

Assessing Online Computer Coaches for Problem Solving: Measures of Utility

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Why computer coaches?

- Problem solving is important, but research shows:
 - Novices: focus on surface features; “equation search”
 - Experts: focus on underlying physics; systematic decision-making
- Cognitive Apprenticeship
 - Modeling
 - **Coaching** → hard to build into large classroom setting
 - Fading
 - Scaffolding
- Computer coaches: on demand, individual coaching for solving problems
 - Emphasize decision-making, within an expert-like problem-solving framework (*Competent Problem Solver* – K & P Heller)
- See also GC09, GC10, FD08, FD09 and PST 2C13-2C15



Research questions

- Will students naturally use computer coaches?
- How do students use them? Does a student's usage pattern tell us something about the student?
- Do students find the coaches useful?
- Do the coaches improve student problem solving?
 - (see E. Frodermann's talk immediately following)



Implementation tests

- 35 coached problems developed
- Used in 3 sections of a calculus-based introductory mechanics course
 - Fall 2011 (221 students) – students could complete HW using WebAssign OR using coaches
 - Spring 2013 (148/103 students) – students completed HW using WebAssign; coaches could be used to help w/ HW
- Data collected:
 - Pre/post-test scores (FCI/Math/CLASS)
 - Survey of student background and expectations
 - Keystroke data monitoring students' use of coaches
 - Student opinions regarding the coaches (mid & end semester surveys)



Do students use the coaches?

- Track total # of coaches attempted during Spring 2013 (N = 251, 70% m, 30% f)
- Three groups identified for further study:

L = light user: 0-20%

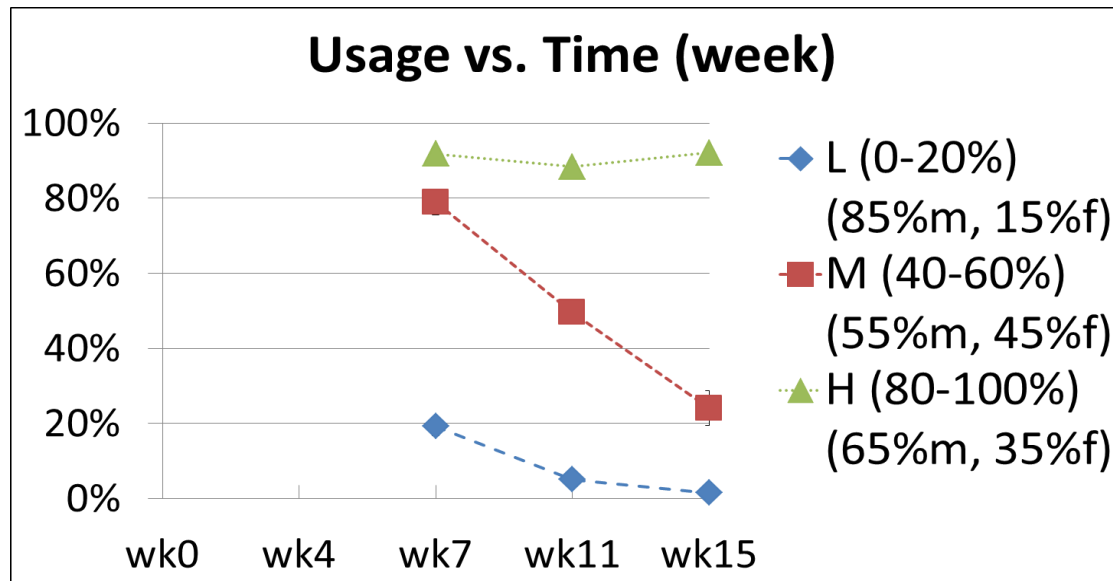
$N_L = 72 = 29\%$ of N

M = medium user: 40-60%

$N_M = 38 = 15\%$ of N

H = heavy user: 80-100%

$N_H = 49 = 20\%$ of N



m = male
f = female



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Attributes of users?

