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Special Issue
Engineering Education: Beyond Technical Skills
Part I—Lessons Learned, Good Practices, Assessment Methods
Guest Editors
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Basic engineering skills are not the only key to professional development, particularly as engineering problems are everyday more and more complex and multifaceted, hence requiring the implementation of larger multidisciplinary teams, in many cases working in an international context and in a continuously evolving environment. Therefore other outcomes, sometimes referred to as professional skills, are also necessary for our students, as most universities are already aware. In this study we try to methodically analyze the main strategies for the promotion of professional skills, mainly linked to actuations which directly affect students or teachers (and teaching methodologies) and which take advantage of the environment and available resources. From an initial list of 51 strategies (in essence aimed at promotion of different drivers of change, linked to students, teachers, environment and resources), we focus on the 11 drivers of change considered more important after an initial evaluation. Subsequently, a systematic analysis of the typical problems linked to these main drivers of change, enables us to find and formulate 12 major and usually repeated and unsolved problems. After selecting these typical problems, we put forward 25 different solutions, for short-term actuation, and discuss their effects, while bearing in mind our team's experience, together with the information from the studies carried out by numerous teaching staff from other universities.
Keywords: professional skills; engineering education; continuous improvement strategies

The so called 'Soft Skills' (SSs) are the set of non-technical skills that enable a given individual to interact effectively and harmoniously with other people. These skills are also interesting for the promotion of deep knowledge and to foster academic success. The case study analyses the very special 'Projeto FEUP' course that promotes SSs across all engineering programmes in the Faculty of Engineering of the University of Porto (FEUP), in Portugal. This is done right after the arrival of students at the institution by means of producing several communicational items over an adequate technical work. The study involved 781 students. The presented results hint that Soft Skills are, in fact, improved after half-semester but this is not the sole product of the mentioned course.
Keywords: engineering education; professional skills; soft skills; curricula design; academic success

Machine Design is the most perspective field of study in the Faculty of Mechanical Engineering (FME) at the University of West Bohemia with regards to the demand for graduates in this field. These days, the main issue of higher education in the Czech Republic related to Machine Design is the lack of opportunities for students of Machine Design to acquire practical knowledge and experience in the field. The problem is that engineering companies offer work experience only to individual students as they try to hire them after graduation. But engineering companies are not motivated enough to contribute to the Machine Design teaching process by providing knowledge and experience to the majority of students. As this is not going to change soon, universities have to provide real applications to its students instead. Currently, there are not enough opportunities for students to acquire practical knowledge in the field during their studies. The required amount of work experience for engineering students in the Czech Republic is only one week, which is insufficient in comparison with the German system, where internship semesters are a mandatory part of studying at a Fachhochschule (University of Applied Sciences). It is necessary to provide practical information and real applications in class to compensate for the lack of practical experience. FME is concerned in this matter and it has launched the project for enhancement of the teaching process. A new concept of electronic learning materials for Machine Design was developed as a part of the project. The learning materials were developed by academics in cooperation with local engineering companies to provide students and academics at FME with real design projects reworked for learning purposes. The Machine Design teaching process is complicated due to the complexity of the mechanical design process, as it has its own particularities which need to be considered while creating learning materials. When describing the mechanical design process, not only the design process itself has to be described. Also the production processes, project schedules, economic aspects of the design project, legislative, technical standards and regulations have to be described as well. As these parts of the mechanical design process affect each other, it is important to describe them in the context of the mechanical design process to show the interconnection between them. The electronic form of learning materials was selected as it offers many advantages over the standard printed form. The main reason for selecting the electronic form of learning materials is the ability to work with Computer-aided engineering (CAE) models. Three-dimensional CAE models replaced drawing boards in every engineering company several years ago and thus it is important to include CAE models in the Machine Design teaching process. Thanks to the technology of exporting CAE models to the standard

portable document format (PDF) it is possible to modify CAE models for learning purposes and use them as a learning tool. CAE models can be enhanced with a large amount of information regarding a design project such as manufacturing processes, materials or component functions and can be supplemented by technical drawings, illustrated project descriptions and further information. All the learning material is converted into a single PDF file so that every student can access it anywhere, anytime. Versatility and interactivity are the biggest benefits of the new electronic learning materials. The new electronic learning materials can be used when explaining new subject matter to show its application, or as a basis for students' assignments, individual work, teamwork or dissertations. The sample electronic learning materials are being produced and will be made available to students through the courseware of the University of West Bohemia. This paper intends to present the learning materials and describe their form, structure and content and their benefits for academics and students of Machine Design.

