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In our era of the technology-enabled entrepreneurship and technology-driven innovation, engineering education has a key role to promote a sustainable model for educating leaders and for creating new contexts for experimental and experiential learning. One of the key challenges modern Engineering Education faces is the fast integration of knowledge to curricula and the design of participatory and student-centered learning models. The nature of engineering problems requires a variety of skills and competencies that have to be developed. This editorial serves as a position paper for the role of ICTs for the provision of personalized learning in Engineering Education. The main contribution is the provision of an integrated model which requires five success factors as prerequisites for the design of any STEM Curriculum and more specifically of engineering curricula.

Keywords: Engineering education; active learning; personalized learning

In recent years the world has been a witness to a brutal onslaught of emergent technologies. As such it is not surprising that social networking has permeated through practically every human activity with amazing speed. Educational systems have not lagged behind; and not only is that true, but it is also evident that social networks have ostensibly penetrated in engineering education. This relevant and irrefutable fact has generated the necessity of posing systematic research activities on a worldwide scale that are related to this topic. In this context the topic covered in this paper is Social Network Research related to Engineering Education. Specifically, our research concerns the way or ways in which link prediction in social networks is able to improve teaching-learning processes in engineering education. A suitably natural environment for the application of such research is that of scholarly publications related to computer science, particularly networks. The results of our research are promising; they facilitate valuable information regarding the tendencies of the actors immersed in engineering education, be they students or faculty members.

Keywords: engineering education; social networks; link prediction; computer science publications

Inma Rodríguez-Ardura, Antoni Meseguer-Artola and **Gisela Ammetller**

1579–1585   How do the Experiences of Virtual Presence and Flow Differ? Evidence from Engineering and ICT Online Education

Virtual presence and flow are usually presented as two core facets of the individual's immersion in online education settings, yet their delimitation is still unclear. We seek to address this issue by theoretically explaining, and empirically showing, their different extents. From a sample of students of engineering and ICT programmes in a pure-online education setting, we have found that although virtual presence and flow are both triggered by focused attention (which in turn is prompted by a similar feeling of perceived control), virtual presence is directly activated by the challenges perceived in the online environment—and its activation facilitates flow states. The findings also support the impact of challenge and skill on perceived control. These results shed light on the complexity of immersive experiences in virtual education environments, and offer implications for higher education institutions and instructors.

Keywords: virtual presence; flow; online education; human-computer interaction

A. M. Artoli and **Hassan Mathkour**

1586–1595   Model-based Assessment of College Alumni Applied to Computer Engineering and Sciences

In the fields of computer engineering and computer science, it is crucial for academic institutions to update their curriculum and develop their environment in response to raised opinions of college stakeholders, mainly college alumni and employers. Program outcomes and alumni competence need be measured and analyzed periodically and their results must be conveyed to curriculum committees, administration, enrolled students and policy makers within the college and the institution. The main purpose of this work was to relate program outcomes with the college and university objectives, to measure the alumni satisfaction on the college programs, and to report the progress of alumni and stakeholder satisfaction in the College for Computer and Information Sciences. We report here the progress in quality and competency of the college alumni as compared to a previously conducted survey.

Keywords: Model-based assessment; computer engineering education; quality of computer engineering education

Eugenijus Kurilovas and **Valentina Dagiene**

1596–1603   Computational Thinking Skills and Adaptation Quality of Virtual Learning Environments for Learning Informatics

The paper aims to analyse and propose scientific methods suitable for evaluating the adaptation quality of Virtual Learning Environments (VLEs) matching Informatics learners' needs. The authors' approach consists of the consecutive application of the principles of multiple criteria decision analysis for identifying the VLEs adaptation quality criteria, sets portrait method to analyse the interconnections of the VLE adaptation quality criteria and the learners' computational thinking skills, fuzzy group decision making theory to obtain final evaluation measures of the VLEs quality criteria, and scalarization method to obtain the final results of evaluating the VLEs quality. While applying these methods, appropriate decision support system was developed. This system consists of the learners' computational thinking skills' questionnaires, observations results and conclusions, VLEs adaptation quality criteria, their ratings (values) and weights, and final evaluation results that propose a proper decision. This approach should help Universities and schools to create, buy, or find free VLE software mostly suitable for teaching and learning Informatics. Computational thinking term is detailed in the paper, and interconnected with the VLEs adaptation quality criteria using sets portrait method. After that, multiple criteria decision analysis approach is used to evaluate the adaptation quality of VLE in terms of its conformance with the learners' computational thinking styles. The experts' additive utility function is proposed to use for the expert evaluation of the adaptation quality of VLEs. Trapezoidal fuzzy numbers method is proposed to use for establishing both weights and ratings (values) of the VLEs quality criteria matching learners' computational thinking styles. Practical example of the experimental evaluation of three popular open source VLEs is also presented in the paper. Presented research results are particularly useful for Informatics/software engineering education.

