ILEM - Integrated Learning Environment for Mechanics

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- Collaborators: Gerd Kortemeyer, Andrew Pawl, Sara Julin
Integrated Learning Environment for Mechanics (ILEM)

- E-text
- Multi Level Homework
- Videos
- Advanced Assessment
- Simulations
- Social Interaction
Pedagogy

Modeling Applied to Problem Solving (MAPS).

• Students learn how to plan for solving problems in Mechanics.

• Start with specifying the **System** and the **Interactions**, and then Choose a **Model**.

• Collaborative problem solving: groups of 2-3 students working on white boards.

• First implemented in a short ReView for students who failed the fall course.
Performance

- More than 1 standard deviations on a final retest.
- Positive shift in Attitudes towards Science and Problem Solving
- About one letter grade improvement in the following EM course
Performance

Electricity and Magnetism z-score

Mechanics z-score

0.49±0.16 (p=0.002)
Performance

0.76±0.24 (p=0.001)

0.49±0.16 (p=0.002)

Control Group
Wiki Text

- http://scripts.mit.edu/~srayyan/PERwiki/
- MAPS instructional material + Research based online resources
Wiki Text

• In LONCAPA:

• /res/MIT/RELATE/MAPS_8011/
## Traditional (55%) and research-based problems (45%)

<table>
<thead>
<tr>
<th>Complexity</th>
<th>Cognitive Processes</th>
<th>Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Declarative</td>
</tr>
<tr>
<td><strong>Easy</strong></td>
<td>Recalling, Executing</td>
<td>Vocabulary terms, Facts</td>
</tr>
<tr>
<td><strong>Medium</strong></td>
<td>Recalling, Executing, Integrating, Representing</td>
<td>Facts, Time sequences</td>
</tr>
<tr>
<td><strong>Hard</strong></td>
<td>Recalling, Executing, Integrating, Representing, Analyzing errors</td>
<td>Facts, Time sequences, Multiple Principles</td>
</tr>
</tbody>
</table>
Multi Level Homework

Unit 4 -- Describing Motion Homework 2
- Read This Page First
- Describing Motion Homework 2 - easy
- Describing Motion Homework 2 - medium
- Describing Motion Homework 2 - hard

Choose Your Own Path Homework

Determine your own path:
At what level would you like to begin this homework? (Level 1 = easiest, Level 3 = hardest.)

- Level 1 (Easiest)
- Level 2
- Level 3 (Hardest)

Submit Answer  Tries 0/99
Implementation

• Experimental Course at MIT Fall 2010 (10 students)

• Whatcom Community College: Fall 2010, Spring 2011 (60 students)

• University of Wisconsin Platteville: Fall 2010, Spring 2011 (120 students)

• MIT Spring 2011 (70 students).

• Workshops at AAPT winter and summer meetings
What is next?

Assessment

Learning Resources

Social Instruction

Performance Indicators
What is next?

- Assessment
- Learning
- Social Instruction
- Performance Indicators
Assessment

- Our objective is to define measures of learning; subsequently displaying such measures to students and instructors.

- Currently we our formulating the basic research to define useful properties and how they should be displayed.

**Current Research Efforts**

- Analysis of discussion boards
- Item Response Theory
- Time-on-task
- Asset Window
Item Response Theory

Generalized goal of IRT is to provide discrimination of students and resources within LON-CAPA

• Currently testing IRT methods on data outside LON-CAPA

• Multiple Institutions: MIT, MSU, and UGA

• Figure: comparing classical test and item response theories at estimating student skill for an MIT intro mechanics course

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Time-on-task

Further discrimination of problems and resources through analysis of time

• Course wide measurements

• Student and resource specific measurements

• Would like to understand effects of displaying “time-based” information to students

Figure: measuring the time between submissions for all resources from 3 physics courses: MIT, MSU, UGA
Discussion Board Analysis

Spring 2011: Required students to post to discussion throughout the course

• Analysis is underway, with the aim of classifying posts and measuring utility
• Homework where students posted their plans for solving difficult multi-concept problems
• Would like to more greatly facilitate such activities in LON-CAPA

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Asset Window

How do we recommend “educational resources” to students based on material and problems?

• Provides links to other resources: previously worked problems, videos, online text, etc...

• Relies heavily on associations and mappings of relationships between content/resources

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<table>
<thead>
<tr>
<th>Resource</th>
<th>Description</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIT - OCW</td>
<td>Walter Lewin Video - Friction</td>
<td>5.0</td>
</tr>
<tr>
<td>Problem</td>
<td>Related Problem</td>
<td>4.0</td>
</tr>
<tr>
<td>Wiki text</td>
<td>Course or outside content</td>
<td>3.0</td>
</tr>
</tbody>
</table>
Asset Window

How do we recommend “educational resources” to students based on material and problems?

• Provides links to other resources: *previously worked problems, videos, online text, etc...*

• Relies heavily on associations and mappings of relationships between content/resources

Can we apply such a recommender to other elements in LON-CAPA?

• We think yes, e.g., Content pages in our Wiki

• Such a recommender may also facilitate other aspects of LON-CAPA

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Conclusions

We are excited to be working within the LON-CAPA community, and we welcome collaborations.

Thank you for your attention!