Motivation

- To assess problem solving, a complex cognitive activity, in a classroom situation.

Study

- In Fall 2011, 35 computer coaches were used in one section (219 students) of an introductory calculus-based mechanics class at the University of Minnesota.
- Students could complete their homework either by working through the computer coaches for a given topic or by submitting a correct answer to the same problems through WebAssign within 3 attempts.
- 4 quiz problems and 2 final exam problems were analyzed using a problem-solving rubric.
- Results from the final exam problems were compared with another section of the class and less-frequent (LC) completion.

Table 1: Problem solving rubric

<table>
<thead>
<tr>
<th>ID</th>
<th>Useful Description (ID)</th>
<th>Physics Approach (PA)</th>
<th>Specific Application of Physics (SSP)</th>
<th>Mathematical Procedure (MP)</th>
<th>Logical Progression (LP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>Useful, appropriate and complete.</td>
<td>Contains minor omissions and/or errors.</td>
<td>Parts of the description/approach/etc. are missing and/or contain errors.</td>
<td>Not useful, inappropriate and/or incoherent.</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>Most of the description/approach/etc. are missing and/or contain errors.</td>
<td>Does not include a description/approach/etc.</td>
<td>NA(S)/NA(P) Not applicable to the solver/problem.</td>
<td></td>
</tr>
</tbody>
</table>

Analysis

- 159 students with a complete set of data were used in the analysis.
- Two experienced raters each scored half of the solutions using the rubric.
- The raters trained by first scoring a common set of 10 student solutions, comparing and discussing their ratings, then repeating the process until their agreement was at least 90% before discussion.

Quiz 1 Problem 1

As the stunt coordinator on a movie set, it is your job to arrange a scene in which a stunt double steps off a bridge and lands onto some mattresses in the back of a large truck that is driving under the bridge. You find that the bridge is 50 feet above the ground. The truck will be driving under the bridge. You decide to calculate where to place a traffic cone by the side of the road so that when the truck passes the cone, the stunt double will step off the bridge and land safely in the back of the truck.

Fig.1: Sample student solutions scored with the rubric.

Table 2: Differences in background variables between frequent (FC) and less-frequent (LC) completers groups.

- Only 9 out of 159 students completed less than 10 coaches. Median number of coaches attempted (completed) is : 31 (24)

Results

Characteristics of within class comparison groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Gender</th>
<th>Proportion</th>
<th>Average Completion Time (minutes)</th>
<th>Average Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC</td>
<td>M, F</td>
<td>.4, .6</td>
<td>31.5</td>
<td>4.1</td>
</tr>
<tr>
<td>LC</td>
<td>M, F</td>
<td>.3, .7</td>
<td>42.5</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Discussion

- Students frequently chose to use the coaches.
- Students with lower pre-test scores tended to complete coaches more frequently.
- Frequent completers included a much larger fraction of females.
- After quiz 1, the FC group scored higher on a majority of the problems in each category except for Mathematical Procedure, which was not a skill addressed by the coaches. This pattern, while suggestive, is not statistically significant.
- The coach class has a larger FCI gain (g=0.55) than the comparison class (g=0.41).
- The computer coaches were in addition to the cooperative group problem solving pedagogy. Combined use of individually effective pedagogies may not result in a cumulative gain.
- A longer timescale may be needed to observe the development of problem solving skills.
- It is also possible that the coaches have no effect on problem solving.

References