Volume 22 Number 5 2006 ISSN 0949-149X

The International Journal of Engineering Education

Contents

The Lehigh Valley ASM Materials Camp, held twice at Lehigh University, offered a new perspective on the way a materials camp for high-school students can be developed and presented. The distinguishing characteristic of the Lehigh Valley Chapter camp was that it was planned, developed, and presented by graduate student volunteers from Lehigh University. The focus of the camp was making materials science applicable to the high-school students by showing them how to recognize the role of materials science in applications they were already familiar with, such as sports, entertainment, and transportation.

Keywords: K-12; materials camp.

This work presents some topics related to the teaching and learning of viscoelasticity in solids at the undergraduate level. It is recommended that the molecular and mechanistic aspects assigned to the viscoelastic behaviour of materials should be focused on, besides all the mathematical formalism, experimental techniques and applications. Some suggestions are made on laboratory practices and demonstrations, where the use of dynamic mechanical analysis is exemplified. It is suggested that active and cooperative learning techniques could be implemented in this subject, in order to obtain higher results. Finally, some cases are presented on pedagogical experiments and demonstrations that could be executed in the classroom.

Keywords: viscoelasticity; glass transition; learning techniques; dynamic mechanical analysis; polymers.

This paper describes an ongoing study on the use of concept maps in an upper-division chemical engineering laboratory to enhance student learning. The Unit Operations Laboratory was chosen for the study since it is a comprehensive laboratory in which students are required to be familiar with various aspects of chemical engineering practice. The study was implemented in three stages. In the first stage the students were introduced to the idea and construction of concept maps. The second stage involved the construction of concept maps during a pre-lab session in which the students were orally tested about the exercise they were about to undertake. The last stage was the submission of the final reports in which the students were again required to hand in other concept maps. The students completed the lab practice in groups of three to four, and were asked to create both individual as well as collective concept maps. The present study produced three tentative findings. First, the first stage mainly produced simple concept maps that barely contained basic chemical engineering principles. These initial maps, however, developed and became more complicated as the students went on completing the lab practice and subsequently preparing the report. Secondly, it appears that each student wanted his/her contribution in the collective concept map construction to be acknowledged. Thus, the students were believed to be motivated. Thirdly, since the concept maps produced were collected and displayed in the lab for comparison with the subsequent lab sessions, the students seemed to get a feeling of continuity, something that is not normally noticeable in the traditional lab practice. These findings indicate that concept mapping has a positive effect on student learning. The paper ends with a discussion on the study with respect to its pedagogical values and applicability to other courses.

Keywords: concept mapping; chemical engineering; laboratories.

This paper presents a conceptual model for the Web-based virtual testing and learning (WVTL) in applied sciences, especially in the area of materials science and engineering. WVTL is not an existing field but rather an idea, which could be easily handled for educational purposes and staff training as well as for new materials, products and prototypes testing. The paper reports exclusively on the use and services of simulations on the Web and the potential use of WVTL as well as the trends and opportunities in the area.

Keywords: Web-based testing; materials

An interactive Web-based experiment was designed as a preparation tool for students in the Materials and Mechanics Laboratory course at Texas Tech University. In the Web-based experiment, the students were given an introduction to the concept of hardness, what it means, how it is measured, and the calibration and utilization procedure using a Rockwell tester. In three semesters, three sections of the class were exposed to lectures but not to the virtual experiment and three sections (three groups) were exposed to both lectures and the virtual experience. Each group was given a pre-lab quiz to assess their understanding of the concepts and objectives of the experiment. The groups exposed to the virtual lab were also given a short quiz on the procedure of the experiment. The pre-lab quizzes were graded without prior knowledge of the students' section or group affiliation. Grades were compared between groups that were exposed to both the lecture and the virtual laboratory and those groups who were only exposed to the lecture. The average grade of the students in the lecture and virtual laboratory groups was approximately 20 % higher than that for the lecture alone group. This difference was statistically significant ($p < 0.05$) based on a t-test. The average grade on the knowledge of the procedure prior to actual experiment for the lecture and software groups was 75 on a 100 basis. Also, these students showed a great understanding of the hands-on procedure without significant input from the instructors. The lecture-only groups did not have a good idea of the procedural steps and required significant guidance from the instructor. Student evaluations of the software revealed that students were very enthusiastic about using the module as a pre-lab preparation tool but not as a replacement for the actual experiment. In this paper, the design of the software, important elements of the virtual lab and the evaluation results will be presented.

Keywords: Web; virtual lab; metallurgy; hardness test.

