

Evolution of C₃PO: Customizable Computer Coaches for Physics Online

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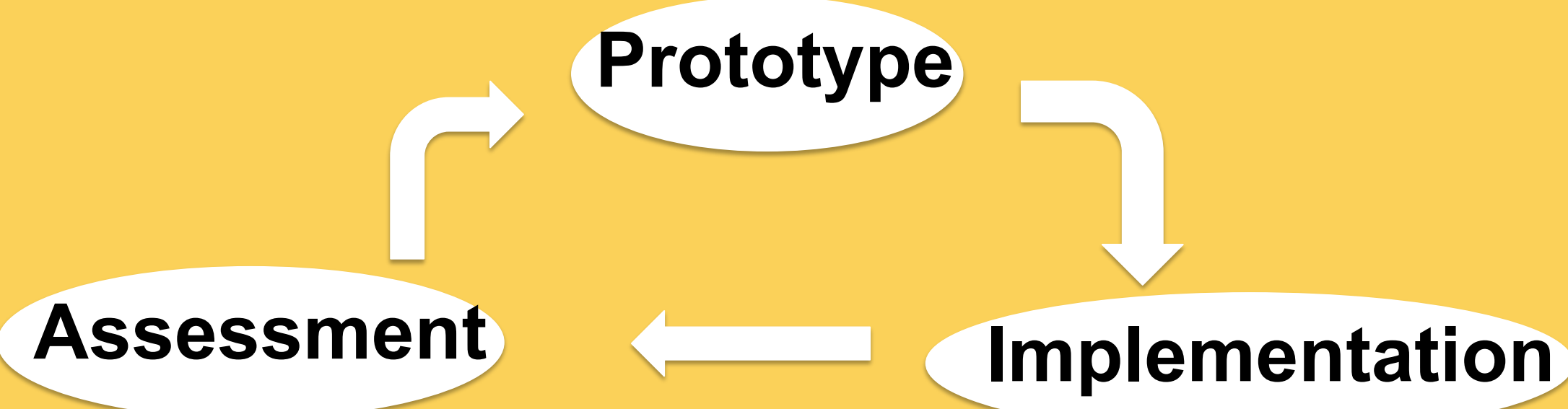
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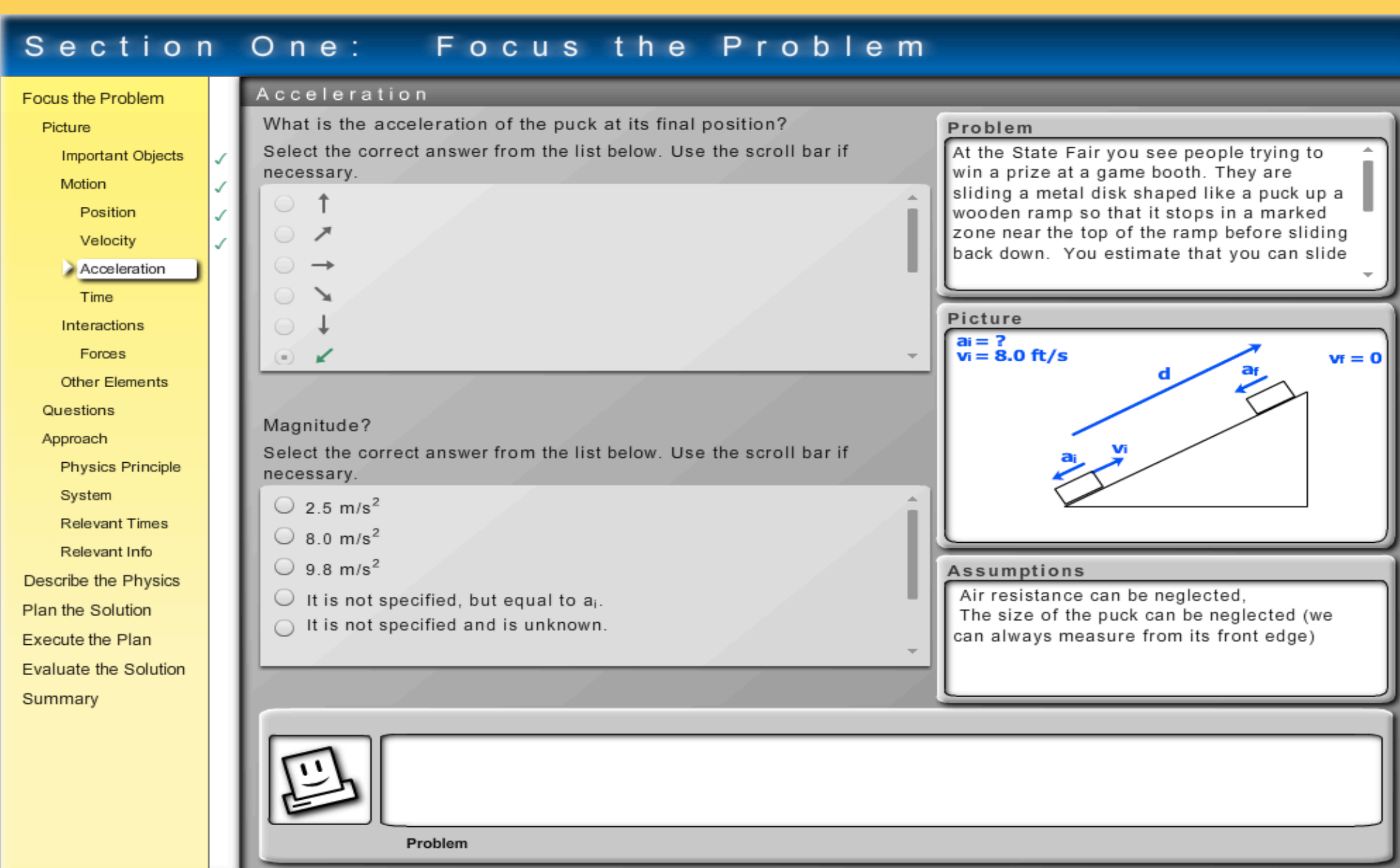
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Background

