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Contents

Part I
Special Issue: Active Learning
Guest Editors: Noel Leon, Darinka del Carmen-Ramirez and Erik de Graaf

This research shows an experiment using systematic creativity tools, challenge-based instruction and active learning methods with freshman mechanical engineering students during the course Introduction to Engineering at Tecnológico de Monterrey, Monterrey Campus. The objective is to identify ways of impacting on the creative profile and learning abilities of engineering students during their professional formation. The students were divided into two groups: one experimental group and one control group. The experimental group received an introduction to the Theory of Inventive Problem Solving (TRIZ) and was asked to identify and start working on the solution of challenging engineering projects based on active learning methods, while the control group took the course in the traditional way, typically taught in a lecture-based format. Methods for developing teams and for transitioning from worked problems to independent problem solving skills were also explored. The initial data regarding social and demographic characteristics, background, learning ability, and the creativity profile of both groups were recorded and analyzed, and showed that both groups were very similar at the outset. This allowed us to identify the impact of exposing the experimental group to systematic creativity tools, challenge-based instruction, and active learning methods and compare the evolution of the students belonging to each group. The expectation was that the students in the experimental group would enhance their creative and critical thinking skills during their educational endeavor.

Keywords: creativity; TRIZ; learning styles; creativity profile; challenge-based instruction

This paper presents early results of a novel educational framework, currently in development. Incorporating Active Learning and Collaborative Reverse Engineering techniques, this framework aims to completely re-structure the learning system at Monterrey Tech., specifically in engineering courses. This is achieved through the assembly of an experimental, true-scale aircraft RV-10, focusing on the activities of a work-team of students in charge of the aircraft's structural analysis. In addition to obtaining numerical results, this assessment investigates the practical aspects of the developed methodology, such as the efficiency of the educational strategies in realising advanced learning concepts. In particular, it is shown how Reverse Engineering and Active Learning concepts can be successfully implemented as learning techniques, via carefully planned activities. During the latter, emphasis is given to the development of innovative, creative, self-learning, team-work and other desirable skills in students. Several evaluation methods (diagnostic, formative, summative, etc.) are considered, each measuring a distinctive feature of the students' performance. These show that the proposed strategies have a direct and positive impact on the student's ability to generate and synthesize knowledge. The case study described here represents an isolated cell within a larger educational project, thus future work will continue to explore educational issues arising from the aircraft's assembly, to be reported in forthcoming papers.

Keywords: collaborative reverse engineering; active learning; engineering education; engineering design; structural analysis; finite element method

This paper discusses teamwork skills and independent-learning skills that enhance active learning. Problem-based learning (PBL) was incorporated into science, where real-life problems were chosen from the field of engineering to motivate students to activate and develop these skills. The analysis of students' questionnaires shows that engineering students have positive attitudes toward cooperative learning and towards the use of computers in engineering problem solving. Students, who were taught using PBL rated their progress in teamwork skills significantly higher than their peers who were taught in the traditional way. Moreover, the PBL participants reported significant improvement in independent-learning skills using a computer.

Keywords: Engineering education; learning; teaching methods; teamwork; computer-aided instruction

Portfolios are a collection of student work over a period of time. Capstone project portfolios incorporate many forms of written artefacts, e-pages, oral presentations, journals and audio-visual material. Interactive capstone portfolios involve actions by both educators and students to establish a dynamic set of usable and tangible skills. These include the development of writing skills from minor project proposals to major reports or dissertations that are an ongoing learning exercise for the student. For the educator, portfolio development is a method of continuously and actively evaluating and commenting on a student's work, culminating in a final major report. This portfolio report may be in traditional format, or may take the form of several artefacts, viz. electronic portfolios, written report, computer program 3D model, paper poster, (WWW) web page and electronic posters, together with oral presentations. These activities develop communication skills for working within an industrial environment. However, for academic purposes stratification of assessment grades is required, by both peer group assessment and independent academic assessment. Examples of ongoing capstone portfolio content will be given showing that which is submitted formally, and that which remains for the students' creativity, learning and self evaluation.

Keywords: portfolio; capstone; projects

Elements of modern teaching and learning environments such as Active Collaborative Learning (ACL) and Project Based Learning (PBL) are being widely adopted in universities as powerful teaching tools. By design, these tools require the actual immersion of students in learning activities. Furthermore, they emphasize the key responsibilities students have to assume towards their own education. While the majority of universities are taking efforts to train teachers to fulfill teachers' roles, it is rare to find universities where students are trained to fulfill theirs. In this paper we report our experience in designing a course on Biomedical Signal processing based on the concepts of action leaning in an ACL/PBL framework. In particular, we investigate the importance of formally educating our students on modern best practices of university education. Our results indicate the importance of such training and supports the hypothesis that training students on how to learn is an important, but often underemphasized phenomenon.

