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Using Active-Engagement Teaching Methods in Large-Enrollment Classes to Improve Student Learning

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I have always enjoyed learning about scientific concepts and explaining them to other people, and I used to spend a great deal of time and effort preparing extremely clear and detailed lectures. After a while, though, I could not avoid the realization that most of my students were not learning physics very well, despite my painstaking efforts to present concepts clearly, completely, and methodically. Although physics is a difficult subject, I felt that I should be doing a better job of communicating its ideas.

I became aware that university faculty engaged in physics education research were having success with instructional methods that employed "active engagement." In these methods, most often applied in instructional laboratories or small classes, instructors avoid giving students a fully worked-out set of answers and explanations right at the beginning. Instead, they guide students to figure out concepts on their own – as much as possible – through hands-on laboratory investigations or closely guided theoretical reasoning. Instructors guide students to follow productive lines of reasoning through a form of Socratic dialogue, asking many leading questions.

But can these instructional methods be employed in a lecture hall with 80 or more students? The answer is yes. Two effective techniques are: (1) guide students through a sequence of multiple-choice questions that force them to think deeply about the targeted concept, and use a classroom communication system to obtain instantaneous responses from all students simultaneously; (2) allow students to work in small groups on problems requiring non-multiple-choice responses such as diagrams or short answers. Responses to properly designed questions can be very quickly checked by the instructor who circulates around the lecture hall, examining the work of students near the aisles and front row.

The communication system I use is flash cards: each student is given six 5 x 8 cards on which the letters A, B, C, D, E, or F are printed. I write questions on the board along with several possible answers or provide pre-printed questions, and I'll usually give students 15-30 seconds to consider their answer. If they have trouble responding, or if there is much disagreement on the answers (for instance, half with "A" and half with "C") I'll give them another minute (or more) so they can discuss it with each other. This method allows a virtually continuous exchange of questions and answers between instructor and students.

Professor David Meltzer

I have done careful assessment of my students' learning over the years, using several standard conceptual tests as well as questions borrowed from other instructors' exams. I measure students' learning gains, that is, improvement from a pretest given on the first day of instruction to a post-test given the very last day. My students' gains are consistently above those reported in classes using more traditional forms of lecture instruction.

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They are exposed to fewer topics than in a traditional class, but seem to learn the concepts they study in much greater depth. They also learn to analyze problems qualitatively, and not simply by relying on equations. Course evaluations suggest that most students enjoy this method of instruction. Many more details about the assessments and the instructional methods can be found on the website of the ISU Physics Education Research Group, http://www.physics.iastate.edu/per/.

References:

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2. Eric Mazur, *Peer Instruction: A User's Manual* (Upper Saddle River, NJ, Prentice Hall, 1997).