Keywords: machine design; design projects; electronic learning materials; CAE models

Inês Direito, Anabela Pereira and **A. Manuel de Oliveira Duarte**   1556–1561   The Development of Skills in the ICT Sector: Analysis of Engineering Students' Perceptions about Transversal Skills

When starting a career, many engineering graduates possess the necessary technical knowledge but present serious behavioural mismatches. The lack of transversal skills, such as working well in teams and successful time management, can represent an important handicap in their careers and the resulting limitations can significantly impair their capability to undertake the roles that companies expect from them. In the present study, 297 ICT engineering undergraduate and post-graduation students were surveyed about their perceptions about their proficiency in and the importance of transversal skills. Findings showed that students rated more highly the importance of transversal skills than their own perceived proficiency in those same skills; post-graduation students (Bologna second cycle) perceived themselves as being more proficient in the vast majority of the transversal skills analysed, and revealed less skills' gaps in comparison with undergraduate students (Bologna first cycle). The results also showed that, in comparison with companies' representatives, students tend to value the generality of transversal skills, suggesting that students are aware of the importance of transversal skills for their future professional roles, but lack a differentiated vision about these skills. These results emphasize the need to invest in initiatives to promote the development of transversal skills during the students' university studies and also alert to the importance of a regular interaction between education systems and companies.

Keywords: transversal skills; ICT engineering; undergraduate students

Roman Žavbi and Nikola Vukašinović   1562–1578   A Concept of Academia–Industry Collaboration to Facilitate the Building of Technical and Professional Competencies in New Product Development

The development of innovative and competitive products is crucial for any company's long-term success in the global information society and the global market. Educational engineering programs should facilitate the building of both technical and professional engineering competences. Project based learning, teamwork and real-life product development in collaboration with industrial companies seem to be appropriate ingredients of such programs. A concept of academia–industry collaboration and its realisations were developed and applied by a strategic alliance of European universities. Initial results of the communication-trust building-creativity triad showed some properties of one of the applied concept realisations. Although the concept and its realisations were deemed successful, identified issues have to be addressed in the future.

Keywords: product development; teamwork; communication; collaboration; engineering competences

Charles E. Pierce, Juan M. Caicedo, Joseph R. V. Flora, Nicole D. Berge, R. Madarshahian and **Briana Timmerman**   1579–1589   Integrating Professional and Technical Engineering Skills with the EFFECTs Pedagogical Framework

This paper describes the Environments for Fostering Effective Critical Thinking (EFFECTs) pedagogical framework that has been developed and implemented across the civil and environmental engineering curriculum at the University of South Carolina. Thirteen unique EFFECTs have been created to date, impacting seven different courses. This instructional approach has been used in courses at all undergraduate levels, from first-year introduction courses to upper division elective courses. The cumulative application of EFFECTs facilitates the integration of technical and professional skills to meet programmatic student outcomes. This paper provides a map of the ABET and ASCE student outcomes that are addressed with EFFECTs, with appropriate examples from different EFFECTs modules. In terms of professional student outcomes, the EFFECTs framework is designed to enhance student communication skills, teamwork, and knowledge of contemporary issues. In addition to these three core outcomes, each EFFECT can incorporate other professional skills, depending on the nature and content of that particular EFFECT. The implementation of EFFECTs has reached a point where most, but not all, upper division students (seniors) have been exposed to the EFFECT approach at least once during their academic program. Survey results on student self-perceptions of professional skill development are reported in this paper. Based on those findings, teamwork is the highest rated outcome. Professional skill development was also found to improve significantly when students are exposed to EFFECTs in more than one course.

