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Daniel Toll, Tobias Olsson, Morgan Ericsson and Anna Wingkvist	1069–1077	Fine-Grained Recording of Student Programming Sessions to Improve Teaching and Time Estimations

It is not possible to directly observe how students work in an online programming course. This makes it harder for teachers to help struggling students. By using an online programming environment, we have the opportunity to record what the students actually do to solve an assignment. These recordings can be analyzed to provide teachers with valuable information. We developed such an online programming tool with fine-grained event logging and used it to observe how our students solve problems. Our tool provides descriptive statistics and accurate replays of a student's programming sessions, including mouse movements. We used the tool in a course and collected 1028 detailed recordings. In this article, we compare fine-grained logging to existing coarse-grained logging solutions to estimate assignment-solving time. We find that time aggregations are improved by including time for active reading and navigation, both enabled by the increased granularity. We also divide the time users spent into editing (on average 14.8%), active use (on average 37.8%), passive use (on average 29.0%), and estimate time used for breaks (on average 18.2%). There is a correlation between assignment solving time for students who pass assignments early and students that pass later but also a case where the times differ significantly. Our tool can help improve computer engineering education by providing insights into how students solve programming assignments and thus enable teachers to target their teaching and/or improve instructions and assignments.

Keywords: computer science education; learning analytics; educational data mining; computer engineering education

Egle Jasute, Svetlana Kubilinskiene, Anita Juskeviciene and Eugenijus Kurilovas	1078–1086	Personalised Learning Methods and Activities for Computer Engineering Education
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This paper aims at establishing interconnections between Felder-Silverman learning styles model (FSLSM) and inquiry-based learning (IBL) activities. FSLSM model is known as the most suitable for engineering education and e-learning. IBL are known as very helpful for students while studying STEM (Science, Technology, Engineering and Mathematics) subjects incl. Computer Engineering. Interconnections are established using expert evaluation method based on trapezoidal Fuzzy numbers. Evaluation was performed by mascil project's teachers-experts in computer engineering. The established interconnections are useful while creating suitable IBL-based learning scenarios for students having different learning styles. These learning scenarios could be created using ontologies-based recommender systems for computer engineering education and STEM subjects using created interconnections.

Keywords: computer engineering education; STEM subjects; Felder-Silverman learning styles model; inquiry-based learning; expert evaluation; trapezoidal Fuzzy numbers; mascil project

Anita Juskeviciene, Egle Jasute, Eugenijus Kurilovas and Jelena Mamcenko	1087–1096	Application of 1:1 Mobile Learning Scenarios in Computer Engineering Education
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The paper aims at presenting case study on personalised mobile learning scenarios on Computer Engineering and other STEM subjects in Lithuania. Fleming (VARK) learning styles model was used to personalise Creative Classrooms Lab (CCL) project's mobile learning scenarios by establishing suitable learning components for particular students according to their personal needs. Personalised mobile learning scenarios were compared against traditional "one size fits all" learning scenarios. Comparison was performed on the base of the analysis of Lithuanian CCL teachers' answers on questionnaire during the 2nd cycle of CCL project implementation and previous research results on expert evaluation of these types of learning scenarios. During this cycle, inquiry-based learning (IBL) activities developed in mascil project and a number of mobile applications (apps) were used by Lithuanian teachers while implementing the mobile learning scenarios, and interconnections between personalised IBL sub-activities and mobile apps were established. The authors have also analysed CCL observation visits' final report in terms of learning personalisation, creativity and innovation in schools. Based on this three-fold research, the authors concluded that (a) pedagogical change is

necessary to improve learning outcomes for students, and (b) the main success factors in implementing mobile learning scenarios in Lithuania were: (1) identification of students' learning styles; (2) identification and application of suitable learning activities, methods, learning objects, tools and mobile apps according to students' learning styles; and (3) use of proper sets and sequences of learning methods while implementing mobile learning scenarios.