Keywords: engineering education; decision support system; virtual learning environments; computational thinking; multiple criteria decision analysis; expert evaluation; quality; adaptation; trapezoidal fuzzy numbers

Athanasios S. Drigas, Marios A. Pappas and **Miltiadis Lytras**

1604–1610   Emerging Technologies for ICT based Education for Dyscalculia: Implications for Computer Engineering Education

In recent years there have been significant advances in the use of ICTs (Information and Communication Technologies) in the education of students with learning disabilities. In this paper we represent some important studies which highlight the importance of using ICTs, with special reference to online and mobile learning applications, both for assessment and intervention required for students with dyscalculia. Results of the studies revealed that the use of ICTs in education and especially in children with dyscalculia, may in the future become an integral part of the global education process, however there are still many parameters to be investigated.

Keywords: assessment; ICT; intervention; dyscalculia; online applications; mobile applications

María Teresa García-Álvarez, Laura Varela-Candamio and **Fernando Rubiera Morollón**

1611–1617   Simulation in Software Engineering Education: A System Dynamics Proposal

The shortage of engineering professionals in working life together with the development of new teaching technologies had led to the necessity of real practices in engineering education field. This paper shows a project management simulation in which System Dynamics is proposed to apply for analyzing the effects of adding manpower to a software project management on total productivity, total costs and project duration. Students study how the introduction of new staff has different types of influence depending on the relationship established among the factors involved in the system. Results reveal that this method has a great impact in the competent training of engineers who need real management capacities and real experience in planning and project monitoring. Moreover, students increase their participation and interest in the concepts and encourage their comprehension into the performance of the system.

Keywords: system dynamics; human resource management; software engineering education; business; simulation; teaching based on learning

Eugenijus Kurilovas and **Irina Vinogradova**

1618–1624   Improved Fuzzy AHP Methodology for Evaluating Quality of Distance Learning Courses

The aim of the paper is to present a new methodology for evaluating quality of distance learning courses (DLC). DLC quality management is one of the main parts of the overall knowledge management activities in Higher Education institutions. The methodology proposed consists of creation of DLC quality model (i.e. criteria system), and consecutive application of several stages of new quality evaluation method based both on Fuzzy and Analytic Hierarchy Process (AHP) methods. Since DLC consists of two parts i.e. the content of the course and particular learning methods implemented by application of services and tools provided by virtual learning environments (VLE), DLC quality model should consist both of online content quality criteria, and VLE quality criteria. Since quality is a very complicated notion depending on multiple criteria, one should use multiple criteria decision analysis theory to create DLC alternatives' evaluation methodology. Evaluation method proposed consists of application of MCEQLS (multiple criteria evaluation of the quality of learning software) approach using triangular Fuzzy numbers to elaborate the ratings (values) of the quality criteria, and criteria weights elaboration method based on Fuzzy and AHP methods. The last method is absolutely novel in scientific literature.

Keywords: knowledge management; distance learning courses; quality evaluation methodology; quality criteria; weights; ratings; fuzzy numbers; analytic hierarchy process

Francesco Colace, Massimo De Santo, Donato Di Stasi and **Mario Casillo**   1625–1636   An Adaptive Educational Hypermedia System for Supporting Students in their Traditional Learning Process in Computer Engineering Education

Our "information-oriented" society shows an increasing exigency of life-long learning. In such context, the E-Learning approach allows flexibility requested by such kind of learning process. With a plethora of E-Learning providers and solutions available on the market, there is a new kind of problem: the selection of the most suitable E-Learning contents for the various users. In this scenario, Adaptive Educational Hypermedia System can be an effective approach. This paper addresses the design problem of an adaptive educational hypermedia system by the definition of its main components: the user model, the learning content model tracking strategy and the adaptation model are introduced. The proposed Adaptive Educational Hypermedia System has been integrated in an e-Learning platform, Moodle. An experimental campaign has been conducted with interesting results.