- Compute average values of measures for students in each group

	N	<5 h/wk study time*	Expected grade		FCI pre-test
			A	B	
L	48	25%±3%	71%±3%	29%±3%	58%±3%
M	27	4%±1%	70%±4%	30%±4%	49%±4%
H	35	8%±1%	40%±4%	60%±4%	41%±3%

- The expected study time, expected grade, and pre-test FCI scores distinguish L, M, and H groups
- *Study time choices: <5 h, 5 – 10 h, or > 10 h



Attributes of users?

- On average:

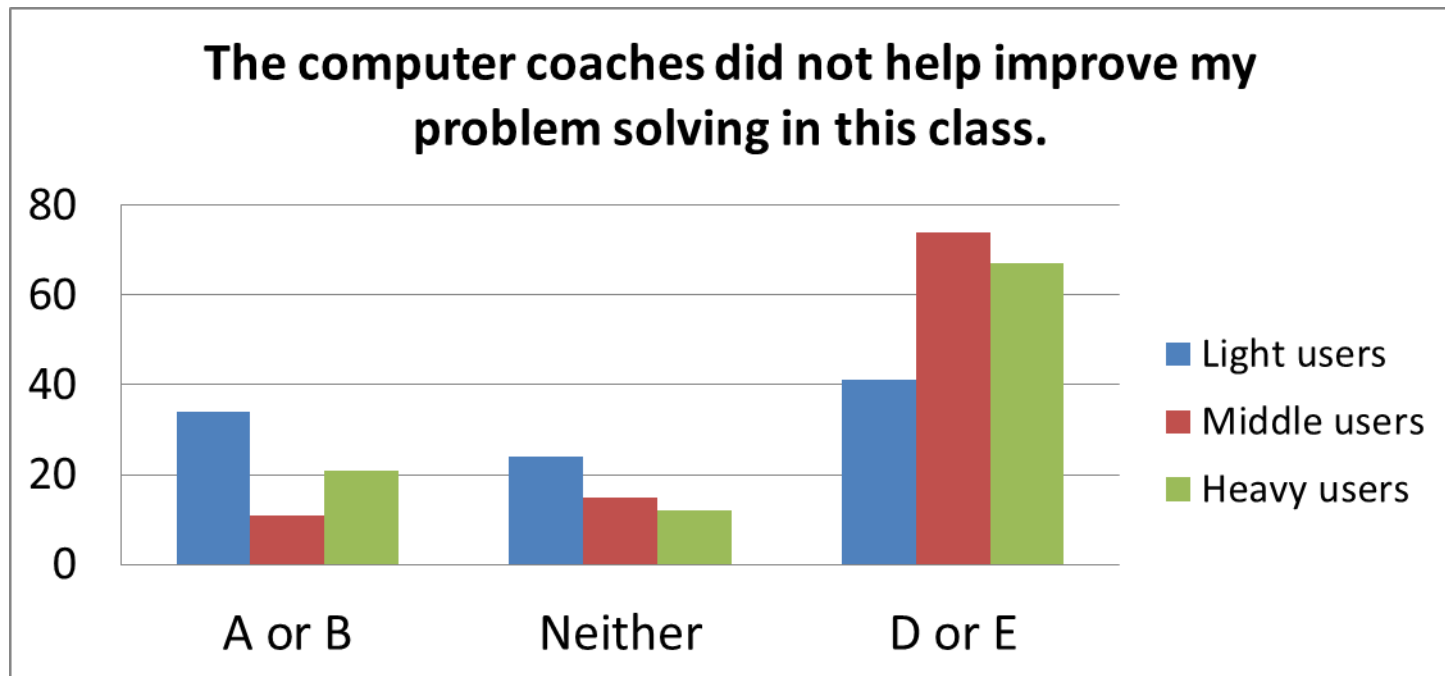
Low use (L) -- More confident, better prepared

Heavy use (H) -- Less confident, less prepared



Do students find coaches useful?

