Computer Coaches

- Online computer programs (Hsu & Heller, 2004) designed to improve students’ problem-solving skills by coaching them while they practiced solving problems were introduced into an introductory physics class.
- The coaches were designed within the framework of cognitive apprenticeship (Brown, Collins & Newman, 1989) to support the processes of modeling, coaching, and fading, all in the context of expert practice.
- The coaches emphasize the decision-making in solving problems.

Implementation

- Computer coaches were developed for 35 problems
- The coaches were available to 3 sections of a university calculus-based introductory mechanics course during two semesters.
  - Fall 2011: One section of 221 students
  - Spring 2013: Two sections of 148/103 students
- Students were required to complete their homework using WebAssign. Coaches were available to help with some problems.
- Data collected included:
  - Survey of student background data and expectations
  - Keystroke data from student use of the coaches
  - Mid- and end-of semester surveys
  - 13 written problem solutions from each student: 8 from 4 midterm quizzes and 5 from a final exam

Assessment Tools

- A research-validated rubric (Docktor, 2009) was used to analyze student written problem solutions.
- The rubric assigns a score based on five categories: Useful Description, Physics Approach, Specific Application of Physics, Mathematical Procedure, and Logical Progression
- Scores assigned by regular TAs for grading purposes are highly correlated with rubric scores (~0.9 for 5 problems together, ~0.82 for individual problems).

Final Exam Problem-Solving Grade

- Comparison groups were created by matching each S13 student from L, M, and H groups to four students who took the same course between S08 and F11 (no computer coaches) using pre-FCI, expected grade, expected study time, and gender (85% perfect match).
- Baseline classes normalized by making average problem-solving grades equal for all classes.
- Analysis of student written problem solutions using a research-validated rubric (see Assessment Tools) indicates that grades assigned by TAs are a useful indicator of problem-solving skill.

Comparison 1

- In Fall 2011, most students (L-, M-, and H-like) used most of the coaches (attempting 28 and completing 21 out of 35, on average).
- Students from the F11 section with coaches and a similar F11 section without coaches (control) were matched to S13 students.
- Scores between the two different final exams used in S13 and F11 were normalized by setting equal the rubric scores of the L-like users from S13 and the F11 control section.

Result 2

- H-like students score lower than L-like students in F11 control section (59.8±3.8% vs. 66.7±2.8%), but H-like students score as well as L-like students in F11 coached section (65.2±2.9% vs. 65.6±2.9%).
- L-like students in F11 control section scored as well as L-like students in F11 coached class (66.7±2.8% vs. 65.6±2.9%).
- H-like students in F11 coached section scored higher than H-like students in F11 control section (65.2±2.9% vs. 59.8±3.8%).

Conclusions

- Historically, less-prepared students (those with lower FCI pre-scores, higher expectations for study time, and lower expectations for course performance) score lower than better-prepared students on problem-solving tasks on the final exam.
- Using the computer coaches boosts the performance of these less prepared and less confident students over what they would achieve without the coaches, up to the level of the better-prepared students.

References