This paper describes a learning module on design optimization courses within a hierarchical research and learning network. In this environment a hierarchical learning network can be created to link diverse inter- and trans-disciplinary teams from a consortium of universities, industry, government agencies and the providers of learning technologies. It is an approach that builds on computer-based training, intelligent tutoring systems, interactive learning, collaborative-distributed learning, and learning networks. As an example of a learning module in this environment, the present design optimization module has been developed and described. This module allows learners of design optimization to get the course material at their own convenience via either the internet or packaged files. Consequently, it is expected that the learner's ability to understand design optimization and review its pertinent details will be enhanced significantly.

Keywords: asynchronous distance learning; advanced learning networks; sensitivity analysis; concept maps; shape optimization; computational fluid dynamics.

Recently, there has been a growing interest in educational collaboration between the East and the West. More Western educators are traveling to the East to provide local students with an 'internationalization-at-home' experience. However, the literature on teaching Chinese engineering students from a Western perspective is sparse. Impressions, opinions and myths about how Asian students respond to western teaching styles are plentiful, and are often based on outdated facts or on observation of Asian students enrolled in Western universities. Chinese societies have changed drastically in recent decades. This paper addresses recent experiences of a Western teacher giving a course to Taiwanese engineering students. Advice is given on breaking the ice, gaining contact with students, activating students, overcoming obvious language barriers, and surviving a completely different education model. It is our hope that our experiences may help other Western teachers adapt more rapidly to a Chinese education environment and maximize the impact of their efforts.

Keywords: Chinese learner; teacher mobility; internationalization; cultural understanding

To introduce engineering students to multidisciplinary team work and the principles of engineering design early in their educational careers, a freshman design project and competition was developed. This project and competition required skills typically associated with the four engineering departments (the Departments of Chemical Engineering, Civil and Environmental Engineering, Electrical and Computer Engineering, and Mechanical Engineering) in the College of Engineering at Villanova University. Students were required to build a model car with proper gearing, construct a bridge, and supply power through an electrochemical reaction to complete a specific set of tasks. Teams could only use the limited materials supplied to them. The competition involved an aesthetics contest, a race (including a hill), a load pull, and a load test of the bridge. The project emphasized teaching the freshmen engineering students about team work, open-ended design issues, long-term deadlines, creativeness, the multidisciplinary nature of engineering, as well as the 'fun' of engineering.

Keywords: Multidisciplinary design, first year design, team-based design, hands-on project.

An integrated set of courses, or Integrated Course Block (ICB), developed for incoming first-year students at the Franklin W. Olin College of Engineering, is presented. Bound by a common theme of 'Kinetic Sculptures', the individual courses in this ICB are mathematics (single variable calculus and ordinary differential equations), physics (kinetics and dynamics of linear and rotational motion, thermodynamics and fluids), and an open-ended engineering project. The project part of the ICB allows students to explore the motion through the design of kinetic (moving) sculptures while utilizing the mathematics and physics concepts learned in the accompanying courses. This paper considers the 'Kinetic Sculptures' ICB from the pedagogical and epistemological points of view by presenting its implementation and discussing the results and analysis of three student surveys taken during three semesters, and seven semesters after participating in the ICB.

Keywords: first-year design experience; integrated curriculum; centerpiece project; kinetic sculpture

Dynamic simulators combined with educational games may create a new and improved learning culture by taking advantage of the new knowledge and skills of today's students obtained from extensive use of interactive computer games. This paper presents a design basis and a set of online learning resources based on dynamic simulators that takes advantage of game-related features. The e-learning resources are used in basic engineering courses. Feedback from approximately 1200 engineering students is analysed, the main conclusion being that students clearly view game-related learning resources as having a positive learning effect.

Keywords: dynamic simulation; games; engineering education; e-learning; user feedback.

This paper introduces a new methodology to analyze grading discrepancies in PBL software-engineering courses with a high student-to-faculty ratio. The methodology is based on a quantitative analysis of the more relevant software features according to the grades assigned by each instructor. In order to reduce the discrepancies detected, a new grading consensus has to be built, and automatic analysis tools must assist the instructors when grading. The evaluation of the methodology in two academic years revealed a 62% reduction of the grading discrepancies, achieving an average inter-instructor discrepancy of 0.10 in a scale from 0 to 1.

Keywords: grading discrepancies; software quality analysis; biases in assessment; project-based learning; massive laboratories; automatic analysis of grades.

This work discusses some issues associated with Web assisted self-assessment of the computer programming skills of first-year undergraduate engineering students. The self-assessment exercises are meant to encourage and motivate them rather than to assess them. The whole system interactivity, based on a client–server architecture, is carried out by means of a computer connected to the Internet with a Web browser. Practical issues of constructing suitable tests and their set up, implementation and results are described. Finally, the results of a survey of students' perceptions and the influence of these on future developments are presented.