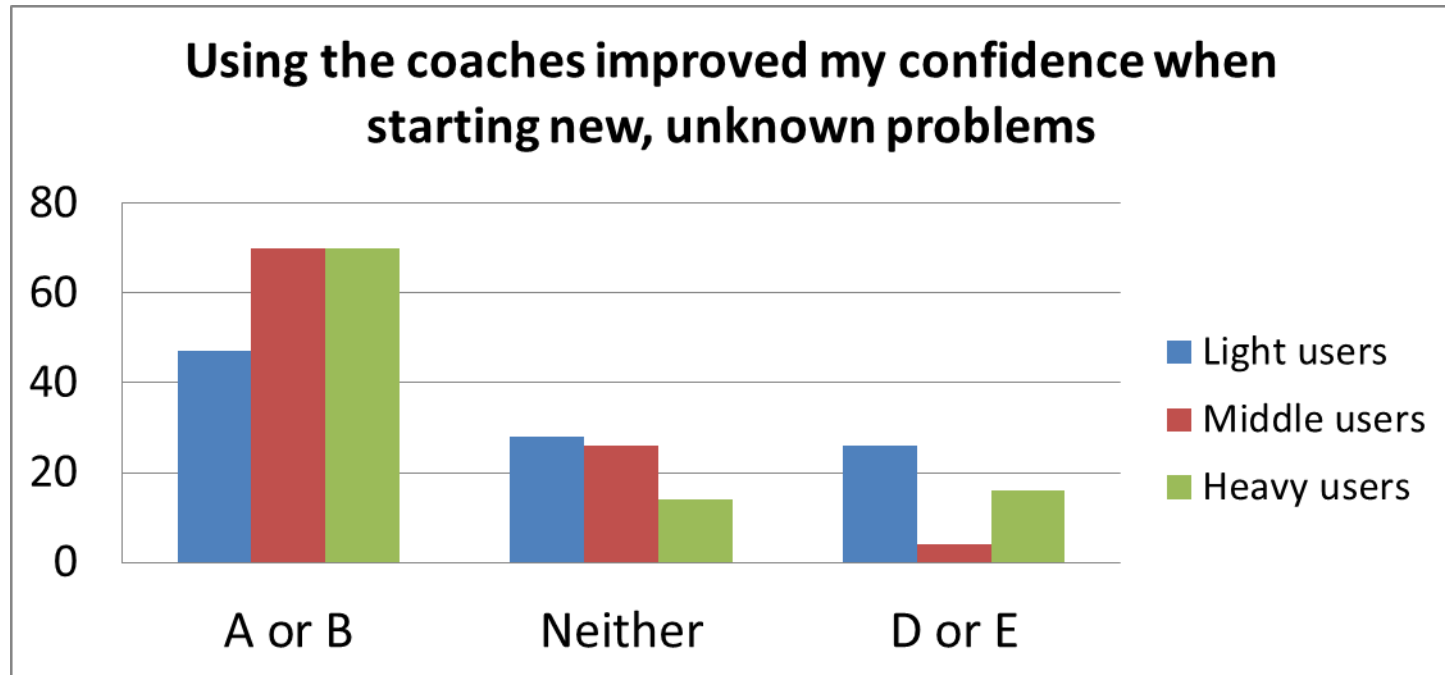
- Fraction of students in each group answering as indicated



A: Strongly agree **B:** Agree **C:** Neither **D:** Disagree **E:** Strongly disagree