Keywords: e-Learning; adaptive educational hypermedia system; computer-assisted education

Hernan Sagastegui Chigne, Jose Emilio Labra Gayo, María Elena Alva Obeso, Patricia Ordóñez De Pablos and **Juan Manuel Cueva Lovelle**   1637–1646   Towards the Implementation of the Learning Analytics in the Social Learning Environments for the Technology-Enhanced Assessment in Computer Engineering Education

In this work we present a formal description of a learning environment framework that gives support to learning analytics. The framework is based on techniques that educational data mining and social network analysis provide. The purpose is to study or discover collaborative relationships that students generate during their learning process and make predictions or assessments about student learning. We also present a new model in the way the learning process is evaluated. This model is more personal and contributes to new possibilities that the digital technologies offer in technology-enhanced assessment.

Keywords: learning analytics; educational data mining; social learning environments; technology-enhanced assessment; informal learning; social network analysis

Amy L. Kaleita, Gregory R. Forbes, Ekaterina Ralston, Jonathan Compton, Darin Wholgemuth and **D. Raj Raman**   1647–1659   Pre-Enrollment Identification of At-Risk Students in a Large Engineering College

Historical data from multiple institutions show that students who achieve a first-semester grade point average (GPA) below 2.0 are at substantially greater risk of leaving engineering programs before graduating with a degree than are those who achieved above 2.0. Identifying these "at risk" students prior to the start of their first semester could enable improved strategies to enhance their academic success and likelihood of graduation. This study used two distinct modeling approaches to predict first-term GPA group (low-risk: GPA ≥ 2.0; at-risk: GPA < 2.0) based upon data available prior to the student's first pre-enrollment advising session. In the case of one of the approaches—which allowed a differential weighting of Type I to Type II errors—we explore how these weightings influences the prediction accuracy. The models used academic and demographic data for first-year engineering students from 2010 to 2012 from a single large public research-active institution. The two model types employed to build predictive models were (1) ordinary least squares multiple linear regression (MLR), and (2) classification and regression trees (CART). For both MLR and CART models, high school GPA and math placement exam scores were found to be significant predictors of first-term GPA. Increasing the cost of missing at-risk students in the CART models improves at-risk prediction accuracy but also increases the rate of false positives (incorrectly identifying a low-risk student as at-risk). The relative simplicity of the CART models, as well as the ease with which error-types can be weighted to reflect institutional values, encourages their use in this type of modeling effort.

Keywords: student success; regression trees; engineering; enrollment

Mª Luisa Casado, Daniel López-Fernández and **Victoria Lapuerta**   1660–1678   Socio-Emotional Competencies in Engineering Education

This paper gathers the research done from 2009 to 2014 in the context of a project consisting of several educational innovation projects carried out at the Technical University of Madrid (UPM) whose aim was to improve the socio-emotional competencies of its students and professors, in line with some requirements of the European Higher Education Area such as "preparing students for life as active citizens in a democratic society; preparing students for their future careers and enabling their personal development". The promotion of these competencies in the engineering students can help them to optimize their academic achievement and to increase their competitiveness in the business world. Meanwhile, the socio-emotional development of the teachers can help them to create an atmosphere that supports student learning. The training techniques (online, blended and face-to-face seminars, and Coaching processes) and the outcome research methods (ad-hoc surveys and tests, pre-post evaluation using Emotional Intelligence evaluation tests) used in the five-year project are presented in this manuscript, as well as the results obtained from the 451 students and 135 professors from six engineering schools of the UPM who enrolled in the project. The benefits of these projects (a significant increase in the students' emotional quotient and in the professors' emotional skills have been achieved) and the sustainability of their activities (an emotional competencies development online classroom, accessible to the entire university community, has been launched) are highly encouraging.

Keywords: transversal competencies; emotional competencies; emotional intelligence; coaching

Jingxiao Zhang, Haiyan Xie and **Hui Li**   1679–1690   Exploring the Cognitive Structure and Quality Elements: Building Information Modeling Education in Civil Engineering and Management

