Assessment of C_3PO: Customizable Computer Coaches for Physics Online

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Computer Coaches

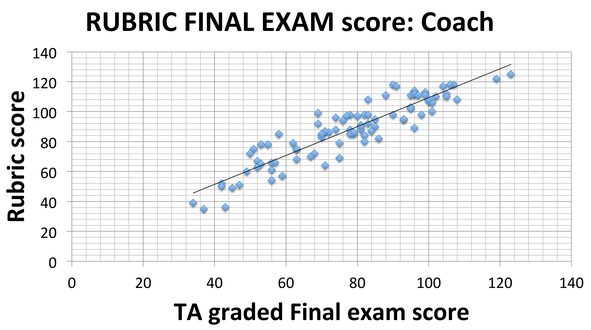
- Online computer programs (Hsu & Heller, 2004) designed to improve students' problem-solving skills by coaching them while they practiced solving problems were introduced into an introductory physics class.
- The coaches were designed within the framework of **cognitive apprenticeship** (Brown, Collins & 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
    Students could complete their homework using WebAssign or the coaches
  - 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.
  - Standardized pre-post assessments (FCI/Math/CLASS)
  - 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).



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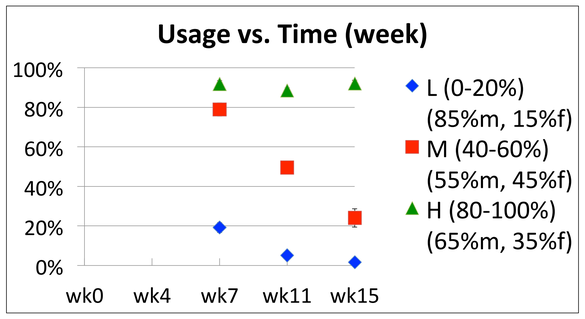
Usage patterns (S13)



- m:male, f:female
- L group: N=72
- M group: N=38
- H group: N=49

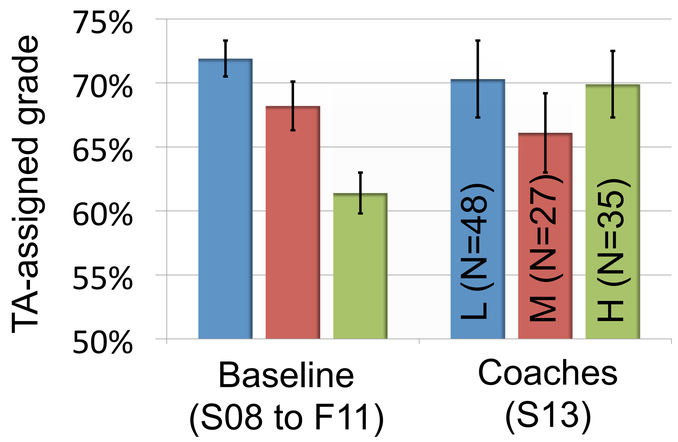
- L group (light/non user): 0-20% (of total coaches attempted)
- M group (medium user): 40-60% (of total coaches attempted)
- H group (high user): 80-100% (of total coaches attempted)

User Characteristics (S13)

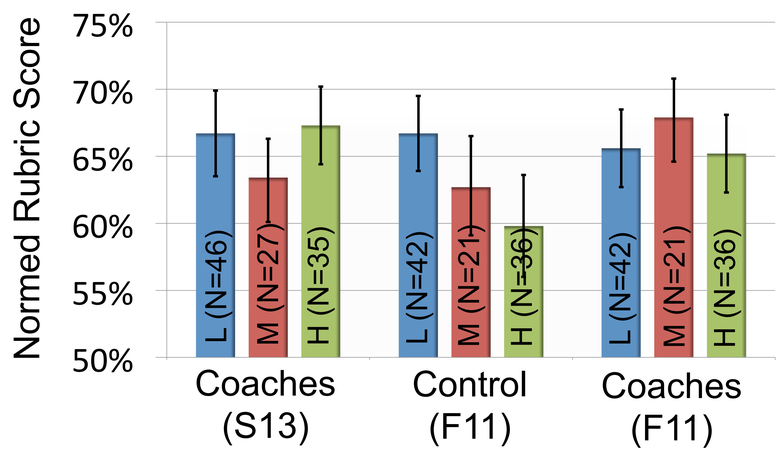
	N	Expected weekly study time (hrs)			Expected grade		Pre-FCI
		≤5	6-10	11+	A	B	Total
L	48	25%±3%	46%±4%	29%±3%	71%±3%	29%±3%	58%±3%
M	27	4%±1%	59%±5%	37%±4%	70%±4%	30%±4%	49%±4%
H	35	8%±1%	63%±4%	29%±3%	40%±4%	60%±4%	41%±3%

- Females are underrepresented in the L group (15%) compared to the class as a whole (30%)
- Pre-FCI: H users are less prepared compared to L users.
- Self-reported expectations: H users are less confident in their ability and expect to spend more time studying than L users.

Final Exam Problem-Solving Grade



Final Exam Problem-Solving Rubric Score



Comparison 1

- 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.

Result 1

- Historically (classes without computer coaches): H-like students score **one letter grade lower** than L-like students on the problem-solving part of the final exam (61.4±1.6% vs. 71.9±1.4%).
- S13 (coaches): Final exam problem-solving grades of H and L students are **the same** (69.9±2.6% vs. 70.3±3.0%).

Comparison 2 (preliminary)

- 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

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