We are developing online computer coaches (Hsu & Heller, 2004) within the framework of **cognitive apprenticeship** (Brown, Collins & Duguid, 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.

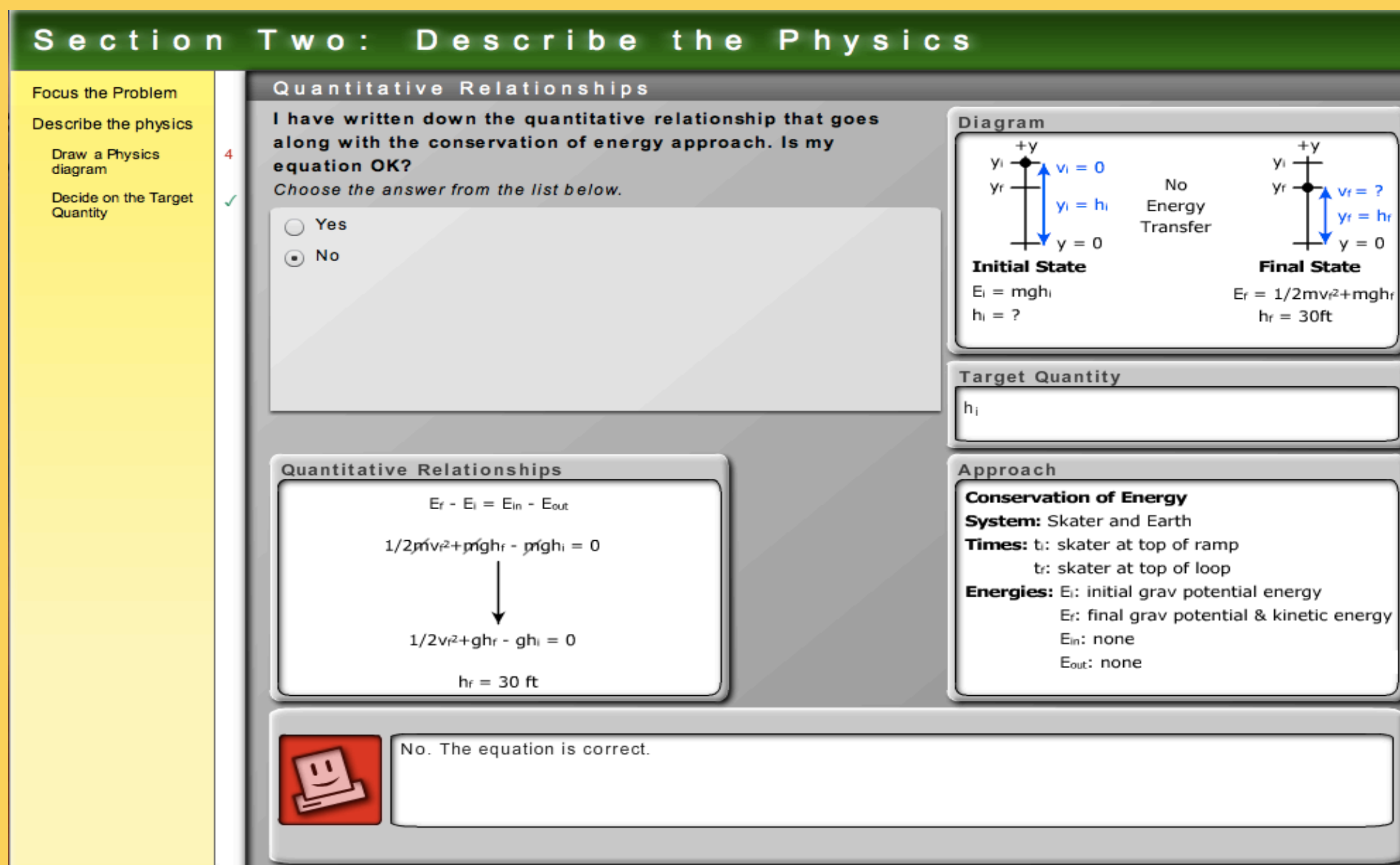


C₃PO: Version 1



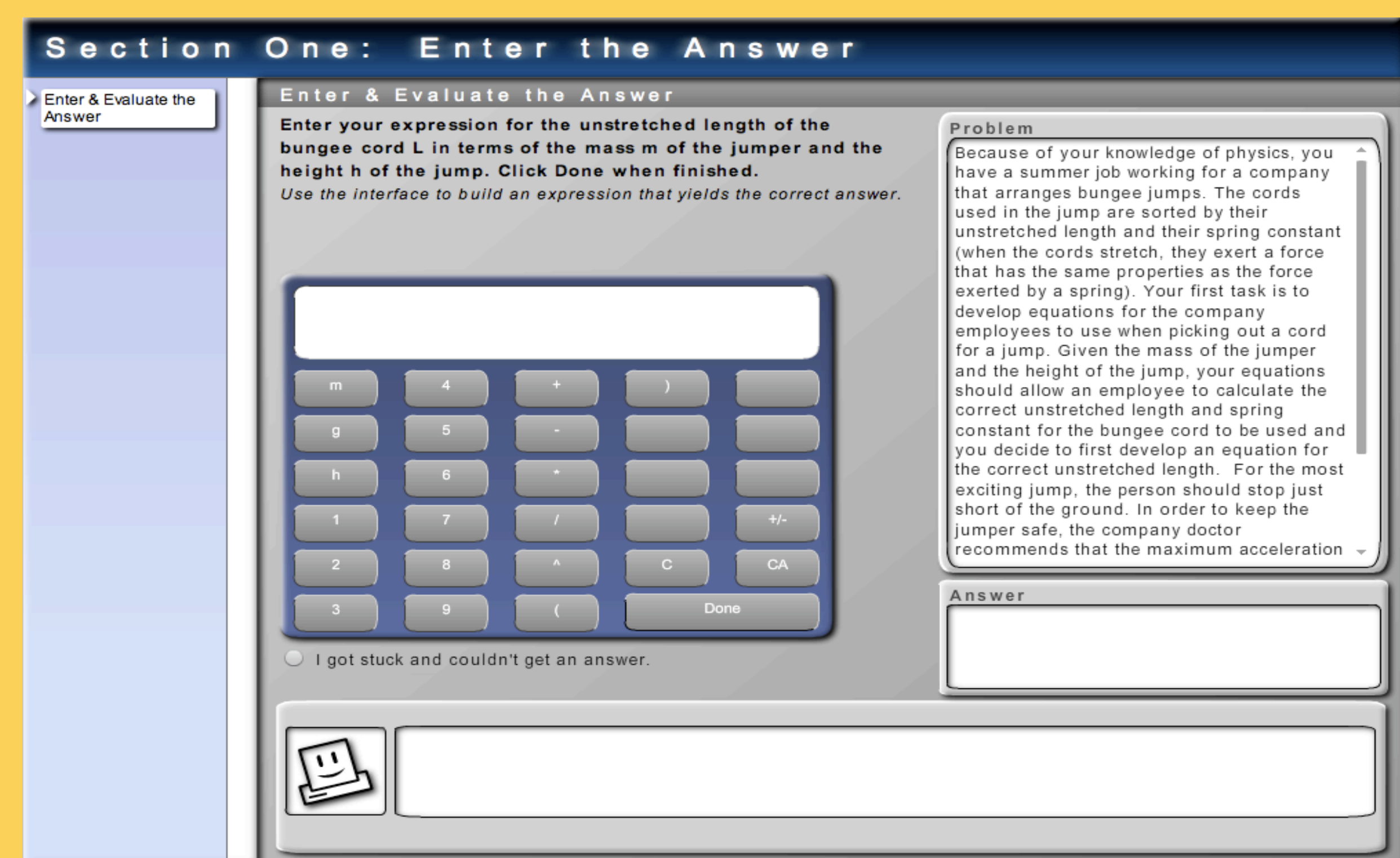
Mode 1 – Guidance

Computer (C) guides, Student (S) decides, C assesses



Mode 2 – Debugging

S guides, C decides, S assesses (C oversees)



Mode 3– Independent practice

S solves, C assesses or helps as necessary

Goal

Test the usage and usability of computer programs designed to provide students with individualized coaching while solving problems.

Questions

- Q1: What are the characteristics of the users?
- Q2: Do students perceive the coaches to be useful?
- Q3: How do the students use the coaches?