Keywords: ABET; ASCE; civil engineering; communication; contemporary issues; critical thinking; professional skills; student outcomes; teamwork

Ismat Aldmour   1590–1601   A New Computer Engineering Curriculum Based on Technology Expansion to Address the Needs of Developing Communities

Computer engineering (CE) is a discipline that best serves the semiconductor, micro-architecture, computer equipment manufacturers, and other similar high tech industries which generally do not exist in developing communities. Therefore, there is often a mismatch problem between the curricula offered by CE departments and the actual needs of such communities. Nevertheless, most attempts for engineering curricula revitalization in developing countries focus on bridging the gap in applying the curriculum models, designed for, and meant to serve the developed communities. Hence, this work presents a new curriculum approach in which the student's learning experience is expanded outside CE to include a technology area of interest to the community. The article revises the typical CE curriculum model and visualizes it as a funnel structure, called the Single Funnel Model (SFM). SFM directs students to core computer engineering courses or courses in a specific concentration area. However, the need for concentration in developing communities with moderate-tech industries in a country like Saudi-Arabia is questionable. Hence, to better serve such communities, it is suggested that concentration areas be replaced by technology wide areas called Technology Expansion (TE) areas. Such a curriculum structure is called the Dual Successive Funnels Model (DSFM). To assess the problem and the suggested model, members of the academic community in the field in universities in the Middle East and Gulf countries were surveyed. The investigation revealed that the academics were, on the average, neutral on the extent of the problem, whereas they think that the new DSFM based on TE suits the needs of their developing communities better than the current SFM based on concentration. They also think that it can help the students develop their professional skills and lead to better integration in work environments.

Keywords: computer engineering education; curriculum modeling; technology based learning; SFM; DSFM

Sara P. Rimer, Jose F. Alfaro, Lauren B. Stadler, Cinda Sue G. Davis and **Herbert G. Winful**   1602–1612   Co-Curricular Programs in Liberia for Student Pipeline into Engineering and Agriculture

After a fourteen year decimating civil war, the country of Liberia was left with the challenge of rebuilding its human and institutional capacity, particularly at the higher education level. The University of Michigan's College of Engineering was awarded part of a United States Agency for International Development grant to improve higher education in Liberia, namely the Excellence

in Higher Education for Liberian Development program. Specifically, the University of Michigan's role in this grant is to increase the capacity of and enthusiasm among young students toward the two most crucial fields in the future of the country: engineering and agriculture. To accomplish this, the University of Michigan developed co-curricular programs at the secondary and university level that (i) create a pipeline of higher educational opportunities for students committed to pursuing careers in engineering and agriculture and (ii) increase the field-specific practical skills and breadth of experiences of those students. A specific focus of these co-curricular programs is on the development of soft skills of the participants—which are key for their future professional success. Already, within the first two years of implementation of these programs, unique and positive results have been demonstrated by the participants. The enthusiasm and commitment of the students toward engineering and agriculture has markedly increased. Furthermore, students have developed and improved their soft skills, such as public speaking, presentation skills, group work, communication skills, study skills, goal development, and critical thinking. In addition, the students exhibited a tremendous ability and initiative to work on open-ended community design projects.

Keywords: Engineering education; agriculture education; engineering outreach; agriculture outreach; K-12 and higher education partnerships; project-based learning; soft skills development

María Jesús García-García, Esperanza Ayuga-Téllez, Concepción González-García[c] and María de los Ángeles Grande-Ortíz

1613–1620 Integration of Teaching Activities for Training in Research Skills in Technical University of Madrid