Undergraduate education in Building Information Modeling (BIM) area for Civil Engineering and Management (CEM) majors cultivates the students' abilities to handle the embedded context constraints, parametric modeling, and the corresponding education guidelines recommended by the assessment associations and agencies. This study focuses on the expected cognitive structure and the training contents of BIM education. The objective of this research is to design, implement, and adjust the subject areas of BIM courses to prepare students for the skills expected by job market. The authors studied the overlap of the scopes between undergraduate BIM education and the job market expectations on the skill structure of BIM abilities. The authors also reviewed the 2013 China Civil Engineering and Management Undergraduate Education Guideline (2013 CCEMUEG). Particularly, the authors developed the BIM cognitive structure concept and the unique, BIM-embedded, education knowledge tree in CEM major. To design the training contents, the authors adopted the Quality-Function-Development (QFD) house concept and its relationship principles, designed the knowledge units and knowledge points of 2013 CCEMUEG with the different corresponding encodings, constructed a path between BIM ability structure and CEM education, and performed the feasibility study of the implementation scheme. The research results include the blueprint of curriculum development and the knowledge framework showing the comparison of characteristics between BIM and 2013 CCEMUEG knowledge units and knowledge points. In conclusion, the research suggests that BIM education in CEM could be implemented in the whole undergraduate learning process, representing the life-span of construction/building projects. This research shines light on BIM education in CEM. Its analysis tool and knowledge tree will be a powerful revelation for the pedagogical design of BIM in undergraduate education.

Keywords: engineering education; QFD house; knowledge tree; quality elements; civil engineering and management; BIM

Benjamin Ahn   1691–1703   Applying the Cognitive Apprenticeship Theory to Examine Graduate and Postdoctoral Researchers' Mentoring Practices in Undergraduate Research Settings

Graduate and postdoctoral researchers regularly mentor undergraduate research (UR) students, yet the literature examining the mentoring practices of these researchers in UR settings is scarce. This study explored the mentoring practices of 17 experienced and highly valued graduate and postdoctoral researchers by conducting semi-structured interviews and analyzing the responses using cognitive apprenticeship (CA) theory. The mentoring practices used during different UR periods (i.e., teaching a literature review process, teaching technical content, training in lab skills or experimental techniques, assisting with data analysis, assisting in creating presentation slides or a poster, and assisting in writing a final report) were identified and classified according to CA principles. The study findings can assist graduate and postdoctoral researchers who are mentoring UR students and can contribute to the development of training programs on mentoring UR students.

Keywords: cognitive apprenticeship; mentoring; qualitative research; undergraduate research

Andre Leme Fleury, Henrique Stabile and Marly M. Carvalho   1704–1718   An Overview of the Literature on Design Thinking: Trends and Contributions

This paper discusses the findings of a systematic review of the literature on Design Thinking from 1980 to 2014. A multi-methods approach combining bibliometrics, content analysis and semantic analysis was applied. The findings indicate that Design Thinking projects share a common set of phases; however, there is no consensus about the most relevant tools and methods to be applied in each project phase. A definition of Design Thinking is proposed. Some Design Thinking characteristics are highlighted: the centrality of the user in a human-centered approach; an iterative prototyping method; exploring wicked and ill-structured problems; applying problem-solving concepts; the reasoning approach is divergent-convergent thinking based on abductive logic; the use of visual techniques to explore ideas; and the importance of interdisciplinary and multidisciplinary team collaboration.

Keywords: design thinking; designerly thinking; innovation process; systematic literature review

V. Pérez-Belis and M. D. Bovea   1719–1731   The Role of Eco-design Education in Influencing the Design of Electrical and Electronic Equipment: A Case Study Involving Industrial Design Engineering Students

The purpose of this paper is to analyse the influence that environmental education in eco-design has on industrial design engineer students facing the design of electrical and electronic toys. From the designer's perspective, eco-design education improves the extent to which environmental requirements are incorporated into the design process of electrical and electronic equipment, thus allowing for the development of products with enhanced environmental performance and greater potential for reuse or recycling. Taking electrical and electronic toys as a target product category, a workshop intended for students of bachelor's and master's degrees related to Industrial Design Engineering, was organized in a Spanish University. The main objective was to determine the extent to which designers include environmental recommendations into the process of designing their products and what type of recommendations they incorporate. In addition, this study determines differences among students from different educational profiles and analyzes the willingness of designers and future designers to participate in this kind of initiatives. The results suggest that training designers in the end-of-life of products and their environmental issues in a practical way makes them more willing to incorporate environmental requirements into the design process of electrical and electronic toys.

Keywords: engineering education; electrical and electronic toys; end-of-life; industrial design

Brooke Cannon, Shuchisnigdha Deb, Lesley Strawderman and April Heiselt   1732–1741   Using Service-Learning to Improve the Engagement of Industrial Engineering Students

Students in an undergraduate ergonomics course within the Industrial Engineering Department participated in a service-learning project. While working with a local sweet potato farm, student teams evaluated packaging operations at the farm and developed both ergonomics and operations improvements. At the conclusion of the course, students (n = 45) completed a survey on their perceptions of the project and its influence on learning outcomes, community engagement, and student development. More than 90% of the students reported that the project helped them learn course topics better than a traditional course method. The transfer students (transferred from a junior college or other university) especially found service-learning as an effective tool to better understand the course topics by having practical experience. Positive responses to the project were significantly higher in female students and students who had parents with an engineering background. Students with prior volunteer experience also had more favorable perceptions of the service-learning project than those who did not volunteer.