Keywords: computer engineering education; STEM subjects; personalised learning; mobile learning scenarios; learning styles; inquiry-based learning; educational data mining; questionnaire for teachers; CCL project; mascil project

J. Ángel Velázquez-Iturbide 1097–1106 GreedEx and OptimEx: Two Tools to Experiment with Optimization Algorithms

Experimentation is an important part of the education of computer engineers. In particular, it is a common educational practice to check algorithms correctness or efficiency. However, experimentation has seldom been used to check the optimality of (optimization) algorithms. The article presents two tools aimed at experimenting with this property. They have some common features, but differ in their degree of generality and scaffolding. GreedEx is a tool for novices, being aimed at the active learning of the foundations of greedy algorithms. It currently supports six optimization problems. OptimEx is a more advanced, general experimentation tool that can be used with any kind of optimization algorithms. If both systems are used in an algorithm course, they should be used at different stages. The paper presents two contributions. Firstly, we present the novel system OptimEx. Secondly, we give recommendations of use for both tools, based on the author's experience using and evaluating them. Of particular interest is a list of incorrect outcomes that may be produced by OptimEx, which are symptoms of students' misconceptions, as well as how to fix them.

Keywords: computer engineering education; optimization algorithms, experimentation, scaffolding, instructional recommendations

Vladimiras Dolgopolas, Tatjana Jevsikova, Valentina Dagiene and Loreta Savulionienė 1107–1116 Exploration of Computational Thinking of Software Engineering Novice Students Based on Solving Computer Science Tasks

During the recent years computational thinking has been actively promoted through the K-12 curriculum, higher education, contests, and many other initiatives. Computational thinking skills are important for a further students' educational and professional career. Our focus is on computational thinking for software engineering novice students, a term meant to encompass a set of concepts and thought processes that are helpful in formulating problems and their solutions. Annually organized international challenge on Informatics and Computational Thinking "Bebras" has developed many tasks to promote deep thinking skills in this area. It is important to motivate students to solve various informatics or computer science tasks and evaluate their computational thinking abilities. The paper presents a study conducted among first-year students of software engineering, studying the structured programming course. As an instrument to measure computational thinking, a test of internationally approved and well-preselected tasks from the "Bebras" challenge has been suggested and validated. The correlation between the students' test results and the structured programming course results has been investigated. We conclude with a discussion and future directions to enhance computational thinking skills of novice software engineering students.

Keywords: computational thinking; Bebras challenge; computer science concepts; computer engineering education; contest; novice programming students; novice software engineering students

Yoshiaki Matsuzawa, Motoki Hirao and Sanshiro Sakai 1117–1127 Compile Error Collection Viewer: Visualization of Compile Error Correction History for Self-assessment in Programming Education

We have developed CocoViewer (Compile error Collection Viewer) for learners in programming to enable them to conduct self-assessment for compiling error records. CocoViewer generates charts that show a trajectory of reducing the correction time of the compile error that is calculated by logs recorded in students' computers during a programming course. Students can see lists of charts for many kinds of compile errors, as well as a particular detailed circumstance of error that is selected by a student. We hypothesized that the system promotes clear understanding regarding their compile error learning, which leads to encourage more experiences of compilation error correction, as well as to reduce unarticulated anxiety for the compile error. The system was tried in a self-assessment context at an undergraduate introductory programming course for approximately 100 non-CS students. The results in the questionnaire showed that the students appreciated the system for a reflection of their process, and we succeeded in reducing unarticulated anxiety for students. The results indicate that self-assessment with CocoViewer enable to boost students' motivation in programming education, which forms the basis of computer engineering education.

Keywords: computer engineering education; programming education; compile error correction; self-assessment; learning analytics

Svetlana Kubilinskiene, Valentina Dagiene, Inga Zilinskiene and Eugenijus Kurilovas 1128–1140 Empirical Study on Robotics Application in Lithuanian Schools

Modern learning environment may be developed by using innovative tools and methods, e.g. robotics. Benefits and efficiency of robotics in teaching and learning processes have recently been drawing an increasing focus among researchers. Application of robotics is useful for students while studying Computer Engineering and other STEM (Science, Technology, Engineering and Mathematics) subjects. The article pursues twofold research aim: (1) to perform systematic review of the literature on application of educational robots in schools in order to identify the experience in use of robotics in primary, basic and secondary schools, and (2) to conduct empirical study in Lithuania on the attitude towards use of robotic technologies in education, the related experience and demand, and identify the causes of low use of robotics in teaching and learning. Systematic literature review has shown that robotics has been paving its way as a teaching aid in a more intensive and flexible manner. The findings of empirical study have demonstrated the potential in use of robotic technologies and current related implications in Lithuanian schools.

