Volume 18 Number 2 2002 ISSN 0949-149X

The International Journal of Engineering Education

Special Issue: Assessment

Guest Editor: Gloria Rogers

Contents

M. S. Wald 107 Editorial

Gloria Rogers 108–109 Guest Editorial

Jirapan Liangrokapart, Funda Samanlioglu, Michael Leonard, Eleanor Nault, James Harrison, Jr. and **D. Jack Elzinga** 110–116 Gathering Employer Assessment Inputs from Focused Discussion Group Sessions with Campus Recruiters

The Accreditation Board for Engineering and Technology (ABET) requires all accredited engineering schools to assess the capabilities of their graduates. One source of program outcome assessment data is feedback from employers concerning the work performance of engineering graduates. This paper describes procedures for planning and conducting focused discussion group sessions with corporate recruiters. A review of literature related to gathering employer assessments is presented. Following the description of the protocol for the discussion sessions is a summary of observations from focused discussion group experiences over two semesters on the Clemson University and the University of Florida campuses.

Joseph Hoey and **Eleanor Nault** 117–127 Trust: The Missing Ingredient in Assessment

Over a decade of mandated assessment, state-level evaluation requirements, and more recently the ABET Engineering Criteria 2000 have focused attention on the need to systematically assess student learning in engineering curricula. A primary impediment to the usefulness of systematic assessment lies in how the culture of assessment interacts with norms of organizational trust within institutions of higher education. Establishing trust is a necessary first step towards creating sustainable assessment systems. In a research institution in the southeastern United States, the use of focus group methods to explore barriers impeding assessment resulted in the identification of several factors pivotal to successful implementation. These factors were supported in the literature, and emerged strongly in subsequent structured small group discussions attended by faculty and administrators. From these results, comparative characteristics of low-trust and high-trust environments for assessment are developed and presented.

Mary Besterfield-Sacre, Larry J. Shuman and **Harvey Wolfe** 128–139 Modeling Undergraduate Engineering Outcomes

An outcome assessment objective is the ability to track students from the point that they enter their engineering program through graduation. By monitoring student progress, faculty can best assure that the desired outcomes are being met and, where they are not, introduce improvements—this is the core of ABET's performance-based criteria. To provide the structure for doing this, a representative model of the engineering education system was developed, evaluated, and validated at the University of Pittsburgh. This model provides insight into those factors and educational processes that influence outcome achievement. The model is based on the assumption that the educational processes a student experiences (i.e. curriculum, in-class instruction, work or research experience, etc.) are related to the graduate's obtainment of certain engineering knowledge, skills, and attitudes (i.e. EC 2000 outcomes), as supported by the engineering education literature. With input from working engineers, an alumni questionnaire was developed to measure various aspects of the model. The alumni responses along with archival data were used to evaluate and verify the overall model. Several promising models that yielded good predictive value were developed for individual outcomes. Differences were found between students who had pre-graduation work experiences and those students who did not. The model for students with pre-graduation work experiences generally showed a consistently high correlation between the predicted and actual outcomes; whereas, a similar model for students without pre-graduation work experience only yielded modest correlation. This paper discusses in detail the approach taken to model the engineering education system and demonstrates how these models have been used to improve the engineering environment at the University of Pittsburgh School of Engineering.

John K. Gershenson, Christine E. Hailey, J. Clair Batty and **Warren F. Phillips** 140–150 Application of Value Engineering Techniques in Curriculum Development and Review

A novel process for curriculum review developed in Mechanical and Aerospace Engineering at Utah State University is described. The process, based on value engineering techniques, is quantitative, allows faculty freedom to innovate and is sufficiently flexible that it can be applied to many engineering programs. Results are tabulated in three systems of matrices. Importance matrices are used to show the relative importance of goals at each programmatic level. Measurement matrices document the level of performance at each programmatic level relative to a set of benchmarks. Correlation matrices are used to correlate the goals from one programmatic level to the next. While other assessment methods may use something similar to our measurement matrices, the use of correlation matrices is unique to this curricular review process. The correlation matrices are used to see if the goals of each level are correct. A curricular review process is then described which employs these matrices to adjust the relative importance of goals and to insert or delete possible new goals. The review process provides a formal way of closing the feedback loops at all programmatic levels from the course level to the objective level. An example of implementation of the curricular review process is presented.

