian Universities (Queensland University of Technology, University of Western Australia, and Curtin University) to explore the key factors using Bayesian Network (BN) analysis, a complex systems approach. The BN model was quantified using coded survey variables and was further compared to write-in responses from a survey of 228 students and 69 supervisors, to explore the benefits of using mixed method analysis in the study of complex phenomena. Key findings indicate that qualitative responses broadly supported the results of the BN analysis, with *supervisor experience*, *style* and *training* identified as key factors. Sensitivity analyses demonstrated that *'student prior experience'* showed the greatest positive influence, whilst *'student obligations'* and *'student attributes'* had the most negative impact on *'HDR student study completion'*. Overall maintaining *'student motivation'* was seen as the single most influential factor on *'HDR student study completion'*. *'CALD student study completion'* can be largely improved through *'supervisor's involvement'* in helping to develop communication and networking skills. Moreover, supervision activities developed through participation of supervisors in respective training programs, followed by improving *'University Support'*, made the biggest positive impact on *'supervisor attributes'*. These findings are useful for universities seeking to prioritise areas of funding, whilst also enhancing the performance of CALD students in these disciplines.

Keywords: international students; Bayesian networks; higher degree research; culturally and linguistically diverse students; engineering

Maria-Jesús Marco-Galindo, Josep M. Marco-Simó and Marc Fuertes-Alpiste 1400–1410 A Computer Engineering Curriculum Model for Teaching Software Development to Bridge the Gap between Academia and Industry

Software development has been traditionally taught in universities starting with programming, then analysis and design phases of software engineering, and ending up with software management processes. However, this bottom-up approach (from the specific to the general software view) is precisely the opposite of the typical accepted software development processes and life cycles found in the professional field. With the aim to bridge this gap between academia and industry, a multidisciplinary team of eleven lecturers of the Universitat Oberta de Catalunya participated in a long-term research study with the aim to propose a new engineering curriculum model in the scope of software development. This paper reports on this study and demonstrates the correct adaptation of the proposed curriculum model to the design of the Bachelor in Computing Engineering within the European Higher Education Area whilst revealing in general a positive impact in the actual implementation of the innovative software development curriculum in our university in terms of academic performance and satisfaction.

Keywords: software development; curriculum model; computing engineering; higher education; industry; bachelor in computing engineering (BCE); European Higher Education Area (EHEA); Universitat Oberta de Catalunya (UOC)

Se-Yeon Jeon, Konstantin Nikitin, Aulia Dewantari, Sumin Kim and Min-Ho Ka 1411–1426 Multifunctional Radar Sensor Laboratory Course Using a Low-Cost Software-Defined Radio Transceiver

This paper presents a radar laboratory course and an educational radar kit developed for the course. This course aims to provide hands-on experience on pulse-Doppler radar (PDR) signal processing algorithms using modern methods and tools. Experiments and project-based learning (PBL) is introduced to the pedagogical methodology of this course. The course is constructed by considering various backgrounds and levels of the students. The student learning consists of three elements: theoretical knowledge, experiments, and proposal writing on their own research topic. The objective of convergence education is reflected on how the students are provided the opportunity to apply their knowledge and expertise in radar system obtained through this course to their own research areas. For an efficient application of the PBL, a suitable educational kit is designed and implemented. The kit is developed as an open software and hardware platform for facilitating the experimental studies of modern radar technologies for students. The kit, a low-cost multifunctional short-range PDR, is a relatively simple platform for beginners. The suggested hardware design is based on a single-chip software-defined radio (SDR) with an inexpensive system-on-chip (SoC). As the experimental prototype is based on commercially available evaluation modules, it is easy to assemble and use, and no special skills or equipment are required. The proposed system enables students to study modern signal processing techniques. The applied pedagogical methodology, course description, experimental kit, projects descriptions, and assessments are discussed.

Keywords: education; hands-on experience; laboratory; project-based learning; radar; pulse-Doppler radar; software-defined radio; experimental kit

Juan C. Miranda and Tomás Rada 1427–1435 An Examination of the Beliefs About Physics and Learning Physics Among Engineering Students

It has been suggested that the attitudes, beliefs and expectations of students about learning physics can impact the way they perform in physics courses. Here, our aim is to understand the beliefs and attitudes of engineering students of an accredited Colombian university about physics and how physics should be taught in this context. Our research process includes the translation of a pre-existing survey, its subsequent validation in the Spanish language, and its application as a diagnostic test. This survey is

based on CLASS, an instrument developed by researchers at the University of Colorado that consists of 42 Likert-type questions. The results of this instrument, which is based on the expert-novice comparison technique, can be distributed into eight categories relating to beliefs and attitudes about physics. We applied this survey to more than 700 first-year students of engineering programs. Based on the student responses, we discuss the overall results and specifically focus on the three categories that had the lowest student favorability values compared to expert opinions—Conceptual Connections (47.1%), Problem Solving Sophistication (44.6%), and Applied Conceptual Understanding (36%). Our overall results (56.5%) are comparable to those obtained by surveying students in other countries and cultures with the same test, such as USA (62%) and Saudi Arabia (55%). Furthermore, we highlight some of the answers of the students, and examine the effects that their beliefs have on their attitude. Therefore, physics courses should be oriented or prepared in such a way that students can strengthen their beliefs and attitudes. Strategies focused on developing high levels of confidence should be taken into account. Finally, we provide some recommendations of how physics teachers can promote a positive attitude among their students, such as classroom debates related to physics topics in order to help students to develop their different perspectives about a specific issue or phenomenon, enforcing the idea that there is not only one correct way to reach a solution or solve a problem.

Keywords: engineering education; physics; physics teaching; CLASS; attitudes; beliefs