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Learning Benefits of Multiple Approaches of Using Physical Models [1]

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Project Description: Learning Benefits of Multiple Approaches of Using Physical Models

The use of physical models to illustrate engineering concepts is an integral part of all of my classes. The use of models enhances student learning in engineering classes because most engineering students are visual learners and can therefore learn in their preferred mode. Physical models can be used in multiple ways both within and outside of the classroom, through demonstrations, small group activities to investigate concepts, or investigations by each student individually, for example. Physical models are most effective at enhancing learning when students are required to make predictions about the outcomes (Crouch et al. 2004; Miller et al. 2013) and when students make the correct observation of the outcome. In demonstrations, the instructor can play a critical role in encouraging critical thinking and in guiding students' observations of the outcomes. In small group and individual activities, the critical thinking and observations are controlled by the students; thus the level of learning may be different. As non-traditional classroom models, such as flipped classrooms and online courses, are implemented, these student-controlled investigations may become more common.

My proposed research project is to compare the learning benefits of various approaches of using physical models, including (1) demonstrations in which students observe an instructor-led demonstration; (2) small group activities in which students work together to investigate a concept; (3) individual investigations that students conduct by themselves outside of class; and (4) videos of demonstrations that students watch individually outside of class.

The research will be conducted in Hydraulic Engineering over a two-year period. I currently use at least one physical model each class period, most commonly in the form of a demonstration and occasionally as a small group activity. The first step, conducted in the first year, is to continue with my usual approach of using physical models for demonstrations, and to assess students learning from these demonstrations. The assessment will be conducted through short non-graded, anonymous quizzes in the class period after the demonstration to assess immediate impacts on learning. A comprehensive assessment will be conducted through an anonymous survey at the end of the semester to evaluate the longer term impacts on learning. This step will provide baseline data on the learning benefits of demonstrations. The second step, also conducted in the first year, is to develop five small group activities, five individual activities, and five video demonstrations based on physical models that I currently use for demonstrations. The third step, conducted in the second year, is to implement these new approaches for investigating concepts with physical models. Similar to the first year, assessment of learning will be conducted through both non-graded, anonymous quizzes and an end-of-the-semester anonymous survey. The learning benefits of the new approaches will be compared to the learning benefits of the demonstrations for each physical model. Some physical models will be used as demonstrations in both years, which will serve as a control to account for the differences in the groups of students who will participate each year.

References

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Miller, K., Lasry, N., Chu, K. and Mazur, E. (2013). “Role of physics lecture demonstrations in conceptual learning.” Physical Review Special Topics – Physics Education Research, 9, 02113, DOI: 10.1103/PhysRevSTPER.9.020113.

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