Coupling Clickers with Computers

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Abstract

My innovation best fits into the pedagogical topic area of ***active and self-directed learning: inside the classroom and/or in preparation for class***. In short, it involves combining the use of student response systems (i.e., clickers) with in-class use of computer-based programming assignments/examples for purposes of enhancing active learning in the classroom. I have applied such an approach to undergraduate and graduate-level courses I teach. Student feedback on the use of these approaches has been very favorable; however, one of the challenges is knowing how to more formally evaluate the effectiveness of these approaches.

Introduction and Objectives

•Teaching computer programming-based problem-solving concepts to engineers has traditionally been a challenge at The University of Iowa as standard lecture-based formats have not worked well.

• Prior to my arrival, some classes had been redesigned to take advantage of in-class computer examples or exercises with success. Use of student response systems (i.e., clickers) in combination with a peer-teaching model provides an additional option for active learning in the classroom, but hadn't yet been used by my department.

•My objective was to incorporate both clickers and computer-based exercises (where possible) in the courses I taught. Unlike in other courses (such as large-lecture physics courses) that had used clickers at The University of Iowa, I had the opportunity to ask clicker questions that required interactive use of computers.

Developmental History of Innovation

Before 2009 (by my colleagues): select classrooms are equipped to provide the availability of computers during class.
2009-2010: I redesign a graduate-level digital image processing course to incorporate use of clickers in combination with in-class computer-based exercises. I also redesign a graduate-level algorithms course to use clickers (but do not use in-class computer exercises as the course is taught in a standard classroom).
2010-2011: I redesign a sophomore-level programming course to use clickers in combination with in-class programming exercises.
2011-2012: I add the in-class use of robots to a sophomore-level programming course.

Learning Activities and Materials

Materials developed for each 50-minute class of a sophomore-level programming course:

- Lecture notes with 2-4 incorporated clicker questions
- Set of programming examples (and associated IDE project file), some involving use of a robot
- Programming-based mini-assignment (to be started during class), some involving use of a robot

(In addition, six more substantial programming projects are developed for completion at home, with approximately half of them requiring use of robots.)

Materials developed for each 75-minute class of a graduate-level image processing course:

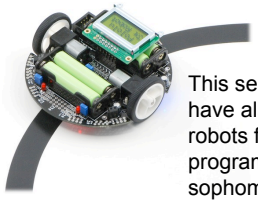
- Lecture notes with 3-6 incorporated clicker questions
- 1-2 interactive programming-based or software-based examples

(In addition, weekly homework assignments are designed, each requiring an implementation of a solution to an image-processing problem.)

I have been using clickers in combination with in-class computer-based exercises and assignments since Fall 2009.

Clickers

Computers



This semester (Fall 2011), I have also started to use 3pi robots for some of the in-class programming exercises (for a sophomore-level programming course).

Execution

Before class:
All files to be used during class are added to each student's source-code repository.

Right before class:
Each student picks up a laptop, turns it on, and downloads the files for the day (from his/her source-code repository).

During the first part of class:
Lecture notes (+ clicker questions) are displayed using one projector, while the laptop (configured like the students' laptops) or hand-written notes are displayed on another projector. Students answer clicker questions, discussing their choices with their peers and use their laptops to program/run small in-class examples.

During the last part of class:
Students begin a programming-based mini-assignment (to be finished at home if not completed during class) and commit their changes to their source-code repositories.

Major Issues to Resolve

•Students clearly like to use clickers and computers during class (based on survey data). However, I struggle with knowing how to formally evaluate the effectiveness of variations of these approaches. A more formal assessment approach would make refinement easier. For example, I would better like to understand what type of questions work best (quick conceptual questions or coding questions versus more time-consuming questions requiring an involved use of computers).

•For lower-level undergraduate courses, I still need to come up with better ways of encouraging/requiring the least-motivated students to have read the material before class (other than on-line quizzes).

Discussion

• Overall, at least when compared with a standard-lecture-based teaching model, coupling clickers and computers seems to be working very well for the programming-intensive courses that I teach.
• Surprisingly, designing clicker questions for graduate-student courses has been easier than designing them for undergraduate courses (and graduate students really like using them as well). This may be reflective of the nature of those courses or it may also be due to the increased maturity of the graduate students.
• For the sophomore-level programming course, in-class use of robots has been very popular. However, not all topics lend themselves to having robot-based examples. Nevertheless, I would like to increase the in-class use of robots in the future.
• I currently have been using a standard clicker model that students purchase at the bookstore. However, with the availability of computers, I would like to explore using a "virtual" clicker instead so that students do not need to purchase one.

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