Patricia Brackin 151–156 Assessing Engineering Education: an Industrial Analogy

Embedding quality improvement methods into the teaching of engineering processes is not new to engineering education. Engineering graduates are expected to be able to develop and design products and processes that meet the needs of customers within given constraints and follow known procedures to ensure quality results. Quality function deployment (QFD) is an internationally accepted planning technique that is used to ensure that quality is designed into a product by incorporating customers' needs. The QFD matrices depict the components of this process for determining engineering characteristics, parts characteristics, key process characteristics, and production requirements. The QFD process will be used as a tool for understanding the assessment of academic programs and meeting the continuous improvement requirements embedded in Engineering Criteria 2000 [1]. The author compares the QFD process with the development of an assessment planning process and outlines considerations needed in developing an assessment tool (both content and process).

Jack McGourty, Larry Shuman, Mary Besterfield-Sacre, Cynthia Atman, Ronald Miller, Barbara Olds, Gloria Rogers and **Harvey Wolfe** 157–167 Preparing for ABET EC 2000: Research-Based Assessment Methods and Processes

On-going research on outcome-based assessment processes conducted by a multidisciplinary team from five major universities is described. The research has been guided, in large part, by ABET's innovative criteria—EC 2000. The paper provides examples of several by-products of this research that have been applied in the engineering education environment. The reader is exposed to strategies for objective setting, an attribute database for use in defining student learning outcomes, and examples of technology-enabled systems that provide constituents with timely results. Specific assessment methodologies currently embedded in triangulation and validation experiments are described.

Paul Wellington, Ian Thomas, Irene Powell and **Brian Clarke** 168–179 Authentic Assessment Applied to Engineering and Business Undergraduate Consulting Teams

The rationale and structure of an authentic assessment strategy used in the multi-disciplinary industry project (MDIP) at Monash University over the last five years. The MDIP involves engineering, marketing, accounting and industrial design students nearing the end of their undergraduate programs working in multi-disciplinary product development teams of 8–10 members. The students work on real problems provided by participating industry partners. The authentic assessment strategy developed to evaluate individual student performance is based partly on group performance on both written and live presentations of their project reports as assessed by both industry partners and supervisors, and partly on the performance of each individual on a range of real-life skills as assessed by the supervisor, their peers and the students themselves. What makes the assessment 'authentic' is that the problems provided by the industry partners are real and the skills that are assessed during the completion of the project are essential for participation in multidisciplinary project teams that operate in modern industrial settings.

Robin S. Adams, Cynthia J. Atman, Rie Nakamura, Gretchen Kalonji and **Denice Denton** 180–192 Assessment of an International Freshmen Research and Design Experience: A Triangulation Study

As part of a university-wide initiative to help students develop a greater awareness of international issues and compete in a global market, our College of Engineering piloted a bi-national program for freshmen engineering students. To evaluate course effectiveness and assess student learning for the University of Washington students we implemented a comprehensive plan utilizing triangulation through multiple methods. Our assessment results indicate course goals were met: freshmen were able to participate and learn from authentic international research and design projects. By adopting a triangulation approach we were able to cross-validate results and develop an enhanced course and more streamlined assessment instruments.

Joseph A. Shaeiwitz 193–198 Mining Capstone Engineering Experiences for Program Assessment Results

Capstone engineering experiences such as design projects, laboratory projects, projects with industry, and research projects are excellent opportunities for program assessment. One method for using capstone experiences for program assessment is to develop rubrics to allow qualitative assessment information to be quantified in a consistent manner between multiple evaluators. The summative results of the assessment process can be used to improve the program, thereby completing the feedback loop to the curriculum. The formative results of the assessment process can be used to develop students' skills over time and make certain that their knowledge and skill base is as desired. An example of how this process is currently used is presented.