Training researchers entails a process of social interaction that enables an advance in knowledge, know-how and attitudes. When engineering students of the Technical University of Madrid (UPM) enrol in an educational cycle consisting of research and post-graduate studies, they are confronted with a need to change the way they conduct their activities, and find themselves unfamiliar with the research methodology and the nature of the study objectives. The acquisition of research skills at this stage of education is not usually part of the teaching syllabus. The investigation conducted here is the action-research type, whereby a situation is studied from the point of view of the participants. It consists of a process of analysis, diagnosis, proposals for change and assessment before the process is re-initiated. The main aim of this experience is to develop the skills associated with research activities. The objective results of this experience show that the trainee researchers acquired the skills that were the object of this work. These skills were manifested by the subjects resolving a real problem, working as part of a research team, and preparing work for publication in a variety of channels for the dissemination of scientific output. The opinion of the experienced researchers was resulted in a very positive valuation of the aspects considered. This action may potentially have a significant impact on the new postgraduate programmes, as it demonstrates that the planning of joint works covering a variety of disciplines and with data corresponding closely to the actual situation not only provides high-quality academic results, but is also capable of generating results from real research projects. With the logical adaptations, it could also be applied in undergraduate courses.

Keywords: doctoral education; researcher training; scientific publications; teaching experience

Benjamin Ahn, Monica F. Cox, Tasha Zephirin, Kehara Taylor, Amadin Osagiede, Yating Haller, Eckhard A. Groll and Stephanie G. Adams

1621–1635 Designing Courses using Case Studies and Content, Assessment, and Pedagogy (CAP) to Cultivate Professional Skills among Engineering Students

Informed from (1) case-based pedagogy literature, (2) content, assessment, and pedagogy (CAP) aspects of developing courses, and (3) two professional development workshops in which engineering faculty created case-based materials to incorporate professional skills into traditional engineering curricula, this paper guides engineering faculty in their creation of short courses or workshops that engage their students in professional skills that often are not taught within traditional engineering classrooms. Steps, excerpts, and examples that are useful in the development of these courses or workshops are provided throughout the paper. The authors envision that the paper will serve as a user-friendly resource that engineering faculty can use to identify, develop, and implement courses that seek to address professional skills in their academic settings.

Keywords: professional skills; case-study; engineering undergraduate; course development

Jorge E. Pérez-Martínez, Javier García Martín and Ana Isabel Lías Quintero

1636–1644 Integrating Generic Competencies into Engineering Curricula

The new degrees in Spanish universities generated as a result of the Bologna process, stress a new dimension: the generic competencies to be acquired by university students (leadership, problem solving, respect for the environment, etc.). At Universidad Politécnica de Madrid a teaching model was defined for two degrees: Graduate in Computer Engineering and Graduate in Software Engineering. Such model incorporates the training, development and assessment of generic competencies planned in these curricula. The aim of this paper is to describe how this model was implemented in both degrees. The model has three components. The first refers to a set of seven activities for introducing mechanisms for training, development and assessment of generic competencies. The second component aims to coordinate actions that implement the competencies across courses (in space and time). The third component consists of a series of activities to perform quality control. The implementation of generic competencies was carried out in first year courses (first and second semesters), together with the planning for second year courses (third and fourth semesters). We managed to involve a high percentage of first-year courses (80%) and the contacts that have been initiated suggest a high percentage in the second year as well.

Keywords: generic competencies; teaching and assessment; curricula; coordination

Javier Carmona-Murillo, Miguel A. Martín-Tardío, Juan Arias-Masa, Juan C. González-Macías, Pedro J. Pardo Fernández and Juan F. Valenzuela-Valdés

1645–1656 Providing Professional Skills to Telecommunication Engineers through a Novel Vertical Approach

The new context of the European Space of Higher Education and the current social environment marked by new technologies implies that new Telecommunication Engineers must be trained not only in technical knowledge but also in the professional skills that they must use in their professional lives. Some learning methodologies, such as Project-Based Learning help develop these skills. This paper presents projects developed in order to teach and assess different skills. The methods used change depending on the year of the academic program. The projects have been designed to focus on "process skills": The ability to work in a multi-disciplinary team, understanding of both professional and ethical responsibility and the ability to communicate effectively. The projects have been assessed through multi-source feedback combined with the use of rubrics to facilitate the evaluation. According to the results, most of the objectives have been achieved. Student satisfaction is very high, as the survey results demonstrate.