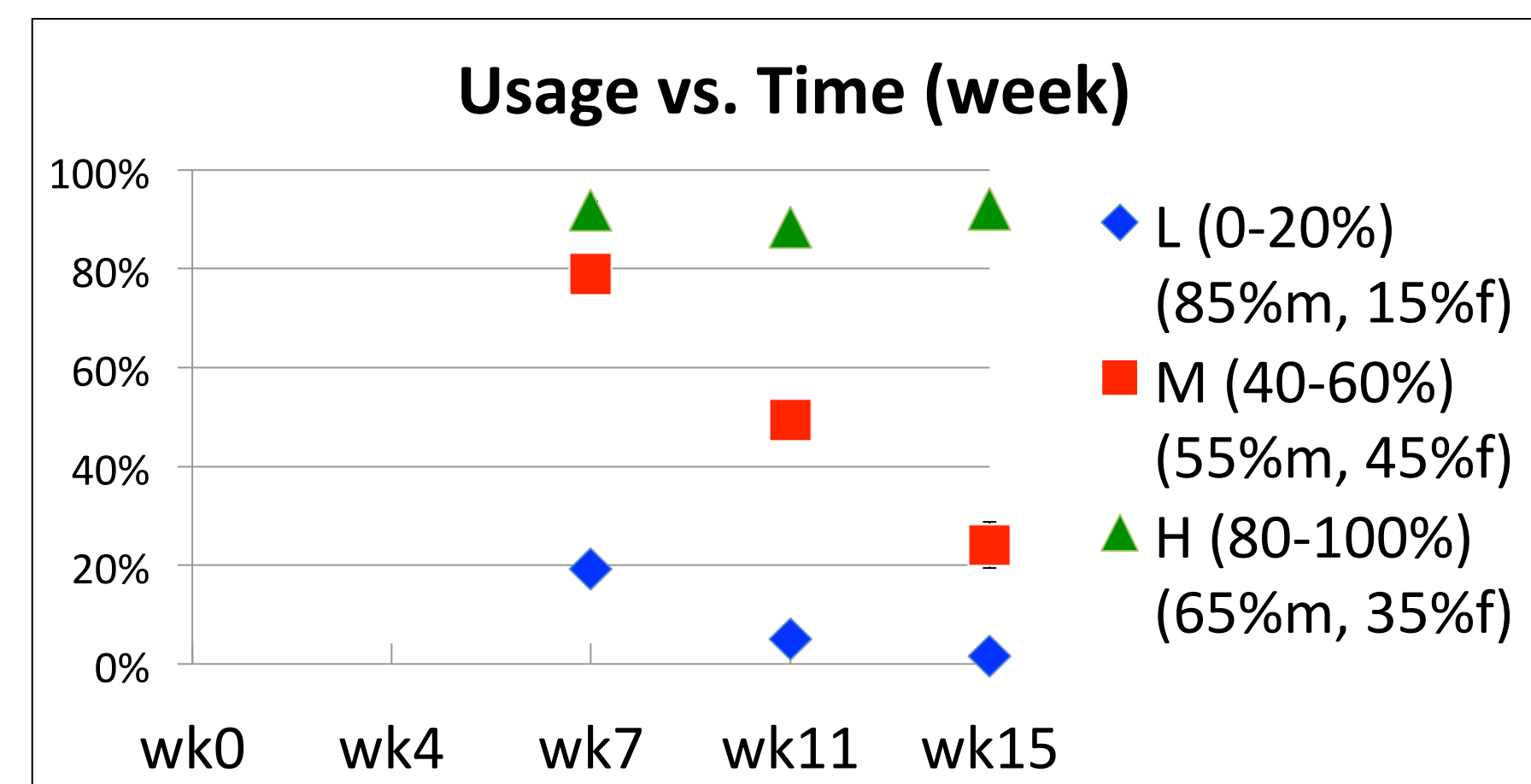
Experimental Conditions

- Computer coaches for 35 problems were incorporated into 2 sections of a calculus-based introductory mechanics course (148/103 students) in Spring 2013.
- Students were required to complete their homework using WebAssign (coaches were available to help with some problems)
- Data collected included:
 - Keystroke data from student use of the coaches.
 - Standardized pre/post assessments (FCI/Math/CLASS)
 - Mid- and end-of-semester surveys about the coaches.
 - Student background and expectations survey

Results

Q1: What are the characteristics of the users?

