

# The International Journal of Engineering Education

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- M. S. Wald** 1 Editorial
- Terrance O'Brien** 2 Guest Editorial
- Innovative Approaches to Teaching and Learning*
- Graham Green and Paul Kennedy** 3–9 Redefining Engineering Education: The Reflective Practice of Product Design Engineering
- The University of Glasgow and the School of Design at the Glasgow School of Art have joined forces to redefine the nature of an engineering curriculum and produce a degree program that is rich in both creative design culture and design engineering skills. Graduates of this program are able, creatively, to critically analyze, evaluate and solve a diverse range of design and engineering problems, including their own life-long learning. This innovative curriculum enables graduates to enter the workforce as true reflective practitioners. This paper examines what can be achieved as a result of breaking down traditional engineering education barriers.*
- Michael A. Mooney and Paul J. Mooney** 10–16 A Student Teaching-based Instructional Model
- The rapidly changing engineering profession demands the education of life-long learners, individuals who can adapt and thrive through change and evolving disciplines. This calls for a dual emphasis in engineering education on process (thinking, integration, discovery, communication) and product (knowledge). Furthermore, instructors of engineering curriculum understand very well the adage 'one never really learns a subject until one teaches it'. The perspective and preparatory effort required in teaching builds strong discovery, integration, comprehension, and communication skills. An instructional framework invoking this adage while building process and product skills is presented. The student teaching model (STM) is geared towards student interpretation, synthesis, presentation, and discussion of content material. This paper presents the development of the STM instructional framework, with particular emphasis on the underlying cognitive principles. The field of cognitive psychology provides the foundation for the STM, yielding insight into why 'one really learns a subject when one teaches it'. Student and instructor feedback from implementation in an upper level undergraduate engineering courses is also provided.*
- John Rosenbaum** 17–23 Practical Creativity: Lateral Thinking Techniques Applied to Television Production Education
- This article suggests methods for teaching creative television production techniques while simultaneously providing technical training in equipment operation and standard production practices. The suggested methods are four lateral thinking techniques: the random word, simple focus, strata, and the filament technique. In a case study, these techniques were applied in two assignments given to students in an intermediate television production course. Twelve group productions, 42 editing assignments and 42 papers on television aesthetics were completed. Responses to self-assessment items on anonymous questionnaires distributed at the end of the course indicated that most students (between 61% and 100%) felt competent in 13 of 14 equipment operation skills covered in the course. Most students (84%) rated their ability to operate complex video production equipment between 'adequate' and 'strong'. Most of the students (92%) rated the group production assignment between 'some value' and 'extremely valuable'; most (85%) rated the individual editing assignment between 'some value' and 'extremely valuable'; and most (79%) rated writing the paper between 'some value' and 'extremely valuable'. Most students (71%) recommended repeating the experimental assignments in subsequent semesters and almost two thirds (65%) preferred the experimental or a mix of experimental and traditional assignments. The author concludes that lateral thinking techniques can be used successfully to teach creative television production, technical equipment operation, and standard production practices. Lateral thinking can also contribute to education in other fields, such as engineering, which value technical training and creative thinking. Although some students may resist nontraditional approaches, most students will appreciate and sometimes even prefer them.*
- Anne K. Ditcher** 24–29 Effective Teaching and Learning in Higher Education, with Particular Reference to the Undergraduate Education of Professional Engineers
- This paper discusses current knowledge about effective teaching and learning in higher education and the implications for undergraduate engineering education. The author considers that aspects of the traditional model of engineering education, such as the widespread use of lectures, the overcrowded content and the assessment methods used, do not lead to high quality learning. Problem-based learning is one approach to overcoming these deficiencies; its advantages are discussed and some examples of its implementation are given.*
- Edmund Tsang, James van Haneghan, Burke Johnson, E. Jean Newman and Sandy Van Eck** 30–39 A Report on Service-Learning and Engineering Design: Service-Learning's Effect on Students Learning Engineering Design in 'Introduction to Mechanical Engineering'
- Service-learning is a form of experiential education in which students apply the knowledge and skills they learn in the classroom to carry out projects that meet a human or community need. Service-learning has been integrated into an 'Introduction to Mechanical Engineering' course to enhance learning of first-year engineering students and to meet the need for more resources in local middle-schools to promote active, hands-on learning of mathematics and science. Student assessment results over a three-year period demonstrate that service-learning is an effective strategy for first-year mechanical engineering students to learn and practice engineering design and teamwork, and to become aware of civic responsibility. Service-learning provides engineering students the opportunity and motivation to develop the 'softer' skills described in Engineering Criteria 2000 and complements the traditional approach to design projects, in which students interact primarily with technical personnel.*
- Suzanne S. Austin and Barbara K. Edwards** 40–58 Transactional Writing: Constructing Knowledge and Reshaping Beliefs in Mathematics
- Engineering employers agree that a good understanding of engineering science fundamentals, e.g. mathematics, and a good understanding of verbal and written communication, are among the attributes held by successful engineers. Observations confirm that males, particularly at higher levels, excel over females in mathematics performance, but not written performance. Yet research confirms that good writers show higher mathematics achievement than poor writers. This article discusses an interdisciplinary project that*

improves mathematics achievement and attitude, and communication skills, and hence, equips more students to consider the field of engineering. Potentially, it could increase the numbers of engineering students among underrepresented groups, especially females.

