Problem Solving Coaches For Physics Tutoring

Part III : ASSESSMENT DESIGN

Presented by Andrew Mason
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PLAN FOR 1\textsuperscript{st} (SMALL-SCALE) STUDY

- ~30 students, 1 lecture session of intro calculus-based class
- Assign into 2 statistically matched groups (~15 for each group)
  - Variables for matching: background information, e.g. HS physics & math level, FCI/CLASS/math pretests
- Subset of tutors available – energy, momentum (4 weeks)
- Treatment and Control
  - Treatment- computer coaching (on Web, outside of class), 4 problems per week
  - Control– normal class setting
- Data collection
  - Written solutions on quizzes & final exam
  - $2 \times 4 + 5 = 13$ for each student
PLAN FOR 2\textsuperscript{nd} (LARGE-SCALE) STUDY

- \(~90\) students, 1 lecture session of intro calculus-based class
- Assign into 2 statistically matched groups (~45 for each group)
  - Variables for matching: background information, e.g. HS physics & math level, FCI/CLASS/math pretests
- All tutors available (kinematics, dynamics, energy, momentum, rotational motion)
- Treatment and Control
  - Treatment- computer coaching (on Web, outside of class), 4 problems per week
  - Control– normal class setting
- Data collection
  - Written solutions on quizzes & final exam
  - \(2\times4+5=13\) for each student
EVALUATING PROBLEM-SOLVING

- Rubric developed to evaluate student problem solutions
  - Validity, reliability have been tested
- Five rubric categories (established by past research)
  - Useful Description
  - Physics Approach
  - Specific Application of Physics
  - Mathematical Procedures
  - Logical Progression

\(^1\)Docktor 2009; Docktor and Heller 2009
<table>
<thead>
<tr>
<th></th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>NA(Problem)</th>
<th>NA(Solver)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>USEFUL DESCRIPTION</strong></td>
<td>The description is useful, appropriate, and complete.</td>
<td>The description is useful but contains minor omissions or errors.</td>
<td>Parts of the description are not useful, missing, and/or contain errors.</td>
<td>Most of the description is not useful, missing, and/or contain errors.</td>
<td>The entire description is not useful and/or contains errors.</td>
<td>The solution does not include a description and it is necessary for this problem (i.e., it is given in the problem statement)</td>
<td>A description is not necessary for this solver.</td>
<td>A description is not necessary for this solver.</td>
</tr>
<tr>
<td><strong>PHYSICS APPROACH</strong></td>
<td>The physics approach is appropriate and complete.</td>
<td>The physics approach contains minor omissions or errors.</td>
<td>Some concepts and principles of the physics approach are missing and/or inappropriate.</td>
<td>Most of the physics approach is inappropriate.</td>
<td>All of the chosen concepts and principles are inappropriate.</td>
<td>The solution does not indicate an approach, and it is necessary for this problem/solver.</td>
<td>An explicit physics approach is not necessary for this problem. (i.e., it is given in the problem)</td>
<td>An explicit physics approach is not necessary for this solver.</td>
</tr>
<tr>
<td><strong>SPECIFIC APPLICATION OF PHYSICS</strong></td>
<td>The specific application of physics is appropriate and complete.</td>
<td>The specific application of physics contains minor omissions or errors.</td>
<td>Parts of the specific application of physics are missing and/or contain errors.</td>
<td>Most of the specific application of physics is inappropriate and/or contains errors.</td>
<td>The entire specific application is inappropriate and/or contains errors.</td>
<td>The solution is specific and the specific application of physics is appropriate and complete.</td>
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<tr>
<td><strong>MATHEMATICAL PROCEDURES</strong></td>
<td>The mathematical procedures are appropriate and complete.</td>
<td>Appropriate mathematical procedures are used with minor omissions or errors.</td>
<td>Parts of the mathematical procedures are missing and/or contain errors.</td>
<td>Most of the mathematical procedures are missing and/or contain errors.</td>
<td>All mathematical procedures are inappropriate and/or contain errors.</td>
<td>The solution is specific and the specific application of physics is appropriate and complete.</td>
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<td><strong>LOGICAL PROGRESSION</strong></td>
<td>The entire problem solution is clear, focused, and logically connected.</td>
<td>The solution is clear and focused with minor inconsistencies</td>
<td>Parts of the solution are unclear, unfocused, and/or inconsistent.</td>
<td>Most of the solution parts are unclear, unfocused, and/or inconsistent.</td>
<td>The entire solution is unclear, unfocused, and/or inconsistent.</td>
<td>The solution is specific and the specific application of physics is appropriate and complete.</td>
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Most of the specific application of physics is missing and/or contains errors.
Specific Application:
Incorrect force term in Newton’s 2\textsuperscript{nd} law (gravity negligible), assumes no acceleration.
QUESTIONS TO BE ADDRESSED

- Will students use them?
- How will students use them? (keystroke function)
- Do they improve students’ problem solving skills?
- Are they adaptable to be used in teaching other physics courses?
- Can this software be modified by faculty to fit their problem solving preferences?
• Interested in seeing how tutor works? Come see us after this session, or at poster session (PST2B17, tonight, 9:20-10:50 pm)

• Website:
  • http://groups.physics.umn.edu/physed/

THANK YOU!
## Sample professor, sorting exercise

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<thead>
<tr>
<th>Category</th>
<th>UD</th>
<th>PA</th>
<th>SAP</th>
<th>MP</th>
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<td>Problem Solving Techniques</td>
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<td>Understand Basic Definitions</td>
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<td>Basic Principles</td>
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