Keywords: signal processing; learning to learn

In response to the 2006 National Defense Education and Innovation Initiative, NASA and DAVANNE LLC have collaborated to create the NASA Robotics Alliance Cadets Program to develop a highly integrated and interactive STEM (Science, Technology, Engineering, and Mathematics) undergraduate curriculum. This paper investigates the NASA Cadets' use of Active Learning to not only meet the nationally recognized need for a formal assessment standard, but also to ensure the sustainability of the program. To demonstrate the program's Active Learning tools wide accessibility and their integration with the program's methodologies, this paper examines the NASA Cadets' robotics platform and its use within an educational experiment co-developed by Cornell University.

Keywords: education; active learning; assessment; STEM; undergraduate; engineering; robotics; NASA; competition

Part II
Contributions in: Engineering Education Research, Statics, Electrical Engineering, Control Engineering, Geological Engineering, Engineering Management, Hydraulic Engineering, Engineering Competencies, Signal Processing and Spreadsheet Applications

This novel diagnostic tool is based on students' performance at second level and the subjects they studied, with their interests and resulting personality types from Holland's Interest Inventory.The intent is to provide an accurate predictor of student performance and in doing so also offer a detailed insight into the influences on student learning outcomes and retention.A greater understanding of the factors influencing student performance can lead to better-informed teaching and learning strategies, the appropriate application of additional support and, as a result, enhanced student learning outcomes and retention.The Self-Directed Search (SDS) interest inventory used in this research is widely regarded as the most contemporary and extensive test available.

Keywords: Diagnostic tool, interests, inventory, second level (high school) results, strategies

Examination stress is probably a factor in the poorer than expected performance of some engineering students. This paper presents some evidence of this connection from a specific third level electronics course together with descriptions of several strategies adopted to alleviate it and resulting changes in performance. The literature on examination stress and the effectiveness of strategies to alleviate it is then reviewed in the light of the above experiences, leading to the conclusion that it is likely that examination stress is a significant factor in the academic performance of some engineering students, and possibly more so for those from Asian backgrounds. Further the literature suggests that the following actions have potential value for alleviating the poorer academic results flowing from examination stress: 1) employing good teaching and well structured materials and study programs; 2) using a variety of styles of assessment with opportunity to practice those styles; 3) allowing memory support such as by allowing open-book assessments; 4) including opportunities for students to comment on the assessment experience either during the assessment or soon afterwards; 5) asking questions that are either individualized or have elements of choice about answers; and 6) relaxing the time pressure on assessment activities.

Keywords: examinations; examination stress; test anxiety; assessment; engineering courses

This paper examines how a learning management system (LMS), coupled with sound pedagogical approaches, is used to develop learning communities for students undertaking a problem-based learning university course. Students use the LMS to undertake team-based work, including meetings, communications, and submission of assessments. Data collected on students' usage of the LMS communication technology, and quotes from students' reflective portfolios, demonstrate that effective learning 'communities' are being created in virtual space. Despite never meeting in person, off-campus students formed functional teams and reported developing a great sense of 'community', which fostered mentoring and collaborative learning. The LMS supported the development of an online learning environment that encouraged reflective thought and dialogue with others, both of which are critical to transformative learning and social constructivism. The learner was compelled to become an active participant in the learning process, which allowed students to appreciate the value of participation, trust, mutual respect, and diversity.

Keywords: learning communities; learning management system; WebCT; problem based learning, teamwork

According to ABET (Engineering Accreditation Commission), engineering programs are required to train the students 'to communicate effectively'. This echoes the increasingly heard call from companies to deliver students with excellent communication skills. Unfortunately, this does not provide an answer to two important questions. First, what is understood by communicating effectively? Secondly, what are the implications of this requirement for the classroom practice of the majority of engineering courses, which do not explicitly incorporate communication skills? According to the authors, the first question can be answered by referring to the rhetorical definition of effectiveness (more specifically the theoretical insights provided by Quintilian) and its relevance for technical communication. According to us, 'communicating effectively' is more an attitude than a highly specific skill to be learned. Furthermore, the second issue can be answered by introducing the idea of the concept of visual rhetoric, which proves to be an ideal tool to focus on audience perception, one of the key rhetorical terms. In accordance with the teaching rationale developed by our colleagues from Antwerp University, which incorporates the strengths of collaborative working, we therefore propose a teaching methodology that can be used in any engineering course that would help students to learn to communicate effectively. After having introduced this teaching

methodology in our communication course, we set up a qualitative study of the revision plans written by our students. In conclusion, we can claim that our students have successfully incorporated the 'attitude' of communicating effectively.