**Paul Humphreys, Victor Lo, Felix Chan and Glynn Duggan** 59–66 Developing Transferable Groupwork Skills for Engineering Students

*Student assessment and the development of transferable personal skills are receiving increasing attention in higher education establishments. This study examined the potential for enhancing student learning through the development of groupwork, presentation and self- and peer-assessment skills on an industrial engineering undergraduate course. A methodology is described which indicates the approach adopted and a questionnaire evaluates students' impressions of the process. The overall conclusion to be drawn from the investigation is that skill development does take place and that students find groupwork an enjoyable learning experience. With regard to self- and peer-assessment, students were not as enthusiastic. Ultimately, there is a need to continue to involve students so that they can see evaluation in a positive, developmental light and to encourage students to take a more proactive role in assessing their performance.*

**Marybeth Lima, Caye M. Drapcho, Terry H. Walker, Richard L. Bengtson and Lalit R. Verma** 67–74 A Model for Integrating Skills across the Biological Engineering Curriculum

*This paper details a model for integrating communication skills (oral, written, group/team, and leadership) across an undergraduate biological engineering curriculum. Instruction in these areas is provided within some of the core courses and has been key for student success. Communication skills are expanded upon as students progress through the curriculum and culminate with the senior capstone design sequence. In this paper, we present this model and discuss the positive ramifications it has had on student learning. Problems encountered include student and faculty resistance and lack of resources. Recommendations for implementing such a model in any engineering curriculum are detailed.*

#### *Student Achievement and Attitude Towards Instruction*

**Siu-Man Raymond Ting** 75–80 Predicting Academic Success of First-Year Engineering Students from Standardized Test Scores and Psychosocial Variables

*The author proposes a model combining standardized test scores and psychosocial variables to predict students' academic success. The Scholastic Aptitude Test (verbal, mathematics, and total) scores and the Non-Cognitive Questionnaire (NCQ) were used for predicting grade-point-average (GPA) of 690 engineering freshmen in a public research university in Southeastern United States of America. Multiple step-wise regression analysis revealed SAT scores and psychosocial variables for predicting student academic performance. Different predictor variables were found based on gender. This study shed light on admissions criteria and academic intervention programs for enhancing academic success of engineering students.*

**Susan Dabney Creighton, Robert L. Johnson, James Penny and Edward Ernst** 81–88 A Comprehensive System for Student and Program Assessment: Lessons Learned

*Recent initiatives by the National Science Foundation (NSF) and Accreditation Board for Engineering and Technology (ABET) have promoted changes in classroom practices to move instruction from a traditional lecture to structured activities that require students to use the knowledge, skills, and abilities required by engineers in the workplace. For instructors to make valid inferences about whether students have mastered these work-related skills, assessments must be aligned with these new curricular emphases. Performance-based assessments offer a more direct method of assessing student outcomes identified in the ABET criteria. Such a shift in instructional and assessment practices in the classroom requires a concomitant shift in the evaluation of the effectiveness of such engineering programs. This article summarizes lessons learned by the authors in two disciplines, engineering and educational research, in the implementation of an assessment system and the use of performance-based assessments to evaluate student and program outcomes.*

**Terrance P. O'Brien, Susan M. Butler and Leonhard E. Bernold** 89–92 Group Embedded Figures Test and Academic Achievement in Engineering Education

*This study was conducted to investigate cognitive style patterns among students in a lower division engineering course and differences in the academic performance of those students related to differences in their cognitive styles. The Group Embedded Figures Test was administered to 130 undergraduate engineering students enrolled in CE 214 Engineering Mechanics-Statics at North Carolina State University. Analysis of variance was used to examine differences in academic achievement of students in relation to their different cognitive styles. The findings identified a highly skewed distribution on the cognitive style scale, with the vast majority being highly analytic. In addition, students who manifested an analytic (field independent) cognitive style achieved significantly higher grades in the course than those with a Global cognitive style.*

**Kim Buch and Chris Sena** 93–98 Accommodating Diverse Learning Styles in the Design and Delivery of On-line Learning Experiences

*The primary purpose of this study was to incorporate principles of learning styles theory into the design and delivery of Internet-based education. Learning styles theory has long been used by educators to enhance the learning experience by individualizing it to accommodate the various ways that students perceive and process information. Although learning style principles have been widely applied to more traditional teaching-learning formats, educators have just begun exploring the potential application to asynchronous formats. This paper first describes Kolb's (1984) theory of learning styles, and then describes how principles from the theory can be adapted for use with computer-delivered instruction. Finally, we report the results of a study designed to measure the effect of customized instruction on students' perceptions of the learning process, and discuss the implications for the increasing numbers of faculty and students involved in on-line teaching and learning.*