Keywords: service-learning; student engagement; community partnership

Allison Godwin, Leidy Klotz, Zahra Harari and Geoff Potvin   1742–1748   Sustainability Goals of Students Underrepresented in Engineering: An Intersectional Study

This paper considers the intersectionality of students' race, ethnicity, and gender, to learn more about how various groups pursue sustainability goals through engineering. The lack of diversity in engineering is a persistent issue which hinders the development of more sustainable engineering solutions. Therefore, this paper investigates sustainability-related beliefs and career outcome expectations among engineering students who identify with groups underrepresented in the field. These topics are investigated using data from a national (United States) survey of students in introductory college courses. The survey sample was stratified by institution type and the number of enrolled students. Responses came from 6,772 individuals enrolled at 50 institutions. Data was analyzed, ethnicity, and gender using descriptive statistics and multinomial logistic and linear regression. The intersectional approach to analyzing the data reveal opportunities to tailor teaching and messaging for greater diversity in engineering. For example, black females are more likely than other groups to want to address food issues in their careers while white females are no different than other groups. Results like these suggest ways to excite various populations about engineering careers, which could help attract much-needed diversity of thought to engineering for sustainability.

Keywords: underrepresented students; intersectionality; engineering; race; ethnicity; gender

Abe Zeid and Alexandra Carver   1749–1758   Developing a CAD Portfolio to Advance Engineering Students' Professional Careers

This paper presents the important elements of compiling a student portfolio. In the field of engineering, there is often a wide gap between students' technical knowledge and their ability to communicate concepts to a broad audience. As a result, many new engineers enter careers without the necessary skills to clearly discuss their work with colleagues from different departments, peers from different organizations, and the wider public.

Some engineering education programs are attempting to incorporate more emphasis on writing and communication into their course curricula, but there are still few opportunities for building and testing students' skills in this area. This paper presents the purpose of a powerful portfolio in terms of what it can offer students, their educators, and their future employers. It also makes an argument for strong communication as a necessary skill in the engineering classroom, in R&D settings within a company, and across different departments and industries. It also offers some suggested guidelines for the process of compiling a portfolio, based on data and documents compiled from both educational institutes and engineering organizations. The intent of this work is to offer students and educators a brief overview of the portfolio process, with emphasis on organizing the components of such a collection so that a potential employer or peer would find them intuitive and easy to understand.

Keywords: portfolio; curriculum; communication; education; engineering; documentation; interview; career path; self-assessment; teaching tools; CAD; design; technical skills

Improvement of doctoral education results from strong alignment of educational requirements with disciplinary expectations. This article reports on a qualitative study of 40 Ph.D. holding engineers working in academic and industry careers conducted through interview methods and constant comparative coding of transcripts, operationalizing Golde and Walker's Stewardship framework and making recommendations for doctoral engineering education. Findings indicate that engineering Ph.D. holders across both industry and academia participate in each of the three tenets of stewardship (i.e., generation, conservation, and transformation) in different ways. As such, we propose a new way to plan and to assess graduate student competencies that can be easily integrated into doctoral engineering programs.

Keywords: stewardship; engineering education; doctoral education

With the aim of characterizing self-regulated learning of engineering students in a Colombian university, students were asked to answer a Spanish version of the Motivated Strategies for Learning Questionnaire (MSLQ); this questionnaire enables obtaining information on epistemic motivation and learning strategies of the students in the courses they are studying. The data found suggest the dimensional structure of the questionnaire did not meet the context of those students. It was decided to make a new translation of the MSLQ into Spanish and make linguistic and cultural adaptations in order to achieve a valid instrument; this work began with the International Test Commission (ITC) guidelines. As a result, a new questionnaire was attained, MSLQ-Colombia. The objective of this article is to present the method used to obtain the MSLQ-Colombia, and the study of the psychometric properties of the new questionnaire. The psychometric properties studied were the construct validity, content validity and reliability. These properties were determined by factor analysis, Cronbach's Alpha and experts consultation. The participants of this research were 1218 engineering students and 12 university teachers. The results indicate the new questionnaire is valid and reliable, provide information to those who may use MSLQ-Colombia to comprehend the results of their investigations, and offer the international community new empirical evidences on MSLQ psychometric properties. It led to the conclusion that the MSLQ-Colombia has similar psychometric properties to the original MSLQ in English, and that the new questionnaire can be useful for the Spanish speaking international community. This article can be a valuable guide for those researchers, who desire making translations-adaptations of the MSLQ into languages-cultures different from English or Spanish, and also, to translate-adapt questionnaires of self-report besides the MSLQ.

