CHOOSING THE RIGHT MIXTURE OF TECHNIQUES AND TECHNOLOGY

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ABSTRACT: Recent years have seen the development of a variety of teaching techniques specifically designed to improve student learning in physics. In addition, new technologies have been developed that help to increase interaction between students and instructors. Choosing which techniques and technologies to use, and then merging these techniques and technologies into a consistent whole, can pose a significant challenge for physics teachers. In this talk I will describe the various techniques and technologies I have used in teaching a two-semester algebra-based introductory physics sequence over the past six years. These courses have gradually evolved to incorporate a mixture of Peer Instruction and Just-In-Time-Teaching using online quizzes, Physlets, and an electronic response system.

This poster describes my experience teaching introductory algebra-based physics over the last six years. I started off using a traditional lecture-based approach. Over the years my teaching style has evolved to a more student-centered approach. However, in spite of the availability of several high-quality student-centered physics curricula, I chose to not adopt any one particular teaching technique wholesale. Instead I have tried to blend a variety of techniques to produce a coherent teaching style that suits my particular needs. Along the way, I have incorporated several techniques into my teaching methods. Overall, this approach has been successful, but I have certainly made mistakes along the way. The sections below give a semester-by-semester account of how my PHY 111 (General Physics with Algebra I) course has evolved. My hope is that by sharing both my successes and failures, I can ease the path for others who might want to try mixing a variety of teaching techniques and technologies.

Fall 2001
• My first semester as a college professor.
• Traditional approach: pure lecture, homework problems from the textbook [1] for completion (not for correctness), 4 tests focusing on calculation problems.

Fall 2002
• Switched to a new textbook [2] and added a bit of group work: students worked in groups of 4 or 5 to complete a review assignment prior to each test.
• Made a hasty decision to switch to Peer Instruction [3] in October after attending the Workshop for New Physics and Astronomy Faculty. Although some students liked the new style, most resisted the sudden change.

Fall 2003
• Before class: online quizzes using a course management system from Jenzabar. Quizzes consisted of roughly five ConceptTest questions similar (or in many cases identical) to those found in Eric Mazur’s Peer Instruction: A User’s Manual [3].
• In class: brief review of the material followed by Peer Instruction using the questions from the online quiz (if needed) as well as new questions. Questions were shown on a projector screen using PowerPoint, and students responded using a number-card system.

Fall 2004
• Added an essay question to the online quizzes (to be more in line with the strategies of Just-In-Time-Teaching [4]) and spent some class time discussing the essay and showing (on PowerPoint) a few sample student responses.

Fall 2005
• Switched to grading online quizzes for completion (one point for answering the multiple choice questions and one point for giving a relevant answer to the essay).
• Devised a “demo problem” for each topic. The demo problems were designed to be very similar to the homework problems I assigned. The demo problem was discussed in class if there was time, but in any case the solution would be posted online.
• My teaching evaluations improved significantly, matching my evaluations from Fall 2001. More importantly, my students continued to show good gains (0.39) on the FCI.

Fall 2006
• Began using Physlets [6]. Online quizzes now typically consist of two questions on previously covered material using Physlet Problems, one question straightforward from the assigned text reading, and two questions on new material using Physlet Illustrations or Explorations.

Lessons I’ve Learned
• NEVER change your teaching style significantly in the middle of a semester.
• Be willing to mix and match teaching techniques to find the combination that works best for you and your students.
• You must be comfortable with what you are doing.
• Your students should hate your teaching methods (although you may need to overcome some initial resistance).
• Teaching methods must fit with your available resources (technology, classroom space, teaching assistants, laboratory/demonstration equipment, etc.).
• Don’t make more than one major change to your teaching methods per semester.
• Experiment with new technologies when feasible, to see if they can aid your teaching.
• Don’t become familiar with new technologies before using them in your course. If possible, try to avoid relying on technical support from others.
• How you implement your teaching strategies can have a big impact on student attitudes in the course.
• If you give online quizzes on material prior to covering that material in class students may resent having those quizzes graded for correctness. If you grade for completion only, then students may put minimal effort into answering the quiz questions.
• Peer instruction works best if the questions are given to students on a handout (rather than displayed on the screen) and students can respond using “clickers.”

Fall 2007
• Don’t make more than one major change to your teaching methods per semester.
• Experiment with new technologies when feasible, to see if they can aid your teaching.
• Become familiar with new technologies before using them in your course. If possible, try to avoid relying on technical support from others.
• How you implement your teaching strategies can have a big impact on student attitudes in the course.
• If you give online quizzes on material prior to covering that material in class students may resent having those quizzes graded for correctness. If you grade for completion only, then students may put minimal effort into answering the quiz questions.
• Peer instruction works best if the questions are given to students on a handout (rather than displayed on the screen) and students can respond using “clickers.”

Technology problems can also have a serious negative impact on student attitudes, so try to avoid using unreliable technologies or technologies that you cannot fix on your own.

References

Figure 1
Plot of normalized gains on FCI for Fall 2004, 2005, and 2006. Points show the mean normalized gain (<g>) for all students, while error bars indicate the standard error of the mean.

Figure 2
Histogram of teaching evaluations from Fall 2001 to Fall 2005. Blue bars represent my average rating on all evaluation items. Red bars represent my average rating for “Overall Quality of Instruction.” All questions use a Likert scale from 1 to 5 with 5 being best.