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From the Editor

Over the approximately quarter century that I have been involved with engineering education research, we have witnessed a number of major initiatives and pedagogical changes. These include the integrated curricula first introduced at Rose-Hulman and Drexel by Jeff Froyd and Eli Fromm respectively; the NSF undergraduate engineering education coalitions; a major focus on active in cooperative learning led by Karl Smith among others; an interest in learning styles promoted by Rich Felder and Rebecca Brent; and the development and spread of concept inventories as a means of assessing learning. More recently we have seen an increased focus on project based learning, student centered learning, distance learning, and MOOCs. Now, one of the most rapidly spreading innovations is the flipped, blended, hybrid or inverted classroom, which is the focus of this issue.

Guest edited by Lorena Barba (George Washington University), Autar Kaw (University of South Florida) and Joseph Le Doux (Georgia Tech and Emory University), the issue features eight papers that explore the various aspects of "flipping." As the guest editors point out: In the flipped classroom, the students come prepared for the in-class session having read texts, watched a video, and completed homework problems. Often, students must complete short quizzes as part of their pre-class preparation. The idea is that they come to class prepared. Class time is then inquiry-based and interactive, with an emphasis on group problem-solving, but with time for the instructor to provide short mini-lectures when necessary to reinforce concepts. To the authors, flipping can be considered a form of blended learning. As an engineering educator (and administrator), I want to know several things about flipping: Does it work? Do students prefer flipped to traditional? Is conceptual understanding improved? Is retention improved? How much extra work is involved to flip a course? These are all questions addressed in varying degrees by the eight papers, which collectively analyze 13 different courses. The guest editors have summarized the papers. While we have yet to reach a definitive conclusion about the value of flipping, the papers do offer some important insights. Here is my summary of the takeaways from the combined findings of these eight papers. Certainly if you are interested in flipping a course, I suggest you read all eight.

Does it work? Several of the authors answer yes! Ferri and her colleagues in flipping a Circuits and Electronics course (for non-majors) found that the hands-on, in-class activities positively impacted student conceptual understanding and confidence for those students who were middle to top performers. However, these gains were not observed for the lowest-achieving students, some of whom admitted to not completing the exercises, especially those activities that addressed higher-level thinking activities. Le Doux and Waller in their "Problem Solving Studio" (PSS) approach, incorporating

"dynamic scaffolding" found that it could significantly enhance students' conceptual understanding. Webster, Majerich, and Madden flipped a fluid mechanics course. Using three measures, they observed that student achievement was significantly higher when compared to a more traditional approach. Karabulut-Ilgu and Jahren used the hybrid model to "flip" a junior level construction engineering course and found students performed at a higher level than those who took the same course in a more traditional format. Finally, Schrlau, Stevens, and Schley found students in a flipped heat transfer course outperformed students in a traditional class on both conceptual multiple choice and closed-form long answer questions.

However, others were not able to find significant learning differences. Saterbak, Volz and Wettergreen, who devoted substantial effort to flip a first year engineering design course, were not able to conclusively show that learning improved over the straight lecture model. Clark and her associates at the University of Pittsburgh flipped and then assessed six courses, achieving mixed results based on direct assessments. They noted that sophomore and junior students were much more positively disposed towards the flipped model compared to both freshmen and seniors who tended to resist it. Clark, Kaw, and Besterfield-Sacre in studying a flipped numerical methods course at the University of South Florida also had mixed results – exam results suggested that the flipped format may be preferred for student achievement compared to a true blended and semi-flipped (aspects of both blended and flipped combined) formats, although the instructor preferred the semi-flipped model, while students rated the blended classroom the highest. Readers should note that there is not consistency among the papers as to the differences (if any) between flipped and blended. However for this latter course at South Florida, there were clear differences between the flipped, blended and semi-flipped models.

What else was learned concerning the flipped model? All authors found that creating video modules for the majority of lecture material resulted in a substantial amount of in-class time for a variety of activities, greatly enhancing active learning within the classroom. Indeed, flipping the course may be the ideal way to introduce active learning. Certainly as Saterbak and colleagues point out, "the exercise of flipping provides educators with an opportunity to seriously rethink the course content and organization." However, they also point out that it may take 10 to 20 hours of instructor time to produce the equivalent of a 30 to 45 minute lecture. They have produced a series of high-quality instructional videos that interested faculty may examine and even adopt.

Clark and her colleagues found student satisfaction over the series of six evaluated courses divided almost equally among preferred, unsure and not-preferred. However 57% of the students did prefer the use of class time for problem solving and other active learning exercises compared to listening to a lecture. Students cited the flexibility and convenience that the flipped model provided and almost a third felt it enhanced the learning process.

Finally, Karabulut-Ilgu and Jahren offer the following recommendations to faculty contemplating flipping a course:

- make the online component required;
- provide scaffolding for online activities;
- keep the number of technical issues to a minimum;
- meaningfully weave the online and face-to-face activities;
- prepare students for the new format;
- provide a well-established and consistent structure; and
- communicate with students in new ways.

I doubt that any of the other authors or the guest editors will disagree with these recommendations. I encourage you to carefully read this set of papers, especially if you are contemplating using the flipped model.

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Editor-in-Chief
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