Keywords: visual rhetoric; communication training; presentation skills

A self-managed team is one that is empowered to determine structure, processes, assessments and corrections as it performs assigned tasks. The autonomy of these teams is needed in flat organizational structures or environments with limited hierarchy. Little research has focused on the antecedents of self-management in teams, especially in engineering and engineering education. This work links self-managed, autonomous team behavior and double-loop learning as described by Argyris in conjunction with Hackman's model of effective teamwork. Traditional methods of team training are contrasted with a double-loop training approach. A differentiated training program was used among freshman engineering design teams in a required, introductory course to determine whether a particular type of team training increased students' ability to be self-managing. Self-management characteristics were observed in this engineering environment. The suitability of a double-loop training approach within undergraduate engineering education is discussed.

Keywords: Engineering education, self-managing work teams, double-loop learning, mutual learning model.

Industry can contribute significantly toward a dynamic engineering curriculum. A major theme in the industry-based dialogue with universities is that engineering graduates need to improve their professional skills; including written proficiencies, oral communication expertise, and teamwork skills. The authors have redesigned a course that combines water and wastewater treatment into a challenge-based instruction that develops both the students' conceptual and professional competences associated with civil engineering. The university joined with an industry partner to use their existing facility as an anchor for challenge-based learning activity. Opportunities for students to demonstrate and practice professional skills were extensively integrated into the design experience. While challenge-based instruction concepts are by no means new, the principles have not previously found widespread application within the civil engineering discipline. The objective of this study was to investigate student experiences for learning both content and professional competencies within a wastewater treatment course. A major finding of this study is that the traditional lecture style course could be redesigned in a manner that develops students' expectation of what it means to be a professional and the skills associated with that, while at the same time advancing their knowledge of wastewater treatment. The students self-reported that the most significant aspects of the learning experience were those related to their professional competencies. Those particular learning experiences relate directly to the skills requested by industry.

Keywords: professional competencies; challenge-based instruction; problem-based learning; learning cycle; STAR Legacy

Energy has become one of the most important topics in recent years. Knowing how much electricity we use and consequently finding ways to save energy are very important in everyday life. Electricity meters have traditionally been mechanical devices, incorporating rotating discs and having geared dials. Recently there has been a lot of interest in metering, and modern microcontroller based electricity meters with LCD outputs have been developed and manufactured. This paper describes the development of a microcontroller based electricity meter with LCD output. The meter described here has been developed for teaching the principles of modern electricity metering techniques to undergraduate engineering students studying Electrical Engineering at the Near East University.

Keywords: energy meter; electricity meter; power meter; teaching electricity metering

This paper discusses the viability of using parallel processing methods to solve control algorithms in real time in the field of Control Engineering education. It is a well-known fact that some types of control problems cannot be dealt with in just one practical session in the lab because of their huge computational load. However, the use of low-cost clusters of workstations (COWs) and message-passing software allows students to program their own control algorithms and visualize the results in real time without having to wait a long time. In this paper we analyze the control of a pH-neutralization process and the parallel performance of the algorithms proposed using an illustrative example, paying special attention to the speedup factor. Thus, this heavy-computational-load example gives a meaningful case study to demonstrate the suitability of using parallel computing techniques to include new experiments in the control lab.

Keywords: parallel computing; distributed computing; dynamic programming; laboratory optimal control; clusters of workstations; real time

In the 1990s, a new degree, Geodesic and Cartographic Engineering, was created in Spain. It is a post-graduate degree, lasting two years. At present, Spanish university degrees are being redefined for their adaptation to the European Higher Education Area (EHEA). Thus, after more than ten years of experience and in view of the implementation of the EHEA, it is essential to analyse how well the degree curriculum is adapted to the professional requirements of our graduates in their working lives. A survey of former students was taken to gather a profile of graduates, job positions and their opinions about the courses they studied. The relationship between the curriculum and the Master's theses written by the students was also examined.

Keywords: Engineering surveying; geodesy; cartography; photogrammetry; mapping; remote sensing; cadastre; curriculum

The design of PID controllers using the root locus method, based on classic module and argument criteria, is currently taught in most basic academic control engineering courses, and is found in most texts on the subject. Traditionally, PID controllers are designed by applying geometrical rules to calculate PID parameters. Although this task can be computerized, it is not easy to achieve because of the special characteristics of the particular equation criteria, which are presented as a trigonometric equation that is generally solved using iterative methods. An alternative method with an equivalent result that is computationally efficient and does not require iterative calculations is implemented in Sysquake © and a new interactive CAD tool is provided: ProPID. Using this tool, students can easily become familiar with PID behaviour in a closed loop and compare the specifications obtained with those desired. This software tool also enables the student to redesign the PID to verify, as far as possible, the desired specifications. All of the design work is implemented within an interactive environment and any modification of the design parameters produces an immediate dynamic response. This key aspect enables students to learn interactively.

