Advances in Engineering Education

SPRING 2017

From the Editor

This marks the 20th issue of *Advances.* It features nine peer-reviewed articles and our first book review. The authors collectively come from fifteen different institutions. These include a number whose faculty typically appear in the engineering education literature, including Worcester Polytechnic Institute, Duke, Iowa State, North Carolina State, Colorado School of Mines, Georgia Tech, Arizona State and George Mason as well as less well known schools: Wartburg College, University of Toledo, Roger Williams, The Citadel, James Madison, Southern Illinois and the University of Northern Iowa. It is being able to see articles by faculty from this latter group of institutions that is particularly gratifying, because it substantiates a reason for founding the journal; that is, providing an outlet for the broader spectrum of engineering faculty to publish significant classroom achievements.

These papers cover a broad range of topics including international education; writing (both at the freshman and capstone design levels); pedagogical tools in thermodynamics (intelligent tutoring and just-in-time-teaching); design (using modeling and a rubric to evaluate design); the use of mixed learning formats and mixed methods for assessment; and the value of sales engineering. In addition, Aditya Johri provides a short review of Richard Felder's and Rebecca Brent's important new book, *Teaching and Learning STEM: A Practical Guide.* We hope that this will be the first in a series of reviews of books, both recently published and those considered more classic in *AEE*. We invite readers to contact us if there is a book they would like to review.

The "lead" article in this issue is by Chrysanthe Demetry and Richard Vaz from WPI and addresses an aspect of that institution's most impressive international activities, which last year received the National Academy of Engineering's Bernard M. Gordon Prize for Innovation in Engineering and Technology. They describe a mixed methods study of the influence of an education abroad program on students' intercultural sensitivity. In particular, the paper focused on project-based education abroad experience in Thailand that was designed to foster intercultural learning. Although their quantitative results relative to a comparison group were not statistically significant, certain of their qualitative results suggest important learning did occur. They relied on the Intercultural Development Inventory (IDI) as the quantitative program assessment and student learning outcomes measure, which (in my experience) may not be sensitive enough to pick up pre-/post-test differences. Certainly, their study reinforces concerns that I share with the authors in defining and assessing intercultural or global competence.

Daniel Bumblauskas, Adam Carberry and David Sly have examined a technical sales program to introduce business concepts into engineering curricula. Such programs enable students to become more business aware while better educating those who will seek careers in the technical sales sector. The team analyzed cohorts of students enrolled in a technical sales for engineers course to assess changing

perceptions and attitudes. They found statistically significant changes in perceptions of interest, need, and technical sales ability and social skills. Not surprisingly, students who were enrolled in the sales minor or had previous sales experience both ranked their prior ability and expressed initial interest higher than those who did neither. This study (and the team's proposed future work) provides a foundation for developing new technical sales programs. The authors conclude: "It is imperative with the growing need for technically knowledgeable sales professionals that programs effectively and efficiently prepare their students for the sales profession." Our experience with a similar program at the University of Pittsburgh confirmed that there is substantial interest among engineering students in pursuing a sales career path. The March-April 2017 edition of ASEE's *PRISM* contains a short summary of this paper.

Mathew Hagge and colleagues have investigated the effectiveness of an intelligent tutoring system (ITS) that assesses student understanding of context specific problem solving decisions, and then prescribes feedback based on that assessment. Of particular interest is how this would improve student conceptual understanding so that correct decisions result. Their ITS was tested on 373 students solving a thermodynamics problem. They found significant improvement in student understanding using a single 40-minute tutor activity for all student cohorts regardless of their initial understanding. Given these promising results, the authors are in the process of creating/testing/making available multiple decision sets and problems using the ITS.

Matthew Liberatore, Rachel Morrish, and Charles Vestal examined the effectiveness of Just-In-Time-Teaching (JITT) in an introductory thermal science course. Their JITT feedback incorporated a variety of active learning exercises in response to students' performance on online homework problems. They found that when a specific course topic was reinforced by a JITT exercise, student performance was higher compared to a control group that did not receive the JITT review. Of importance to faculty, their results suggest that the immediate topical review provided by JITT may be most helpful for the mid-performing students. Over 85% of students indicated that JITT exercises were helpful for engagement and a good use of class time.

Matthew Lammi and Cameron Denson from North Carolina State University have focused on teaching modeling as a "habit of mind and practice" for novice designers engaged in engineering design challenges. Their results suggest that such a focus can be beneficial to both student and instructor. They have observed that modeling served as both a means for representation, but also as an aid for assessing and documenting students' cognitive processes. The four artifacts that the student-designers developed: conceptual, graphical, mathematical and working, demonstrated their design thinking ability, while providing evidence of decisions made throughout the design process.

Mary Katherine Watson and colleagues developed a rubric for examining students' abilities to engage in sustainable design. Their rubric incorporates a set of 16 sustainable design criteria and rating scales directed at capturing student performance and instructor/sponsor requirements. Using the rubric over

a ten-year period, the team observed that sustainable design performance had barely changed, despite efforts to integrate sustainability into the curriculum. They concluded that students in general addressed those criteria that were explicitly required, which related more to social sustainability than other dimensions. Their results suggest that efforts are needed to better compel students to incorporate a wider variety of sustainable design criteria into their design projects. While focused on sustainable design, the authors suggest that the rubric can be used to quantify student design abilities in any design course.

Benjamin McPheron, Charles Thangaraj, and Charles Thomas from Roger Williams University integrated laboratory exercises with lecture in a 'studio' format, enabling students to apply lecture concepts directly to in-class assignments, which were augmented with 'take-home' laboratory assignments. In this mixed learning method format, students acquired skills during lecture in studio laboratory exercises, and then applied those skills to two in-depth take-home projects. To assess the students' developed skills, project results were delivered as research papers that were reviewed "blind" by faculty and peers. Their results suggest that the mixed learning method allowed students to improve skills and tackle more complex problems.

Cary Moskovitz, from Duke University, describes a three-year study that provided students in an introductory engineering course with feedback on drafts of course writing projects. The Volunteer Expert Reader (VER) approach matched students with alumni or employers who then gave students critiques from the target audience perspective on their writing. He found that VER increased student engagement in engineering course writing assignments and may have improved the quality of student writing, suggesting that it could be a useful tool for engaging students in engineering course writing tasks. However, his data also revealed that the success of VER is highly dependent on how it is implemented. Success factors included whether student participation is required or optional and whether students are assigned their own readers. Thus the paper provides a guide as to how to adjust the various parameters in order to maximize its value for faculty who might implement VER.

Ryan Fries and colleagues at Southern Illinois University have focused on written communication skills in capstone design courses and, in particular, how they have changed due to industry sponsorship. Evaluation of student writing samples suggests that grammar/spelling and content organization improve over the course. That is, industry-sponsored projects do help students recognize the relation between professionalism and written correspondence free of errors. Hence this becomes an additional benefit for industry sponsorship.

As always, we would appreciate your comments on this important collection of papers. We continue to solicit papers as well as ideas for special issues. As always, we are happy to add your name to our list of reviewers.

Larry Shuman
Editor-in-Chief