Keywords: engineering education; engineering professional skills; program implementation; project-based learning

Francisco Falcone, Ana Alejos, Pablo Sanchis and Antonio Lopez-Martin

1657–1668 Enhancing the Development of Multidisciplinary Skills in Engineering Students by Promoting Industry and University Synergy

In this paper, the development of different multidisciplinary skills within the framework of development of Final Degree Projects and Master Degree Projects is presented. By means of liaisons established with industry, not only technical aspects of real industrial challenges are covered, but also the necessary transverse competences. The continuous feedback between students, academia and industrial/corporate members leads to an effective multidisciplinary environment, in which all of the participants have the opportunity of experiencing an effective increase in their knowledge base.

Keywords: engineering education; European Higher Education Area (EHEA); Final Degree Project; Master Degree Project

Marinez Cargnin-Stieler, Marcelo
C. M. Teixeira and **Edvaldo Assunção** 1669–1679 Notes on Competencies in Engineering Education

The subject covered in this text is an excerpt of a larger project and presents discussions on teacher's competencies, in engineering education, and also technical and scientific competencies. There is a growing demand for engineering teachers and this raises concern with regards to the formation of these professionals in Brazil. This paper begins with the information collected by electronic mail sent to professors of all Electrical Engineering postgraduate programs in Brazil. The questions/suggestions requested included the advice that could be given to postgraduate students about to enter the teaching profession. This research, grounded in the studies of Braslavsk, Perrenoud, Masetto and Zabalza, among other studies, indicated a convergence towards three engineering professor competencies: in-depth knowledge about the subject to be taught (technical and scientific), knowing the teaching content and to know how to teach this content (pedagogical-didactic competence). In light of these questions, a didactic and pedagogical approach course is proposed, to be addressed collaboratively in the engineering postgraduate program. One suggestion regards addressing case studies or problems experienced by teachers, where the teacher chooses problems or cases grounded in theories, and students assigned to solve them in the best possible way. This could represent an initial setting to discuss and consider the engineering teacher role. In engineering education and pedagogic formation there is a gap that needs to be closed, especially during the doctoral or master program, as this is when the engineering teacher or teaching candidate qualifies technically and scientifically to engage in researching and teaching.

Keywords: engineering education; engineering learning; engineering teaching; early-career professionals

Beatriz Amante and **Lluc Canals** 1680–1688 Evaluation of a Pilot Program that Integrated Generic and Specific Skills on Engineering Degree: A Case Study in Catalonia

The ETSEIAT (Escola Tècnica Superior d'Enginyeries Industrial i Aeronàutica of Terrassa) recently executed pilot programs to introduce generic and specific skills into its study plans. As these pilots are now concluding, an evaluation of their efficiency has been conducted. This paper analyses the answers given by professors who were interviewed (via in-person interviews and online tests) to determine how they developed and evaluated their students' skills. The results of these interviews offer clear data about the progress obtained by the pilot programs, how the professors understood the recently added dynamics and tools, and how the new skills are integrated into the various subjects and courses.

Keywords: engineering degree, generic skills, evaluation, oral and written communication, feedback

Maria Martinez, Noelia Olmedo,
Beatriz Amante, Oscar Farrerons and
Ana Cadenato 1689–1696 Analysis of Assessment Tools of Engineering Degrees

This work presents an analysis that has been done about the assessment tools used by the professors of the Universitat Politécnica de Catalunya to assess the generic competencies introduced in the Bachelor's Degrees in Engineering.

In order to realize this study has been elaborated a survey which has been done anonymously to a sample of the most receptive professors with the educational innovation of the own university. In total there were 80 professors who answered the cited survey, of whom the 26% resulted to be members of the evaluation innovation group (https://www.upc.edu/rima/grups/grapa) the own university, GRAPA. This percentage represents a 47% of the total GRAPA membership, so from the most sensible professors with the evaluation matter in the university, closely the half has answered.