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



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

	N	Expected weekly study time (hrs)			H (N=35)	
		≤5	6-10	11+	A	B
L	48	25%	46%	29%	71%	29%
M	27	4%	59%	37%	70%	30%
H	35	8%	63%	29%	40%	60%

Test	L (N=48)		M (N=27)		H (N=35)	
	Male	Female	Male	Female	Male	Female
	85%	15%	67%	33%	66%	34%
FCI	58%±5%	59%±12%	53%±7%	42%±7%	46%±5%	31%±4%
MATH	58%±5%	66%±8%	53%±6%	61%±9%	54%±15%	45%±4%
CLASS	62%±4%	55%±7%	66%±5%	66%±4%	65%±4%	56%±4%

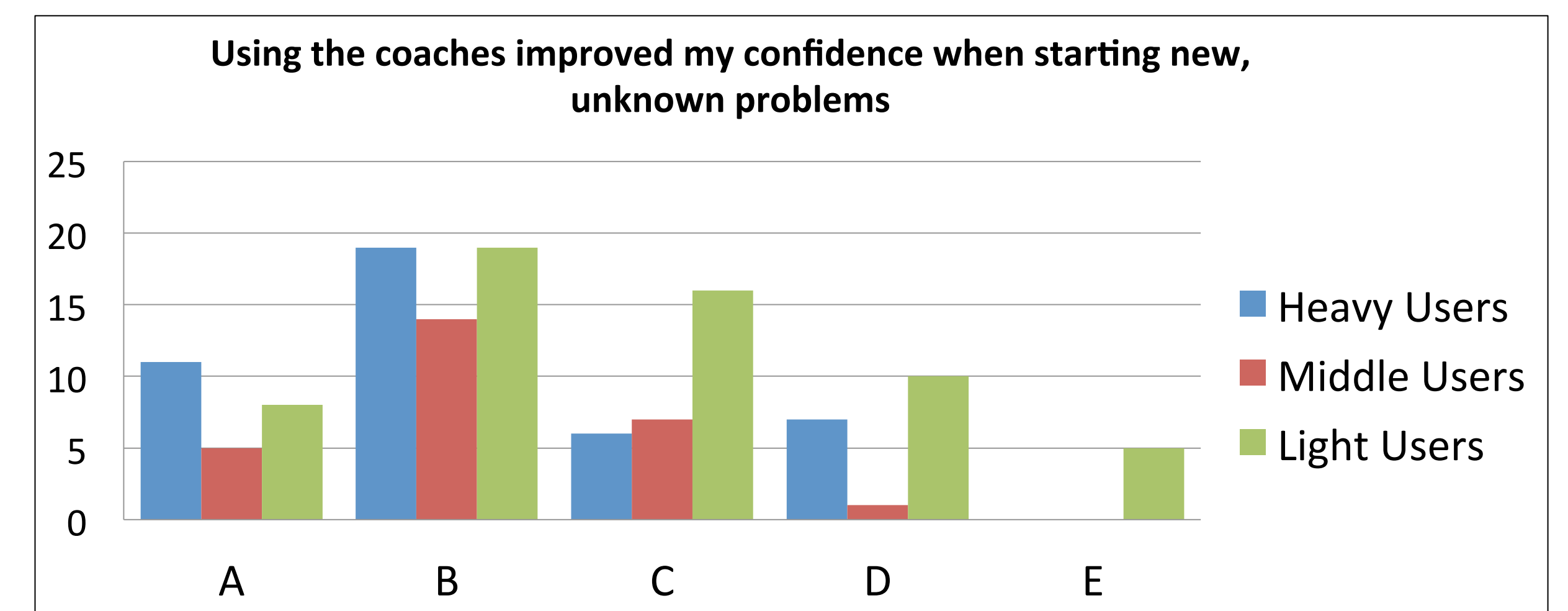
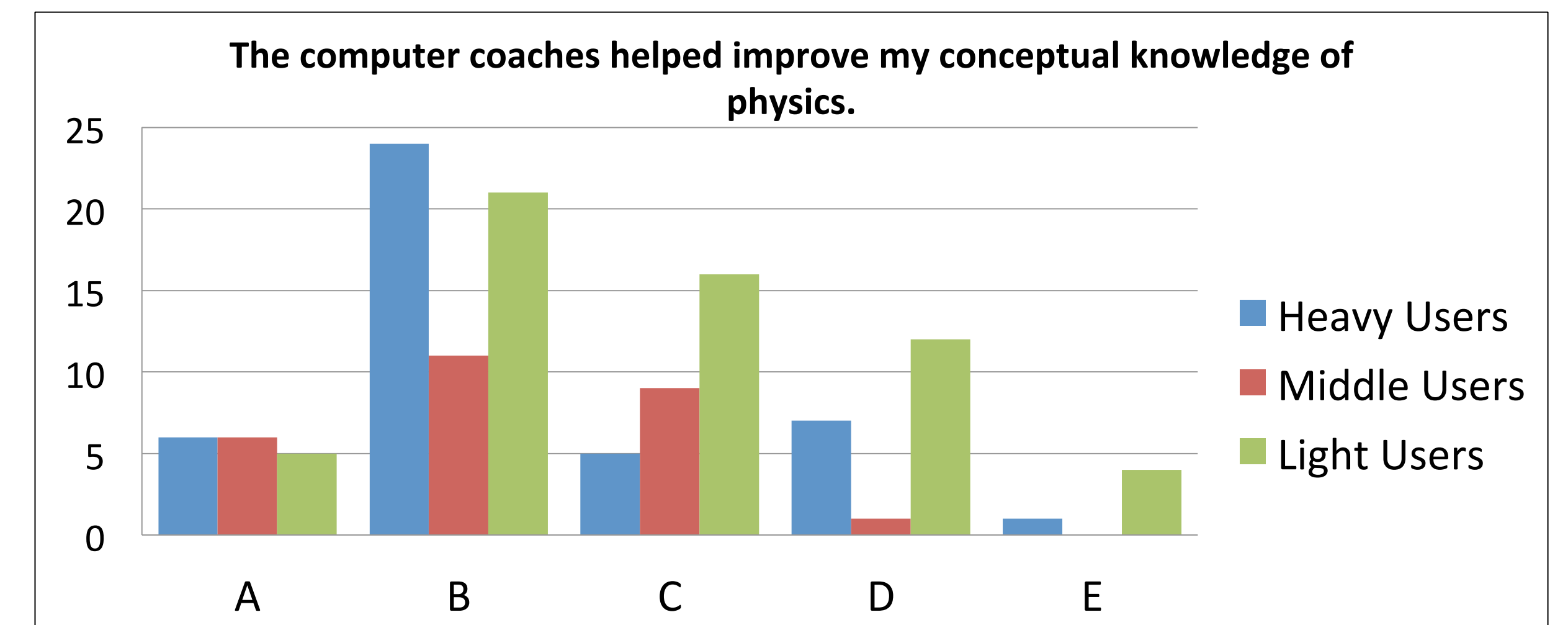
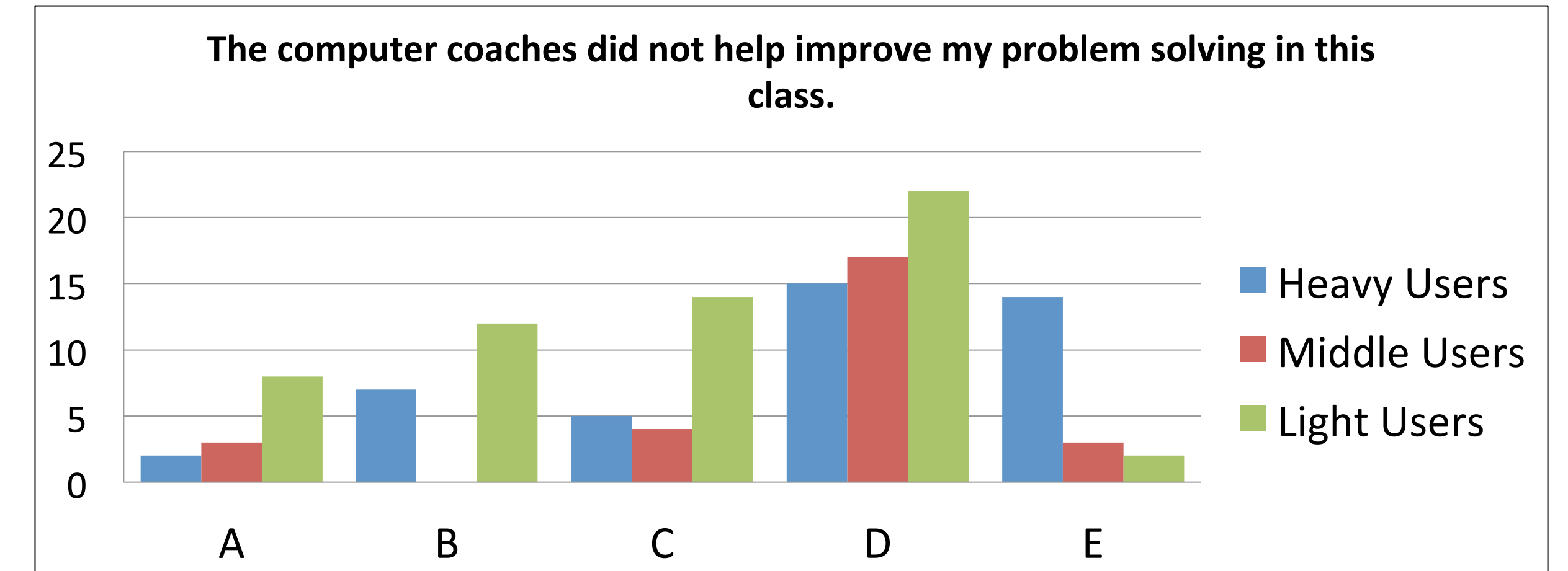
- Females are underrepresented in the L group (15%) compared to the class as a whole (30%)
- Higher FCI pre-test score is correlated with lower coach usage
- Students in the L group expect to spend less time studying and to earn a higher grade
- Students in the H group expect to spend more time studying and are less confident of their success