Julia M. Williams 199–207 The Engineering Portfolio: Communication, Reflection, and Student Outcomes Assessment

According to the Accreditation Board for Engineering and Technology, portfolios are one possible data collection method that engineering programs may use to document student learning outcomes. Despite the apparent endorsement by ABET of portfolios, ABET materials offer little concrete description of how the portfolio concept should be adapted to the documentation of engineering students' learning. This article traces the development of portfolios in the field of writing assessment and then discusses how portfolios are being adapted in engineering education. The documentation of learning outcomes in communication is the test case used to show the five necessary steps in portfolio development and maintenance: defining engineering communication (or any other learning objective); identifying appropriate skills and mapping them in the curriculum they are currently (or should be) developed; correlating portfolio learning objectives to course and program objectives; facilitating opportunities for students to reflect on their learning; and assessing student learning so that students, faculty, and programs can benefit and improve.

Daina Briedis 208–216 Developing Effective Assessment of Student Professional Outcomes

As engineering programs continue to prepare for evaluation under EC 2000, faculty members are experiencing concern over the less well-defined outcomes of Criterion 3 that address lifelong learning, the global and societal context of our profession, and contemporary issues. Designing and implementing assessment for these outcomes might appear to be a time-consuming and ill-defined endeavor. This paper suggests several straightforward classroom strategies that faculty may use to begin to develop these outcomes in their students and describes an effective assessment method that may be realistically implemented and maintained for the long-term.

Ronald L. Miller and **Barbara M. Olds** 217–224 Lessons Learned in Developing and Implementing a Program Assessment Plan

Although there is certainly no single, correct way to develop and implement an assessment plan, this paper presents a case study using a proven process for constructing an effective plan. The process described allows for a wide variety of approaches to assessment, while at the same time providing guidelines so that no important component of a successful plan is overlooked. The paper also includes a number of lessons learned in developing a plan for a specific program in chemical engineering at the Colorado School of Mines. We believe that the process we followed and the lessons we learned can be adapted to a variety of contexts and programs.

Ronald E. Terry, John N. Harb, William C. Hecker and **W. Vincent Wilding** 225–235 Definition of Student Competencies and Development of an Educational Plan to Assess Student Mastery Level

Our experience with the development of an outcomes-based educational plan to satisfy ABET EC 2000 is documented. Critical aspects of our plan include: the method used to define student outcomes; definition of mastery levels that reflect the relative importance of individual outcomes; definition of a core set of outcomes targeted for mastery by all of our students; feedback from our constituencies; a variety of assessment tools including course-level assessment and a core competency exam; and a method for continuous improvement of our curriculum, teaching pedagogy, and the plan itself. Assessment is performed at the competency level in order to provide the feedback necessary to facilitate evaluation and improvement of student learning.

Dervis Z. Deniz and **Ibrahim Ersan** 236–244 An Academic Decision Support System Based on Academic Performance Evaluation for Student and Program Assessment

Statistics plays an important role in assessment and evaluation of performance in academic environments. Universities need to have extensive analysis capabilities of student achievement levels in order to make appropriate academic decisions. Conversely, academic decisions will result in academic performance changes, which need to be assessed periodically and over spans of time. In this work, the different ways in which student performance data can be analyzed and presented for academic decision-making are investigated and a software package called the Performance-based Academic Decision-Support System (PADSS) is developed. The performance parameters chosen can be viewed at the individual student, department, school and university levels.

Maryanne Weiss and **M. Dayne Aldridge** 245–253 Assessing the Effects of the ABET/NSF/Industry Regional Faculty Workshop

In 1998, the Accreditation Board for Engineering and Technology, Inc. (ABET®) implemented Engineering Criteria 2000 (EC2000). To support implementation, ABET is conducting a series of regional engineering faculty workshops. This paper focuses on how assessment was used to improve the structure of the workshop and to insure its continued effectiveness in view of the community's evolving awareness and understanding of EC2000. This paper describes the overall project methodology and implementation. Results reported include survey data from nine of 12 workshops. For the one-year post workshop results, data from the first four workshops are reported.