CWSEI – PHYS & ASTRO Newsletter

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Our department has always been committed to high standards in education. Recently, with support and leadership from the CWSEI, we have made increasing progress in successfully implementing research based educational methods in our classrooms. An increasing number of our faculty are showing keen interest in these developments. In response, we distribute this monthly newsletter to keep you up-to-date with the latest CWSEI efforts.

Prof. Ian Affleck, Phys:107 (Enriched Physics I)

I took over the lecture and tutorial portion of Physics 107 last term from Erich Vogt who taught it for much of the last 40 years, giving excellent traditional lectures. (The lab continues to be run separately by Doug Bonn.) With great help from Jim Carolan and a course-wide TA, Dan Mazur, I made a number of changes in the course including:

- Peer instruction:[1] students would discuss the answers to conceptual clicker questions with their neighbour during lectures – in some cases after a preliminary vote. Teaching staff members would circulate to guide the discussions and make sure everyone was discussing appropriately. Often the questions were used to introduce a topic rather than review a topic already covered during the lecture – a technique known as question driven instruction.[2]
- A few times during the term, students would work on more extended problems during lecture, filling out a worksheet to hand in. Again, they could discuss with neighbours and circulating teaching staff members.
- Pre-reading tests: students were expected to read 10-15 pages from the textbook before each lecture and answer a few simple questions on-line the evening before. This is important in order that the students can participate actively in the peer instruction and because not all subjects can be covered during lectures due to time being taken by peer instruction.[1] The final question on each pre-test was always "What did you find most difficult or interesting in this reading?" I looked over the responses while preparing my lecture.
- Computer programming: vpython was used to do finite time step solutions of equations of motion and produce graphics. (example: 3 body planetary dynamics) The students made simple modifications of programs during tutorials to answer Physics questions.
- New textbook: I followed Chabay and Sherwood, *Matter and Interactions, Vol I* closely and used the associated WebAssign for homework questions. Vpython, which was developed by the authors, is tightly integrated into this textbook. The book is short enough that I could assign nearly all of it as pre-reading. It is a bit unusual in introducing some advanced topics like special relativity from the first chapter. Grading most of the homework automatically on WebAssign freed up TA time to attend lectures. Options were set to allow students multiple attempts at questions.
- Tutorials: these began with a clicker question, partly to keep attendance, then a blackboard (or easel) "context rich" question to be worked on in groups of 3,[3] then a vpython activity.
- Mix of conceptual versus computational questions on exams.

Some things worked well and others not so well.

- Peer instruction was very popular. Bringing my own clicker hub to class helped when I had students discuss and vote a 2nd time after a preliminary vote. That way, I could quickly view their first responses without revealing them to the students.
- Noise level during lectures: after a peer instruction session (lasting a few minutes) it was often hard to quiet the class. I found that ringing a bell after the session and pre-assigning seats, differently each lecture, helped with this problem.
- Work level: 3 pre-reading assignments with tests plus homework every week was probably expecting too much. Participation level in pre-reading tests dropped a bit during the term. Next year I may decrease the number of tests to 2 per week and assign less reading.
- Computer programming: rather than get the students to write code from scratch, we just had them modifying code that Dan created. This involved hunting around for the right lines to change and understanding a few basics about computer codes. The vpython graphics were excellent. A questionnaire indicated that some students found this useful for understanding Physics concepts but some did not. I will probably have the students spend less time on this next year, perhaps partially substituting with more user-friendly simulations from U. Colorado or other sources.

- Blackboard problems to be done in groups of 3 during tutorials were very popular. We tried to get the students into suitable groups and to make sure that all group members understood the solution by the end. This helped to generate discussion which benefited all students in the group.

My overall impression was that these modern teaching methods are effective. It was certainly a lot of work teaching this course for the first time, but these methods made it more enjoyable for me as well as the students. I don't expect the methods to significantly increase the workload for the instructor in future years.

References

1. C.H. Crouch, J. Watkins, A.P. Fagen and E. Mazur, "Peer instruction: engaging students one-on-one all at once", in Research-Based Reforms in University Physics, Edward F. Redish, editor (American Association of Physics Teachers). Available on-line at: http://www.compadre.org/PER/items/detail.cfm?ID=4990

2. I.D. Beatty, W.J. Gerace, W.J. Leonard and R.J. Dufresne, "Desigining effective questions for classroom response system teaching", Am J. Phys. **74**, 31 (2006).

3. P. Heller and K. Heller (University of Minnesota) "Cooperative Group Problem Solving in Physics" http://groups.physics.umn.edu/physed/Research/CGPS/GreenBook.html.