References

- J. S. Brown, A. Collins, & P. Duguid, Educational Researcher 18(1), 32-42 (1989)
- L. Hsu & K. Heller in AIP Conference Proceedings 790: 2004 PERC (pp. 197-200). Melville, NY: American Institute of Physics.

Q2: Do students perceive the coaches to be useful?

- Students rated statements about the coaches on a 5-point Likert scale. A: Strongly agree B: Agree C: Neither D: Disagree E: Strongly disagree



Students ranked 10 class components from most (10) to least (1) useful.

	Light	Medium	Heavy
Lectures	8.3±0.3	7.5±0.9	7.2±0.7
Doing the homework	6.8±0.5	7.2±0.6	8.1±0.4
Computer coaches	4.9±0.5	7.2±0.5	7.0±0.5
Tutor room	4.6±0.6	3.8±0.8	4.3±0.6

- Computer coaches are perceived to be useful by all user groups.
- Computer coaches are ranked as one of the top 3 useful elements.

Q3: How do students use the coaches?

Statement	L	M	H
I tried to solve the problems on my own and used the computer coaches for help if I got stuck	48%	70%	42%
I worked through the computer coaches before trying to solve the problems on my own	3%	4%	37%
Others	49%	26%	22%

- H users seem more dependent on the coaches
- M users shows a dramatic decrease in their coach usage

Shortcomings

- Some students think the coaches take too long or are too repetitive.
- Instructors find it too time-consuming or difficult to modify these coaches.

Development of V2.0 (see PST2C15)

- Make the coaches easier to modify by instructors
- Make the grain size of the help adjustable to better serve users

Related posters: PST2C14 and PST2C15

Our website: <http://groups.physics.umn.edu/physed>

