Introduction

Despite their instructors’ best intentions, students often ignore their own common sense and real-world knowledge when working on physics problems. This separation between physics knowledge and everyday knowledge contributes to a low perception of the relevance of physics and poor student learning and motivation.

To attempt to promote connections between physics and the real world, several types of specialized tutorials have been developed for UBC’s Physics 100 course. In this paper, I analyze students’ conversations during two particular tutorials to examine the connections between the tutorial features, students’ Epistemological Frame, and their references to External Knowledge during problem-solving.

Methods

Jeopardy Question Tutorial

• Jeopardy Questions require students to construct a physics question that corresponds to a given formula which includes numbers and units.
• Students are prompted to construct a realistic situation.

Context-Rich Tutorial

Context-Rich tutorials are word problems with a rich backstory. UBC’s context-rich tutorials have:
• Feasible motivation for calculation, with clear consequences for action
• Concept drawn from everyday life
• Extraneous or missing information
• Structured problem-solving worksheet which prompts for Assumptions and Sensemaking

“External Knowledge”

* A student’s implicit sense of “What is the nature of the activity that I’m engaged in?”
* These frames are revealed by patterns in speech, prosody, and body language1,2

Types of External Reference:
• Interpretation of mathematical or physics abstraction
• Assumption of values or relationships
• Evaluation of an idea or result
• Elaboration of others’ ideas

Epistemological Frames

• A student’s implicit sense of “What is the nature of the activity that I’m engaged in?”
• These frames are revealed by patterns in speech, prosody, and body language1,2

- Five frames were developed from observation of patterns in students’ conversational patterns and implicit goals:
  1. TA – discussion regulated by TA
  2. Conceptual Discussion – focused on interpreting and understanding
  3. Procedural Discussion – focused on how to proceed towards “the answer”
  4. Completing the Worksheet – focused on reading, writing, or calculating in order to fill in the worksheet
  5. Joking / Off Topic

Results

• Frequency of External References is strongly correlated with the Conceptual Discussion frame: in both types of tutorial, students make more External References in this frame than in any other.
• Students working on the Jeopardy Question spend more time in Conceptual Discussion than the Context-Rich Question
• Students working on the Context-Rich Question spend more time in the TA frame and in the Procedural Discussion frame
• The total number of External References is much higher for the Jeopardy Question
• Prompts for Assumptions and Sensemaking were only successful at triggering Conceptual Discussion frame for one out of four Context-Rich groups. The remaining groups treated the prompts as additional tasks that needed “the right answer”

Discussion

• Despite the real-world context and motivation, Context-Rich tutorials seem to predominantly prompt students to focus on “How to get the answer” rather than “How to understand the physics”.
• Students’ reaction to the structured problem-solving prompts suggests that this structure encourages focus on the procedure of completing the worksheet rather than the concepts.
• The high number of External References in the Jeopardy Question is driven by extended proposal, evaluation, and refinement of realistic models to match the given formulae. This suggests much deeper thinking about the correspondences between physics and real life. This extended collaborative criticism is absent from the Context-Rich tutorials.
• Further analysis will be carried out on the other 7 tutorials observed this term. I will investigate whether the correlation between Conceptual Discussion and External References holds across many tutorials, and look for other tutorial features that prompt Conceptual Discussion.

End Notes


Table 1: Comparison of Framing and External References in a Jeopardy Question tutorial (N=4) and a Context-Rich tutorial (N=4)

<table>
<thead>
<tr>
<th>Frame</th>
<th># of External Ref's</th>
<th>Frequency of External Ref's (min⁻¹)</th>
<th>% of Time Spent in Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA</td>
<td>1.5 ± 1.0</td>
<td>1.3 ± 0.5</td>
<td>0.2 ± 0.1</td>
</tr>
<tr>
<td>Conceptual Discussion</td>
<td>24.3 ± 6.5</td>
<td>3.0 ± 1.7</td>
<td>1.8 ± 0.3</td>
</tr>
<tr>
<td>Procedural Discussion</td>
<td>2.0 ± 0.7</td>
<td>3.8 ± 2.5</td>
<td>0.1 ± 0.1</td>
</tr>
<tr>
<td>Worksheet</td>
<td>0.8 ± 0.5</td>
<td>2.5 ± 1.3</td>
<td>0.0 ± 0.0</td>
</tr>
<tr>
<td>Joking / Off Topic</td>
<td>1.3 ± 0.8</td>
<td>0.5 ± 0.3</td>
<td>3.0 ± 1.0</td>
</tr>
</tbody>
</table>

Total: 28.8 ± 4.8

End Notes