The variables analysis realized using the statistical program SPPS v19 shows that for practically the 49% of the surveyed the rubrics are the most utilized tools to assess the generic competencies integrated with the specific ones, and of those the 60% use them frequently or always. The most evaluated generic competencies have been the teamwork (28%), problem solving (26%), effective oral and written communication (24%) and autonomous learning (13%) all of them very recognized competencies for the engineering profession.

Two dimensional crosstabs analysis with SPSS v19 show that there is a significant correlation (Asymp. Sig. 0.001) between the type of used tool and the assessed competencies. However, any significant correlation has not been found between the type of assessment tool used and the type of subject, typology of evaluation (formative or summative), feedback frequency given to the students or satisfaction degree of the students so none of those variables have influence on the kind of used assessment tool. In addition, the results also indicate that there are not significant differences between the GRAPA's professorship and the remain of the surveyed.

Keywords: competencies; assessment tools; engineering degree

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Marcos, Antonio Carretero Díaz, Mª
del mar de la Fuente García-Soto,
Julio Lumbreras Martín, Mª Luisa
Martínez Muneta, Vicente Riveira Rico
and **Manuel Rodríguez Hernández** 1697–1707 Integral Framework to Drive Engineering Education beyond Technical Skills

This paper presents the steps followed at the Escuela Técnica Superior de Ingenieros Industriales (ETSII) at the Universidad Politécnica de Madrid (UPM) to progressively implement an outcomes assessment framework. This assessment is understood as the integral process to guide and guarantee that graduates, when they finish their studies, have acquired the knowledge, abilities and skills established in the program (i.e. outcomes). This is a process linked to the entire program (and not to a single course or activity) and to the cohort of students (and not to the evaluation of each student individually).

At the ETSII, the outcomes assessment process has been designed in accordance with the Accreditation Board for Engineering and Technology (ABET) criteria which establishes 11 outcomes that must be fulfilled by the students as a necessary step in the accreditation process and as a preparation to attain the educational program objectives. The implementation of these 11 outcomes is intentionally unspecified by ABET to encourage each engineering program's faculty to achieve its own specificity considering its idiosyncrasy. This paper describes the approach followed in the ETSII to develop an integral strategy for the institution and to progressively evolve to an outcomes assessment culture. From this experience, some quite generalizable learned lessons are extracted that can be useful for other faculties involved in similar processes.

Keywords: outcomes; competencies; ABET; framework; skills

Carme Martín 1708–1719 Assessing an Appropriate Attitude towards Work in Engineering Education

Appropriate attitude towards work is a generic competency developed in the Bachelor's Degree in Computing Engineering at the Barcelona School of Informatics. This competency includes: the ability to work in teams with responsibility and respect, a proactive attitude, motivation for quality and the continuous improvement in processes and results, as well as the adaptability to organizational and technological changes. In order to develop this competency into a comprehensive integrated experience, a definition in terms of dimensions, which are further defined according to three-level objectives, is required. A set of activities to achieve each objective is proposed. The goal is to define this set in a way that makes it easily integrated into the contents of each course where the competency is involved. The evaluation of the competency can be obtained tracking the progress of students developing these activities. This paper presents a proposal to develop and assess this competency, with a six semester experience integrating activities in the degree program.

Keywords: engineering education; generic competencies; interpersonal skills

Francisco Javier Páez, Carmen García,
Miguel Ángel Álvarez, Juan José Herrero
and **Francisco Aparicio**

1720–1728   Assessment of Professional Competencies Promoted by SAE Formula
Project: The UPMRacing Case

