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%  \quad N_L = 72 = 29\% of N
  M = medium user: 40-60%  \quad N_M = 38 = 15\% of N
  H = heavy user: 80-100%  \quad N_H = 49 = 20\% of N

Usage vs. Time (week)

- L (0-20%) (85%m, 15%f)
- M (40-60%) (55%m, 45%f)
- H (80-100%) (65%m, 35%f)

m = male  
f = female
Attributes of users?

- Compute average values of measures for students in each group

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>&lt;5 h/wk study time*</th>
<th>Expected grade</th>
<th>FCI pre-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>L</td>
<td>48</td>
<td>25%±3%</td>
<td>71%±3%</td>
<td>29%±3%</td>
</tr>
<tr>
<td>M</td>
<td>27</td>
<td>4%±1%</td>
<td>70%±4%</td>
<td>30%±4%</td>
</tr>
<tr>
<td>H</td>
<td>35</td>
<td>8%±1%</td>
<td>40%±4%</td>
<td>60%±4%</td>
</tr>
</tbody>
</table>

- 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

The computer coaches did not help improve my problem solving in this class.

A: Strongly agree  B: Agree  C: Neither  D: Disagree  E: Strongly disagree
Do students find coaches useful?

Using the coaches improved my confidence when starting new, unknown problems

A: Strongly agree  B: Agree  C: Neither  D: Disagree  E: Strongly disagree
Do students find coaches useful?

The computer coaches helped improve my conceptual knowledge of physics.

- 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
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
User traits

- Pre-FCI = preparation for course

<table>
<thead>
<tr>
<th>Test</th>
<th>L (N=48)</th>
<th>M (N=27)</th>
<th>H (N=35)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td>85%</td>
<td>15%</td>
<td>67%</td>
</tr>
<tr>
<td>FCI</td>
<td>58%±5%</td>
<td>59%±12%</td>
<td>53%±7%</td>
</tr>
</tbody>
</table>

- 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):

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<tr>
<th></th>
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<th>Weekly study time (hours)</th>
<th>Expected grade</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>≤5</td>
<td>6-10</td>
</tr>
<tr>
<td>L</td>
<td>48</td>
<td>25%±3%</td>
<td>46%±4%</td>
</tr>
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<td>59%±5%</td>
</tr>
<tr>
<td>H</td>
<td>35</td>
<td>8%±1%</td>
<td>63%±4%</td>
</tr>
</tbody>
</table>

- 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

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- 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