Keywords: robotics; schools; application; systematic review; empirical study; computer engineering education; innovative tools; innovative methods; semantic web; knowledge society

Ekaterina Yagunova, Sergei Pozdniakov, Nina Ryzhova, Evgeniia Razumovskaia and Nikolay Korovkin 1141–1150 Evaluation of Difficulty and Complexity of Tasks: Case Study of International On-line Competition "Beaver"

Interest in the assessment of the quality of traditional educational techniques has grown, especially in relation to the subjects like IT or Computer Science because Informatics tests carried out using computers enable us to evaluate the quality of tasks using log-files. The study focuses on the assessment of difficulty and complexity of tasks for schoolchildren. Based on the analysis of results of 6588 participants in the international informatics competition 'Beaver-2012', it is shown that often usual a priori evaluation made by the organizers of the competition does not correspond to the task's real difficulty for the participant. A cluster of tasks the difficulty of which was underestimated was distinguished. The correlation between the length of the statement and difficulty for primary school children was shown. In order to make the results of the test more valid, a way of dividing the tasks according to their difficulty and complexity was found. Based on the method, recommendations for the organizers of the tests for general public were formulated in order to make the measures of educational outcomes of computer engineering knowledge more valid and accurate.

Keywords: complexity of tasks; difficulty of tasks; informatics; on-line competitions; educational tests; typology of tasks; competition "Beaver"; computer engineering education

Jacqueline C. McNeil and Matthew W. Ohland 1151–1159 The Influence of ABET Accreditation Practices on Faculty Approaches to Teaching

This paper investigates the effect of ABET accreditation processes on quality teaching using thematic analysis of descriptions from faculty in open-ended survey questions and logistic regression of quantitative survey questions about their pedagogy. Ordinal logistic regression related faculty perspectives on accreditation terminology and processes to faculty teaching practices. There were 43 qualitative comments about ABET accreditation and 91 quantitative survey results used in this study. Faculty had overwhelmingly negative views regarding accreditation, believing that it adds to their workload, stifles their creativity, and distracts them from other important objectives including teaching. Faculty who express various negative views of either the goals or the practice of accreditation are less likely to engage in certain student-centered teaching practices. More positively, our findings show that faculty who tend to agree with the student-outcomes focus of the ABET criteria engage in richer educational experiences—they give students more writing assignments and allow students to learn collaboratively.

Keywords: engineering; ABET; accreditation; teaching practices

Glenn W. Ellis and Yezhezi Zhang 1160–1170 The Development of 21st Century Skills in the Knowledge Building Environment

Many of the most important problems facing engineers today have solutions that require not only technical expertise, but also the application of 21st century skills. Knowledge building (KB) is an instructional approach designed to support both deep learning and the development of these skills. In KB learners engage in a sustained discourse to share knowledge, formulate and refine inquiries, and continually improve their collective ideas and understanding of authentic problems. This paper presents an example of applying KB in an undergraduate engineering mechanics course. Data from 77 students engaging in KB and the discourse record of a KB team consisting of 8 students was examined to look for indications of 21st century skill development. Evidence was found supporting high-level creativity and innovation, communication, collaboration/teamwork, information literacy/research, critical thinking and metacognition skills. The discourse also provided evidence that the class was centered on the learner, knowledge, community, and assessment—all best practices for designing learning environments.

Keywords: knowledge building; 21st century skills; learning environment; assessment

M. Rosario Perello-Marín, Pilar I. Vidal-Carreras and Juan A. Marín-García 1171–1181 What Do Undergraduates Perceive About Teamwork?

According to the European Higher Education Area (EHEA), training programs should be built on a set of competences that could lead to higher employability and transferability. Among these competences, teamwork is shown to be a highly desirable skill by employers, but not always achieved by graduates. It is suggested that students learn more from good team experiences than they do from bad experiences. The work presented herein is focused on students' perception of teamwork, since by identifying their perceptions we would be able to build positive students' experiences in teamwork.

The aim of this paper is to establish a catalogue of students' perceptions about teamwork to help faculty members in the identification and analysis of their students' perceptions. In order to obtain students' perceptions, open coding is used. Students' perceptions are drawn from their answers from an open-ended survey that were processed by using the professional software tool Atlas.TI. Eighty-seven third year students participated in this study. The evolution of students' perceptions along an academic year was analyzed. Perceptions of teamwork were measured at both the beginning and end of the academic year in two groups of students. Since teamwork activities of the two groups were different, the relevance of the relation between perceptions and activity's nature has been also considered.