Keywords: teaching/learning strategies; programming and programming languages; evaluation methodologies; interactive learning environments.

Multiple analyses of results are presented from the Statics Concept Inventory, a multiple choice test assessing conceptual knowledge in engineering statics. Results are based on the administration of this test to 1331 students in ten classes at seven US universities during the 2004–2005 academic year. Evidence confirming the validity and reliability of the test is offered. Detailed comparisons are made between inventory scores and performance on course examinations, including evaluations of how inventory sub-scores on specific concepts correlate with performance on certain types of problems. Finally, based on analysis of the prevalence of various answer choices, common misconceptions are identified.

Keywords: statics; assessment; multiple choice test; test administration

Since the Pinewood Derby (PWD) began more than fifty years ago, it has been one of a Cub Scout's first encounters with engineering principles. The PWD is an event in which seven- to eleven-year old Cub Scouts, with help from parents or leaders, construct a car out of a simple block of wood, four nails acting as axles, and four plastic wheels to race down a track under the power of gravity. Concepts such as friction, energy, roughness, and dynamics are indirectly learned as a result of a car's performance. To promote engineering education to elementary-level children, these concepts are taught to Scouts and their parents through the use of an outreach program, the organization, methods, and assessment of which will be discussed in this paper. Consisting of several stations to demonstrate the effects of rolling and sliding friction, wheel alignment, and weight distribution, the outreach program allows the Scouts to experience first hand how they can improve their car's performance. Hands-on activities as well as actual data also help keep the Scouts interested and motivated to build the most optimized car, and concurrently learn basic engineering principles. Since the PWD is held annually among hundreds of groups internationally, outreach programs have the potential of impacting thousands of Scouts every year and provide a basis for continued interest in engineering.

Keywords: outreach; Cub Scouts; tribology; Pinewood Derby; workshop

Multi-agent systems are advocated as a model for designing complex, distributed engineering systems. Yet the practice of teaching the use of intelligent agents in modeling and simulation of next generation open, dynamic, adaptive, and intelligent engineering applications is still in its infancy. In this paper we present a unified and coherent framework for teaching a graduate level agent-directed simulation course for computer science and engineering students. The framework aims to: (1) promote extending our horizons by introducing multiple dimensions for the use of agents in simulation; (2) emphasize focusing on teaching the theory, methodology, and fundamental principles underlying the agent-based modeling framework, and (3) suggest a shift from a predictive modeling worldview toward a new computational epistemology perspective that advocates exploratory experimentation with agent-based models. Based on these premises, a synopsis of the structure, delivery strategy, and the underlying rationale for the design of the course are presented.

Keywords: agent-based simulation; modeling and simulation; multi-agent systems; agents; education

Global competition has created multinational supply chains where raw materials production, marketing, and consumption can be in different countries in order to achieve cost-effective production and higher customer service levels by taking a systems approach to supply chain management. Therefore, a key to successful management is acquaintance with interdisciplinary multicultural environments, and with utilization of communication technologies. In this research, a global learning environment for industrial engineering and business students was designed, implemented, and evaluated.

Keywords: global learning, supply chain management, global teams, case study.

This paper provides an overview of the development and implementation of a three-year industrially supported Sports Technology Bachelor Degree Programme (with an optional placement year in industry) from within the School of Mechanical and Manufacturing Engineering at Loughborough University, UK. The paper describes how engagement between course providers, industry and students has been encouraged and integrated into the curriculum. It is highlighted that the degree programme has flourished as a direct result of the already strong research activities in this area. Attention is given to the structure and content of the programme, links and discussions held with the sporting goods industry and the aspirations and career destinations of students and graduates. We have initiated many industry activities and believe that this is a key factor in attracting increasing student numbers. Examples include, one-year student placements in industry, industry sponsorship of undergraduate projects, extensive donations of equipment for teaching purposes, ongoing input from a departmental industry advisory board and a programme steering group that includes senior industry, academic and sports governing body representatives. In addition, industry are involved directly in teaching which includes visiting lectures, site visits and factory tours. Emphasis is given to how the needs of industry have been accommodated and how industrial support was sought and subsequently integrated into the programme. Insights gained from student feedback forms are discussed. It is hoped that the paper will be of interest to others operating similar programmes and perhaps more importantly to those currently considering how to work co-operatively with industry to enhance engineering education for undergraduate students.

Keywords: sports science; sports engineering; undergraduate; admissions statistics.