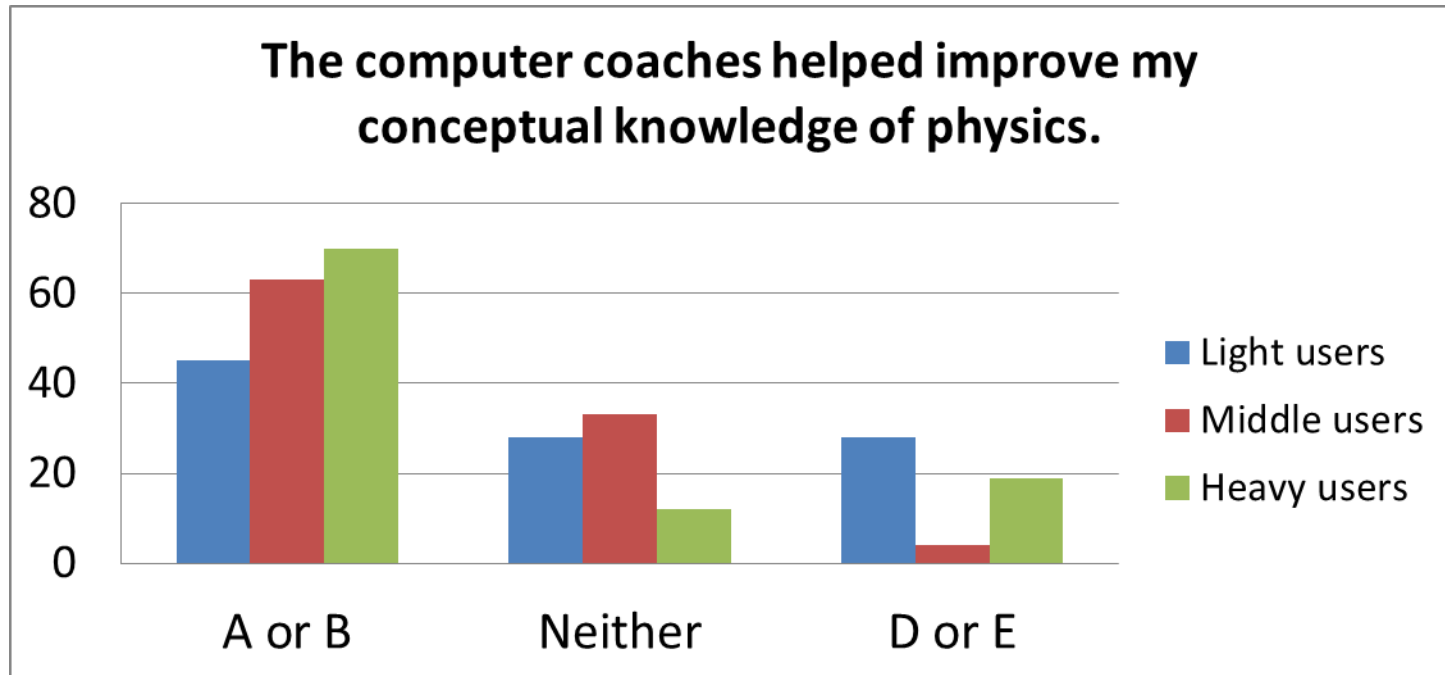
Do students find coaches useful?



A: Strongly agree **B:** Agree **C:** Neither **D:** Disagree **E:** Strongly disagree



Do students find coaches useful?



A: Strongly agree **B:** Agree **C:** Neither **D:** Disagree **E:** Strongly disagree

- Even light users find coaches helpful
- Conceptual knowledge not explicitly taught with coaches



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Summary

- Investigating computer coaches to improve student problem solving
- Characteristics of computer coach users (Sp 2013)
 - Light users (L): more confident, better prepared
 - Heavy users (H): less confident, less prepared
- Students report that:
 - Coaches improved problem solving
 - Coaches improved confidence
 - Coaches improved conceptual understanding of physics
- Thanks to the UMN PER group for their hospitality during my sabbatical leave!



Extra slides



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User traits

- Pre-FCI = preparation for course

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%

- Total Pre-FCI: L: 58%±3% M:49%±4% H:41%±3%
- **The gender, pre class FCI scores, expected study time and expected grade serve as the primary identifiers of these groups**



User traits I

- What traits distinguish the different user groups?
- Student attitudes/expectations (from 1st week surveys):

	N	Weekly study time (hours)			Expected grade	
		≤5	6-10	>10	A	B
L	48	25%±3%	46%±4%	29%±3%	71%±3%	29%±3%
M	27	4%±1%	59%±5%	37%±4%	70%±4%	30%±4%
H	35	8%±1%	63%±4%	29%±3%	40%±4%	60%±4%

- Low usage (L): Expects A, less work
- Medium usage (M): Expects A, more work
- Heavy usage (H): Expects B, more work



Attributes of users II

- FCI pre-test scores

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%

- Total Pre-FCI:
 - L: 58%±3% ↔ better preparation
 - M: 49%±4%
 - H: 41%±3% ↔ weaker preparation
- The gender, pre-test FCI scores, expected study time and expected grade distinguish L, M, and H groups