Keywords: teamwork; professional skills; students' perceptions; higher education

Kali Prasad Nepal 1182–1193 Simplified Framework for Managing Team Learning in Engineering Subjects

Teamwork has been included as a major component of graduate attributes in all engineering programs at universities. In spite of enormous research advances in theoretical aspects of learning and working in teams, anecdotal evidence suggests that most engineering academic staff are inundated by student complaints of not being able to learn and work in teams due to numerous reasons. In order to facilitate engineering academic staff and engineering schools, this study develops a simplified framework for managing learning teams in engineering subjects that integrates theoretical conceptions, empirical evidences and anecdotal practices by reviewing a substantial body of existing literature. The framework identifies that in addition to managing student complaints about learning and working in teams more effectively and efficiently, engineering academic staff and engineering schools need to focus on specifying learning outcomes of teamwork, identifying appropriate approaches to achieve these learning outcomes, judging the suitability of teamwork-based learning in a particular educational context, developing a clear plan for implementing teamwork, implementing and monitoring teamwork, and reflecting and re-evaluating teamwork. The developed framework can be a useful tool to help understand these essential components and complexities of team learning.

Keywords: engineering students; learning teams; managing learning teams; simplified framework

Kyle F. Trenshaw, Renata A. Revelo, Katherine A. Earl and Geoffrey L. Herman 1194–1207 Using Self Determination Theory Principles to Promote Engineering Students' Intrinsic Motivation to Learn

Research based on Self Determination Theory (SDT) posits that autonomy, competence, and relatedness are important psychological needs for fostering intrinsic motivation. Although competence and autonomy are clearly defined in the literature, relatedness and its role in motivation are less clearly defined, as relatedness is often discussed in terms of project work, collaborative learning, and group experiences. This study seeks to describe the salience of students' motivation toward learning in a second-year engineering course (Computer Engineering I) that was redesigned to promote students' intrinsic motivation to learn. After completing the redesigned course, 17 students were interviewed about their experience throughout the semester. During interviews, students were asked to describe their experiences in the course and to discuss how those experiences affected their motivation. Interviews were coded to capture students' situational motivational orientations during the course and the psychological needs they mentioned in relation to their experience. The analysis of students' descriptions overwhelmingly pointed to relatedness as the most salient need in supporting their motivation in the course. Contrary to expectations based on the SDT literature for K-12 students, the analysis revealed a lesser salience of competence and autonomy for the college students in our study. Students' statements were coded least frequently as pertaining to autonomy out of the three psychological needs of SDT, even though the course designer's primary goal was to support students' autonomy. While autonomy support within classroom environments does affect students' motivation within the course context, relatedness, rather than autonomy, was most salient in our context. Engineering educators should explore how the social context of large engineering courses may create a deep need for supporting relatedness.

Keywords: self determination theory; relatedness; sophomore course; second year; thematic analysis

Rachel L. Kajfez, Holly M. Matusovich and Walter C. Lee 1208–1221 Designing Developmental Experiences for Graduate Teaching Assistants Using a Holistic Model for Motivation and Identity

The first step to strategically improve developmental programs for Graduate Teaching Assistants (GTAs) is to understand GTAs' motivations for teaching and their identities as teachers. The objective of our work was to propose and evaluate the Longitudinal Model of Motivation and Identity (LMMI) for examining the teaching motivation and teacher identity of GTAs, specifically in engineering. The proposed model is based on Self-Determination Theory and Possible Selves Theory; both theories are used to holistically understand a GTA's teaching experience. The LMMI was evaluated through a set of online journal entry surveys administered to 65 GTAs teaching in first-year engineering programs. Thirty GTAs provided survey responses, and the results of our research provide a baseline understanding of GTAs with regard to motivation and identity, confirming that the LMMI is appropriate for this context. Specifically, we describe potential implications for GTA development with regard to knowledge of content, sense of responsibility, connectedness to other GTAs, and future faculty identity. We conclude that these four items related to motivation and identity are essential in creating appropriate developmental programs for GTAs to ultimately improve teaching within engineering.