Keywords: interactive learning; control design; PID; root locus; CAD tools; simulation languages

This paper presents the strategies of the Project Management course for undergraduates followed at the Engineering Faculty of the University of Zaragoza. It is based on the management by each student group of a project for a real client. The course is supported by the services provided to the groups by a Project Management Office set up by the teachers of the course. On analyzing the failed projects carried out during terms 03/04 and 04/05, lack of internal coordination was detected as the most recurrent cause explaining

failure to achieve the expected results in certain groups. This research has resulted in the inclusion of a series of changes, aimed at offering the student groups a more professional work environment in which to carry out their projects. The results obtained once the changes were made point to the importance of ensuring internal coordination within student groups in order to prevent project failure, as well as the positive reaction of the students to their new working environment.

Keywords: project management; engineering education; experiential learning; cooperative learning; project management office; newly formed groups

In this paper the implementation of a distribution fitting using Excel spreadsheets is described. The implemented spreadsheet uses the definition of names, different formulae and the Add-in solver. An important advantage is the way in which the optimum location parameter is found. The usefulness of the sheet is guaranteed by its simplicity; in fact, it has been used satisfactorily by maintenance engineering students.

Keywords: Maintenance Engineering teaching; spreadsheet application; curve fitting; Weibull distribution

This paper presents the development of a new hydraulic, hybrid vehicle-based laboratory course for the Mechanical, Industrial, and Manufacturing Engineering Department at the University of Toledo. The objective is to provide an educative tool for undergraduate students and to advance the research of hydraulic, hybrid vehicle technology. The educative module is based on a problem-solving learning approach that aids students in gaining a richer understanding of elements from courses of the Mechanical Engineering curriculum such as Fluid Dynamics and Hydraulics, Energy Systems, Vibrations, Mechatronics and Controls. Additionally, the modules developed for the hydraulic hybrid system will become available on the internet for other universities to utilize. The laboratory also serves as a research tool for the advancement of hydraulic hybrid vehicle technology. To this end, both graduate and undergraduate students will be performing experiments and simulations that will enhance understanding of hydraulic hybrid systems. The knowledge obtained will be utilized to help optimize the design of hydraulic hybrid vehicle technologies.

Keywords: Active learning; problem solving; hydraulic hybrid vehicles.

In this paper we present computer-based instructional materials developed as part of the Open Learning Initiative (OLI) at Carnegie Mellon University that, upon completion, would constitute an entire online course in Statics. These materials reflect recent progress in re-thinking Statics instruction, including a recently proposed object-centered approach to teaching Statics that deliberately separates out individual concepts and treats them sequentially. These materials also benefit from studies of conceptual knowledge in Statics, and the development and psychometric analysis of a Statics Concept Inventory. The computer-based implementation of instruction incorporates many general lessons from the learning sciences that are broadly relevant. The structure of the course materials is presented, including how it reflects a sequence of learning objectives, which are addressed through means that fully capitalize on the capabilities of the computer. Assessment at multiple levels is embedded into the materials, with the aims of both facilitating learning and monitoring progress. The effect of these materials on learning is quantified for its first use in a traditional statics course.

Keywords: statics; elearning; free online education; online learning

Embedded data storage systems are becoming indispensable tools for many domestic and industrial electronic products. While Hard Disk Drives (HDDs) remain the most cost-effective form of non-volatile data storage, up and coming novel technologies such as Probe-Based Storage Systems (PBSSs) are gradually making their way into the data storage market. Unlike semiconductor memories, both HDD and PBSS use movable read/write heads for locating stored data bits. Therefore, the performance of the head positioning servomechanism of these systems plays a very important role in enhancing their storage capacities. Position Error Signal (PES), which defines the offset between the read head and the data track, is a critical element in ensuring high performance of the head positioning servomechanism and advanced methods of generating PES generation attention. This paper presents a toolkit that can be used for simulating and analyzing PES in different storage systems with movable heads. The developed toolkit with MATLAB Graphical User Interface (GUI) can be used by students to enable them to understand and visualize the PES generation process. Engineers in the data storage industry can also benefit from this toolkit in their effort to develop new, improved demodulation schemes. The developed toolkit is user-friendly and portable, with the input data and structures of different components easily changeable for rapid generation, analysis and evaluation of servo signals in PBSS and magnetic recording systems.

Keywords: position error signal; hard disk drive; probe-based storage; head positioning servo