Assessing students’ problem-solving skills: Measuring the effect of an intervention

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The intervention

Online computer programs designed to improve students’ problem-solving skills by coaching them while they practice solving problems were introduced into an introductory physics class.

Computer coaches

The computer coaches (Hsu & Heller, 2004) were developed in the context of a cognitive apprenticeship (Brown, Collins & Newman, 1989) and emphasized the use of a general decision-making framework for solving all problems.

Implementation details

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

References


Analysis of student written problem solutions using a research-validated rubric (Docktor, 2009) to analyze final exam problem solutions. The rubric assigns a score based on five categories: Useful Description, Physics Approach, Specific Application of Physics, Mathematical Procedure, and Logical Progression.

TA-assigned scores are found to be highly correlated with rubric scores (~0.9 for 5 problems together, ~0.82 for individual problems).

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Usage patterns

User groups (S13)

- L group (light/non user): 0-20% (of total coaches attempted)
- M group (medium user): 40-60% (of total coaches attempted)
- H group (high user): 80-100% (of total coaches attempted)

Comparison 1

Comparison 2 (preliminary)

Result 1

Results:

- 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%)
- H-like students in F11 coached section scored as well as L-like students in F11 control section (65.2±2.9% vs. 59.8±3.8%).

Assessment Tools

- We used a research-validated rubric (Docktor, 2009) to analyze final exam problem solutions. The rubric assigns a score based on five categories: Useful Description, Physics Approach, Specific Application of Physics, Mathematical Procedure, and Logical Progression.

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