Promoting professional competencies is becoming an issue of interest and major concern in university environments. The assessment of individual students has usually been based on their knowledge and skills in solving problems on paper in an environment where time is scarce and information is restricted to the data given in the written instructions. However, the human resource managers of the major companies rate basic professional competencies very highly in the graduates that they take on, putting less importance on the level of technical knowledge possessed at the time of they are being taken on. In 1982 engineers from Ford, Chrysler and General Motors in the United States, being aware of how newly graduated engineers were adapted to automotive companies, designed a competition for universities throughout the world: Formula SAE. This competition involved conceiving, designing, manufacturing and competing with a formula-type vehicle. In 2003 the University Institute for Automobile Research (UPM—INSIA), was set up as the first Spanish Formula SAE competition team, called UPMRacing. The aim of this paper is the assessment of the professional competencies promoted by the Formula SAE project in individual students participating in the UPMRacing team. The compeTEA questionnaire[©] has been selected to assess competencies in the context of the UPMRacing team. This questionnaire has been applied to the team members in two milestones: when they start their participation (initial stage), and after they compete. Results conclude that this learning activity increases the professional competencies in a significant way, mainly in case of the students with the lowest level of professional competencies in the initial stage. Additionally, the main deficiencies identified in the participating students were the acquisition of organisational and planning competencies.

Keywords: professional competencies; Formula SAE; UPMRacing; assessment; psychometric test

Raquel Martínez, Camino González,
Pascual Campoy, Álvaro García-Sánchez
and **Miguel Ortega-Mier**

1729–1740   Do Classes in Cooperative Classrooms Have a Positive Influence on
Creativity and Teamwork Skills for Engineering Students?

Contributing to the acquisition of professional creativity and teamwork skills has been a special challenge for some of the subjects taught at the Technical University of Madrid (UPM), and this has been a starting point for the work described in this paper. Some professors have intuited that the use of cooperative classrooms could facilitate the acquisition of these skills. We describe the new methodologies applied within cooperative classrooms by some professors, and present the procedure for measuring students' perception of their own learning outcomes, skill improvements, and overall satisfaction with the use of this kind of classroom. For this project, 250 students enrolled in several subjects answered a questionnaire. The features of the subjects involved in the project are widely disparate. We present the results of the statistical analysis with special emphasis on creativity and teamwork skills, and we conclude that the use of cooperative classroom has a positive influence on the acquisition of these skills. This work has the added value of being the first analysis of student perception of the use of cooperative classroom in the acquisition of creativity and teamwork skills.

Keywords: creativity; teamwork; new methodology; public speaking

Ángel García-Beltrán, Santiago Tapia
and **María-Jesús Sánchez-Naranjo**

1741–1748   Performance and Professional Skills in an Online Java Programming Course
for Engineering Students

The main purpose of this work is to describe the case of an online Java Programming course for engineering students to learn computer programming and to practice other non-technical abilities: online training, self-assessment, teamwork and use of foreign languages. It is important that students develop confidence and competence in these skills, which will be required later in their professional tasks and/or in other engineering courses (life-long learning). Furthermore, this paper presents the pedagogical methodology, the results drawn from this experience and an objective performance comparison with another conventional (face-to-face) Java course.

Keywords: online course; Java programming; self-assessment; teamwork; proficiency test; life-long learning

Angel Méndez, Miguel Florensa,
Cristina Molleda, Consuelo Fernández,
Angel Alcazar, Jose Bruno Ramiro-Diaz,
Enrique Sardonil, Emilio Manrique and
Teresa Montoro

1749–1758   Development of a Method of Assessment of the Problem-Solving
Competency at the Technical University of Madrid

The competence evaluation promoted by the European High Education Area entails a very important methodological change that requires guiding support to help lecturers carry out this new and complex task. In this regard, the Technical University of Madrid (UPM, by its Spanish acronym) has financed a series of coordinated projects with the objectives of developing a model for teaching and evaluating core competencies and providing support to lecturers. This paper deals with the problem-solving competence. The first step has been to elaborate a guide for teachers to provide a homogeneous way to asses this competence. This guide considers several levels of acquisition of the competence and provides the rubrics to be applied for each one. The guide has been subsequently validated with several pilot experiences. In this paper we will explain the problem-solving assessment guide for teachers and will show the pilot experiences that have been carried out. We will finally justify the validity of the method to assess the problem-solving competence.

Keywords: European High Education Area; competencies assessment; problem-solving, rubrics

1759   Guide for Authors