Volume 19 Number 6 2003 ISSN 0949-149X

The International Journal of Engineering Education

Contents

This paper describes an approach, based on common practices, for explicitly defining instructional objectives for university courses, mapping educational activities to those objectives, and using assessment tools that measure student proficiency in attaining the objectives. The advantages of implementing the approach are enhanced quality of instruction, increased student learning, and improved assessment. A case study in engineering demonstrates that data from the assessment can be used in several ways, including improvement of course instruction, supporting changes to educational activities, and supporting program objectives and accreditation. Student evaluation data for two instructors over several terms demonstrates that student perception of the course improved after implementing explicitly defined objectives.

The E-pal Program linked undergraduate Kenyan students with practicing engineers, researchers, and other technical North American professionals in an e-mail 'pen pal' dialogue for the duration of an introductory fluid mechanics course. The Program aimed to counteract the dearth of resources at the Kenyan university by utilizing the Internet to facilitate the central three goals of the program: (1) to demonstrate to students applications of taught concepts and material, (2) to expose students to the range of sub-disciplines, careers, and engineering problems within fluid mechanics, and (3) to promote the use by students of the Internet in an environment where its value had not previously been demonstrated. The Program was found to be popular with student and practicing engineer participants and highly successful in achieving its goals. This paper gives an overview of the Program and its context within the Kenyan academic environment, delineates its successes and lessons learned, and discusses pedagogical value and applicability to other courses and situations with recommendations for implementation.

A critical part, and sometimes the whole, of any postgraduate programme is the undertaking by the students of a project. One of the most crucial phases in this undertaking is the project selection. It is also this phase where students, invariably, receive no formal training and this could delay the whole undertaking substantially; in some cases leading to premature abandonment of the project or the degree programme altogether. This paper attempts to fill this gap by providing a framework and a methodology that would enable the student to develop a greater comprehension of the problem and to make a rational choice. The framework is based on decision analysis and comprises a two-stage procedure: (a) technical uncertainty and dominance screening and (b) the application of SMART (Simple Multi-Attribute Rating Technique). A hypothetical case is considered to illustrate the methodology and the results are discussed.

Several studies concerning industrial design, technology and engineering learning have been conducted on students in Hong Kong. The findings indicate that the students are weak in problem finding (that is, the identification of needs or problems). The absence of cultural studies was found to be one of the main factors limiting the development of the level of insight and understanding needed to identify problems. All of this further limits the ability of students to exercise critical judgement in other learning activities. By reviewing the findings of the case studies in Hong Kong, this paper tries to point out that cultural studies should serve as one of the key foundations for engineering students to make critical judgements in their future educational endeavours and careers. This paper then discusses the importance of incorporating cultural studies in the engineering curriculum in a more organised and regular way instead of only as optional activities, and identifies key activities, contents and elements of cultural studies in the curriculum. In the last section, discussing Kissock's ten-stage decision-making model, this paper suggests how a more flexible and dynamic teaching and learning arrangement can be developed for cultural studies in the curriculum.

Mechanical Engineering

Computer-based instructional materials offer great potential for engineering education. Using readily available development software, sophisticated graphics and animations can be created to present engineering topics in ways that are not possible within the confines of the traditional textbook and lecture format. This paper presents examples of instructional media developed for the Mechanics of Materials course. These examples include lecture supplements, animated example problems, interactive example problems, interactive instructional learning tools, and games. Using animations, graphics, and interactivity, the instructional media is designed to engage and stimulate students, to effectively explain and illustrate course topics, and to build student problem-solving skills.

The focus in engineering education is moving from an emphasis on theory to a balance between concrete experiences and analysis. This paper reports on such initiatives made to the Mechanical Engineering curricula at the US Air Force Academy and at the University of Texas, Austin. In particular, these two institutions have been collaborating for the last four years to improve ME courses through new initiatives in three areas: 1) use of hands-on activities, 2) incorporation of interactive multimedia, and 3) new tools to improve team dynamics. The development, implementation and assessment for this project are described below, along with extensive references describing the details of each individual improvement. For example, we have quantitatively measured significant improvements in team performance for our design courses. We have also seen dramatic increases in student interest level in the machine design courses. Based on these results, specific suggestions on how these educational enhancements might be implemented at other institutions are given.

The classical problem of deflection of a cantilever beam of linear elastic material, under the action of a uniformly distributed load along its length (its own weight) and an external vertical concentrated load at the free end, is experimentally and numerically analysed. We present the differential equation governing the behaviour of this system and show that this equation, although straightforward in appearance, is in fact rather difficult to solve due to the presence of a nonlinear term. The experiment described in this paper is an easy way to introduce students to the concept of geometric nonlinearity in mechanics of materials. The ANSYS program is used to numerically evaluate the system and calculate Young's modulus of the beam material. Finally, we compare the numerical results with the experimental ones obtained in the laboratory.

Chemical Engineering

Illustration of heterogeneous catalysis concepts in laboratory courses is not usually simple or economical. For our undergraduate senior lab course we have developed an environmentally friendly experiment dealing with several aspects of heterogeneous catalysis, having in mind the use of readily available and relatively inexpensive equipment and chemicals on a compact setup, which students can safely

operate. The experiment deals with the acid-catalyzed sucrose inversion, performed in packed bed chemical reactors, where the catalyst is a cation-exchange resin in the H^+ form. An additional reactor is included for illustrating an enzyme-catalyzed system. The conversion achieved is determined using the Flow Injection Analysis technique.

Manufacturing Engineering

This paper details the development and implementation of a course on the design and manufacture of composite prototypes. The course is taught as a design elective resulting in student groups designing and demonstrating a manufacturing process to fabricate an actual composite prototype. The students are responsible for determining their own metrics in evaluating their manufacturing process. The paper identifies key learning points, and the course syllabus demonstrates the implementation of the learning kernels. Projects from the past seven years are itemized, and lessons learned are drawn from the cumulative experience. The course was developed at the University of Maryland to instruct undergraduate students about the manufacturing of composite structures by providing a hands-on design experience of a real-life composite prototype. The students are formed into teams and are responsible for developing a manufacturing process to produce a composite component. The students demonstrate the feasibility of their process by producing a prototype. The students conduct a preliminary marketing analysis and must conclude whether or not further pursuit of their manufacturing process is warranted. The course enhances the undergraduate design experience while training students in the science of composite manufacturing.