Keywords: Longitudinal Model of Motivation and Identity, graduate teaching assistants, developmental programs

Onnida Thongpravati, Alex Maritz and Paul Stoddart 1222–1235 Fostering Entrepreneurship and Innovation through a Biomedical Technology PhD Program in Australia

The integration of entrepreneurship, innovation and biomedical engineering is a relatively unexplored field of interdisciplinary research and practice, and the aim of this study is to delineate the integration of these disciplines. This paper presents an overview of a unique research and application intervention in the form of a new Doctor of Philosophy (PhD) training program in Technology Innovation, delivered in the context of the Australian Medical Technology industry. The program is administered by the Australian Research Council Training Centre in Biodevices and Diagnostics "BioReactor" at Swinburne University of Technology in Australia. The Swinburne BioReactor program has recently been designed to develop biomedical engineering students to become the next generation of entrepreneurs, industry-ready applied researchers and leaders in the field of biomedical devices and diagnostics. The program provides a paradigm shift from traditional PhDs to industry-oriented PhDs by integrating multi-disciplinary research, entrepreneurship education, design-led innovation training, mentorship, industry partners, collaboration and a unique and innovative stage-gate program structure. The PhD recruitment, program features and associated entrepreneurship and innovation curriculum, as well as program structure, activities and timeline over the duration of PhD study are also described. The program overall provides a contextual approach that can be adopted by other program designers and educators not only in Australia but also more broadly in other countries and locations, especially in areas of biomedical engineering.

Keywords: biomedical engineering; biodevices; entrepreneurship; technology innovation; Ph.D. training program

Justin L. Hess, Nicholas D. Fila and Senay Purzer 1236–1249 The Relationship between Empathic and Innovative Tendencies among Engineering Students

The study of empathy in engineering education has potential to improve the education of innovative engineers through the application of empathically guided engineering principles and processes. This paper explores the relationship between empathic tendencies and innovation behavioral tendencies among 160 engineering students at a large university in the mid western United States. We first examined the correlations between four empathic tendencies as measured by the Interpersonal Reactivity Index (perspective taking, fantasy, empathic concern, personal distress) and four innovative behavioral tendencies as measured by the Innovative Behavioral Scales (questioning, idea networking, experimenting, observation). Next, using multiple regression analyses, we explored the unique contributions of the empathic tendencies towards each innovative behavioral tendency. Correlation analysis revealed several significant relationships between empathy and innovation; the greatest relationship was between perspective taking and observation. The collection of multiple regression models indicated that the empathic tendencies contributed to the innovative behaviors in unique ways. Perspective-taking was the strongest predictor in three of the four models, whereas personal distress was a strong negative contributor to each of the innovative behavioral tendencies. We explore these results and their implications for engineering educators.

Keywords: empathy; innovation; empathic design; discovery behaviors

Patrícia Schrippe, Flaviani Souto Bolzan Medeiros, Andreas Dittmar Weise, Carla Hartmann Sturm and Jaïne Fatima Koschek 1250–1259 Mapping of the Undergraduate and Graduate Curriculum in Industrial Engineering in Brazil

In Brazil the number of public and private universities is increasing to improve the national development. In this way, undergraduate and postgraduate courses in Industrial Engineering have also increased. This paper aims to analyze undergraduate and postgraduate courses in Industrial Engineering in Brazil. To do this, we considered the emphasis of the classification, course, the geographical location and research areas. Methodological, a qualitative, quantitative and descriptive study was developed, with the plan to collect data from a literature search of the data available on the websites of the Brazilian Association of Industrial Engineering and the Ministry of Education. The study indicates that their distribution is heterogeneous and the quality is short of the market's requirements.

Keywords: industrial engineering; Brazil; undergraduate in industrial engineering; postgraduate in industrial engineering; mapping; industrial engineering education

Nicholas Loyd and Sampson Gholston 1260–1267 Implementation of a Plan-Do-Check-Act Pedagogy in Industrial Engineering Education

This paper explores the impact of introducing a learning-through-application-based teaching method to science and engineering instruction in higher education. The growing gap between traditional teaching approaches and the needs of today's college graduates is addressed by introducing a learning pedagogy based on Deming's Plan-Do-Check-Act (PDCA) cycle. A semester of experimentation with a class of thirty-one students shows that 94% of students experienced a significant increase in learning and 90% have increased confidence in application. Results suggest that, compared to traditional teaching approaches, the proposed method could be a more effective way of teaching science and engineering.

