Research Designs to Test and Refine the Pathway Active Learning Environment

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Project Overview

Pathway Active Learning Environment

• Develop an interactive online synthetic tutor
  – Targeted at high school & intro college physics students
  – For supplemental instruction at home
  – To study student learning processes

• Seek to exploit benefits of human tutoring\(^1\)
  – Interaction is mostly student-centered\(^2\)
  – Students must self-explain\(^2\)
  – Students must challenge their constructed explanations\(^2\)

\(^1\)Bloom (1984) \quad \(^2\)Chi et. al (2004)
Active Learning Environment

Two Components

• Guiding Lessons
• Synthetic Tutor (SI)
Active Learning Environment

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• Guiding Lessons

• Synthetic Tutor (SI)
Active Learning Environment

• Three lessons cover Newton’s Laws

• Can be thought of as “problems in video contexts”

• Can involve textbook-style problems & questions, observation & measurement, or both

• Connects to the real-world

• Uses established pedagogy

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3 Karplus & Butts (1977)
Active Learning Environment

- Can answer natural language questions
- “Quickstart” menus enable selection of questions
- Multimedia can support tutors’ verbal responses
- Attempts to develop a synthetic social interaction
- Currently offers two tutors
- 7 different experiences total

4. Okita et al. 2008
Factors in Testing the PALE

• PALE logs (through student accounts):
  – student responses
  – changes to responses
  – queries to SI tutor
  – several other types of actions

• PALE logs these with a time stamp for time-resolved analysis

• PALE does not log facial expressions, thoughts, feelings, or mutterings
Three-modes of Testing

- One-on-one interview setting
- In-classroom setting
- At-home setting
Three-modes of Testing

• One-on-one interview setting
  – Observe details of use that the log would miss
  – Get student’s immediate feedback
  – Cross-check on physics knowledge

• In-classroom setting
  – Access the student population in a controlled environment and encourage completion
  – Teacher can observe and cite difficulties

• At-home setting
  – Test under ultimate design condition: This is a system that is to be used at home
One-on-one Interview Mode

Testing PALE Fall 2010

- Algebra-based college physics students (N = 22)
- All 7 PALE experiences were used
- Volunteers were solicited for modest compensation
- One session per week for three weeks.
- Worked on a lesson for 1 hr. and discussed the lesson and their work for ~30 min.
- Interviews were conducted by SI tutors
In-class Mode

Testing PALE Fall 2010

- Five classes of highschool physics students (n = 12, 13, 10, 8, 16; N = 59)
- Students completed the lessons in-class under the supervision of the classroom teacher.
- 4 of the PALE experiences were used (One tutor was eliminated)
At-home Usage Mode

Testing PALE Fall 2010

• Concept-based college physics students, mostly elementary ed. majors in a large enrollment class (N = 107)
• Students were assigned the completion of one lesson per week for a homework grade
• 4 of the PALE experiences were used (One tutor was eliminated)
Data Analysis

Schematic of a data set

<table>
<thead>
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<th>Student 1</th>
<th>Q₁</th>
<th>A₁</th>
<th>A₂</th>
<th>Q₂</th>
<th>A₃</th>
<th>Q₃</th>
<th>A₄</th>
<th>A₅</th>
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<tbody>
<tr>
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<td>A₃</td>
<td>Q₁</td>
<td>Q₂</td>
<td>A₄</td>
<td>Q₃</td>
<td>A₅</td>
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<tr>
<td>Student 3</td>
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<td>Q₁</td>
<td>A₂</td>
<td>Q₂</td>
<td>Q₃</td>
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<td>A₃</td>
<td>Q₅</td>
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<td>Q₁</td>
<td>Q₂</td>
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</tr>
<tr>
<td>Student 5</td>
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<td>Q₁</td>
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<td>A₄</td>
<td>A₅</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Additionally we have
• Video recordings of algebra-based students’ usage
• Transcripts of algebra-based students’ interviews
• Teachers’ comments and observations
Data Analysis

Multi-faceted analysis procedure is needed

• Quantitative analysis & data-mining of PALE log

• Phenomenographic analysis of interview data

• Integrative procedure to obtain a complete picture

• This is an ongoing effort
Summary & Future Work

Summary

• Collected three complimentary data sets with PALE
• Each addresses different but related aspects of PALE testing
• Multi-faceted analysis techniques will likely be needed to extract a clear picture of PALE’s efficacy

On-going Efforts

• Continue data analysis efforts
• Continue acquiring data in different settings with different student populations
References


The End

Thank you

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