Keywords: MSLQ, self-regulated learning; learning strategies; motivation to learn; psychometric research; engineering education

Massive Open Online Courses quickly infiltrated higher education, leaving little time for large-group discussions on their role in engineering education. We argue that a research agenda around the role of MOOCs in engineering education is necessary for fully leveraging them in our context. While four articles published between 2011–2015 outline future directions for MOOCs research, previous studies did not gather input from the community on the most pressing research needs, corresponding corresponding questions, or the research needs unique to engineering education. The purpose of this study is to present a research agenda around the role of MOOCs in engineering education that is informed by multidisciplinary perspectives (i.e., MOOCs, learning science, and engineering researchers and practitioners). Three NSF-funded workshops took place at engineering conferences throughout 2014 to facilitate the accomplishment of this goal. Thematic analysis of 65 workshop participants' survey responses led to an agenda that includes six research foci—namely, MOOCs participants; MOOCs course design; MOOCs technology development, delivery, and adoption; the role of MOOCs across education contexts; administrative concerns involving MOOCs; and MOOCs as a platform for large-scale education research. Ten to fifteen corresponding research questions per foci are presented. Implications of this work within and beyond engineering education are also discussed.

Keywords: MOOCs; research agenda; engineering education

This paper analyzes faculty comments collected in 1997, 1999, and 2002 in surveys of engineering faculty teaching practices using thematic analysis. The objective was to see if there were common themes in the comments from faculty in supportive/unsupportive climates. Comments from a 2014 survey administration were classified by teaching practices (traditional vs. non-traditional) and institutional climate (traditional vs. non-traditional), creating four conditions. These comments were then analyzed using a collective case study approach. The study of the two collections of open-ended comments was supplemented by multinomial logistic regression of survey items from the 2014 administration relating faculty teaching practices and the institutional climate for teaching. In the historical data, faculty views of student evaluations evolved from seeing it as a negative burden to describing is as positive evidence of student learning. Faculty comments included many references to administrators who only "pay lip service" to the importance of teaching, although some faculty spoke positively about their campus's commitment to quality teaching. Faculty awareness of and pressure to use student-centered methods increased with time. The collective case study identified faculty in all four conditions, although they were not equally prevalent, and illustrates the experience in each condition using faculty comments.

Keywords: engineering faculty; faculty development; institutional climate

This paper provides a comprehensive overview of the history of engineering management and clearly shows the various phases, both at national and international level, that finally culminated in the commencement of a graduate degree program in engineering management at the University of Naples Federico II and its subsequent evolution to entrepreneurial engineering. Nowadays, the relevance and the strategic importance of engineering skills in the development of innovative businesses and organizations motivates the investigation of the role of the engineer in society. The new figure of the engineer-entrepreneur is so complex and multi-dimensional that it becomes very important to collect contributions of literature from distant areas of investigation not strictly related.

Keywords: education history; engineering management; entrepreneurship; engineering skills; managerial skills; entrepreneurial skills

Object-oriented programming (OOP) abstract concepts are often difficult to understand for students, since it is not easy to find the equivalence of such concepts in daily life. In this paper we will study if an interdisciplinary approach based on an introduction to robotics and robot programming helps the student in acquiring the OOP concepts. For our experiments, we selected a sample of thirty individuals among students with an adequate knowledge of procedural programming. This sample was divided into two groups of fifteen students each: for the first one we used a standard introductory approach to C#, whereas for the second one we developed an experimental course that included a demonstration program that illustrated OOP basic concepts using the features of a specific type of commercial ball-shaped robot with sensing, wireless communication and output capabilities. After the courses, both groups were evaluated by completing a multiple-choice exam and a C# programming exercise. Our results show that the student group that attended the course including the robot demo showed a higher interest level (i.e. they felt more motivated) than those students that attended the standard introductory C# course. Furthermore, the students from the experimental group also achieved an overall better mark.

Keywords: interdisciplinary projects; mobile robots; object-oriented programming; robot programming; teaching-learning strategies