Keywords: Deming Cycle; Shewhart Cycle; PDCA; PDSA; pedagogy; learning; mastery

Young Jae Jang and Vina Sari Yosephine 1268–1278 LEGO Robotics Based Project for Industrial Engineering Education

This paper presents the development and implementation of a LEGO robotics based project in an undergraduate-level class on manufacturing systems. In industrial engineering (IE), which includes manufacturing as a major application domain, advanced IT technology and automation science have recently been integrated with manufacturing. As modern manufacturing becomes more complicated and relies increasingly on automation, a new approach is required for IE education. The Department of Industrial and Systems Engineering at Korea Advanced Institute of Science and Technology (KAIST) has developed a LEGO-based Automated Production System (LAPS) design project module for a manufacturing class, using a LEGO robotics kit and MATLAB LEGO support software. In this project, students design and develop an automated production line using LEGO. The aim of the project is to motivate the students to learn about the dynamic flow behavior of production lines and about the design and analysis of manufacturing automation by working through the LAPS design activity. After two years of pilot trials and official implementation

in an undergraduate manufacturing class with 32 students, it is found that the LAPS project is significantly effective in motivating students. A survey and class evaluation also shows that students are very satisfied with the class involving the LAPS project. This paper describes how innovations in IE education are possible with new educational technology such as LEGO robotics kits. It also demonstrates how LEGO robotics can be used to effectively teach the dynamic flow behavior of manufacturing systems and how to design manufacturing systems while taking account of this dynamic behavior.

Keywords: project based learning; LEGO based education; LEGO mindstorms; industrial engineering education; manufacturing systems

Bárbara Rangel, Ana Sofia Guimarães, 1279–1288 Integrated Design Concept in Civil Engineering Education
Ana Vaz Sá and Fernando Brandão Alves

The current difficulties in the Construction Industry have confirmed the urgent need for interdisciplinary between all the design disciplines, from engineering to architecture. The requirement for high levels of building efficiency and the optimization of the building process is making increasing demands on the accuracy of designs. The project is no longer a sum of contributions, but a design methodology that combines the answers to all the different requisites of the building, an integrated design project. This multidisciplinary approach to design problems is only possible if it is present in the design process from the outset. This implicit complicity is only possible if it starts in university education, searching for a unique common language of construction. This article shows an example of the implementation of integrated project delivery (IPD) methodology to the project based learning in civil engineer education. Exploring the experience undertaken in last year's in one of the courses of the Integrated Master in Civil Engineering (MIEC) of the Faculty of Engineering of the University of Porto, the implementation of the IPD methodology along lectures and studio classes, proved to be a more efficient learning performance among students in what concerns to the understanding of the relation between the design process and the convergence of all engineering disciplines that have to work together with the architecture design practice. Therefore, the methodology implemented in the architecture course in the 2nd semester of the 2nd year (1st cycle) of the MIEC, described in chapter 3, allows students to learn the design methodology as an integrated disciplinary project and to become able to access the available work tools, from project design to construction process. As a result, the improvement in the students 'ability to acquire knowledge' was clearly visible in the increase of final grade average since the IPD methodology was implemented in the course (2010/11). Also, student's motivation for developing extra homework became higher due to their initiative and commitment.

Keywords: Integrated design concept; integrated project delivery; civil engineering education; project based learning

Alberto Abelló, Xavier Burgués, 1289–1312 A Software Tool for E-Assessment of Relational Database Skills
M. José Casany, Carme Martín,
Carme Quer, M. Elena Rodríguez,
Oscar Romero and Toni Urpí

The objective of this paper is to present a software tool for the e-assessment of relational database skills. The tool is referred to as LearnSQL (Learning Environment for Automatic Rating of Notions of SQL). LearnSQL is able to provide automatic feedback, and grade the responses of relational database exercises. It can assess the acquisition of knowledge and practical skills in relational database that are not assessed by other systems. The paper also reports on the impact of using the tool over the past 8 years by 2500 students.

Keywords: computing engineering education; interactive learning environments; improving classroom teaching; blended learning; authoring tools and methods

Luca Di Angelo, Francesco Leali 1313–1324 Can Open-Source 3D Mechanical CAD Systems Effectively Support
and **Paolo Di Stefano** University Courses?

Most universities have introduced 3D CAD education and training in their engineering courses in recent years so as to respond to the actual needs of the industrial world for high-skilled design engineers. It is well demonstrated that the effectiveness of such courses depends on teaching an effective design approach rather than training for the use of specific commercial CAD tools. Since open-source CAD software has emerged in many fields as a promising alternative to commercial off-the-shelf systems, the present paper investigates the possibility for universities to adopt open-source instruments to effectively support their educational goals. Open-source 3D CAD systems are quantitatively evaluated by an original Compliance Index which considers the design tools typically used to model and draw industrial products and their weights in accomplishing the design tasks. The results obtained for the evaluation of a set of open-source CAD systems are presented and critically discussed.

Keywords: 3D CAD; Open source 3D CAD; Software evaluation; CAD teaching.