Using a Computer Game to Introduce Scientific Argumentation to Students

Robert C. Wallon, Chandana Jasti, Hillary Lauren, and Barbara Hug; University of Illinois at Urbana-Champaign

Abstract

This paper reports a design-based study that aimed to develop curriculum materials that could be used by high school biology teachers to introduce students to the practice of scientific argumentation with a game-based approach. We report a case of teacher use of the curriculum materials through two iterations of revision. We describe teacher instruction and provide evidence of student learning during each iteration. Implications for research, curriculum development, and game development are discussed.

Methodology

Table 1. This design-based case study followed one teacher’s enactment of the curriculum materials and game in two consecutive years of two iterations of materials.

<table>
<thead>
<tr>
<th>Year</th>
<th>Teacher</th>
<th>School</th>
<th>Student participants</th>
<th>Enactment materials</th>
<th>Data collection &amp; analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1 (Iteration 1)</td>
<td>One teacher was followed for two consecutive years. She had 10 years of teaching experience. Attended professional development workshop for curriculum unit, and used the curriculum unit with the Golden Hour game in her classroom.</td>
<td>High school located in a small urban community. About 80% of the school’s students identified as low-income.</td>
<td>Anatomy &amp; Physiology elective course with mostly upperclassmen students (15 students)</td>
<td>Curriculum lesson: The Golden Hour game</td>
<td>Teacher enactment data (audio recordings and classroom observations) Transcribed audio files used to identify themes with a framework for characterizing teacher instruction (adapted from McNeill and Krojek (2005)) Student artifact data (students’ written arguments, medical recommendations) Screened using a game-specific rubric (adapted from McNeill and Krojek (2005)); statistics calculated in SPSS</td>
</tr>
<tr>
<td>Year 2 (Iteration 2)</td>
<td>One teacher was followed for two consecutive years. She had 10 years of teaching experience. Attended professional development workshop for curriculum unit, and used the curriculum unit with the Golden Hour game in her classroom.</td>
<td>High school located in a small urban community. About 80% of the school’s students identified as low-income.</td>
<td>Anatomy &amp; Physiology elective course with mostly upperclassmen students (15 students)</td>
<td>Curriculum lesson: The Golden Hour game</td>
<td>Teacher enactment data (audio recordings and classroom observations) Transcribed audio files used to identify themes with a framework for characterizing teacher instruction (adapted from McNeill and Krojek (2005)) Student artifact data (students’ written arguments, medical recommendations) Screened using a game-specific rubric (adapted from McNeill and Krojek (2005)); statistics calculated in SPSS</td>
</tr>
</tbody>
</table>

Theoretical Framework

Scaffolding scientific argumentation
- Features of curriculum materials and learning environments
- Game-based science learning
- Contextualized learning environments

Research Questions

- How does a high school science teacher introduce scientific argumentation using curriculum materials that feature a computer game?
- How might differences in written scaffolds across two iterations of the curriculum materials influence the quality of student arguments?

The Curriculum Unit and Game

Why Did a Bump on the Head? Curriculum Unit
- Contains 7 lessons on the neuroscience of traumatic brain injury (TBI)
- Lessons 1 and 3 incorporate The Golden Hour

The Golden Hour Game

Provides students with an interactive and contextualized way to learn about the science of TBI and practice scientific argumentation.

Players act as medical students to examine and treat a young man who has been in a mountain biking accident. The game has three scenes:
- Scene 1: Emergency Medical Services
- Scene 2: CT scan and TBI diagnosis
- Scene 3: Neurosurgery

The end of each scene (Figure 1) includes a dialogue based on the Claim, Evidence, Reasoning (CER) framework (Figure 2).

The Harvest of the Brain

Figure 2. Flowchart of the dialogue between the lead physician and the player at the end of Scene 1. Text blocks in grey are spoken from the physician, and text blocks in green are dialogue options presented to the player. Throughout the dialogue, the physician prompts the player to choose the best (1) claim, (2) evidence, and (3) reasoning. Depending on which option the player chooses, the physician provides appropriate feedback. If the player chooses the strongest response, the physician moves onto the next part of the CER dialogue. If the player chooses a weaker response, the physician provides a rebuttal or reason for why the response is weaker, and the player can try again.

Discussion and Significance

- Curriculum materials should be revised to include more explicit support for teachers to introduce scientific argumentation and the CER framework.
- A scaffolded prompt may help improve overall quality of arguments in a class.
- Game developers and curriculum developers should consider the synergistic interaction of game, curriculum, and instruction when designing classroom interventions.

References

- SEPA National Institutes of Health
- National Institutes of Health

Figure 3. Box plots of student scores from Iteration 1 and Iteration 2 show a relative increase in student scores across the distributions and a narrowing of the range of scores during Iteration 2.

Figure 4. Example student artifacts that earned a score close to the mean of the groups for Iteration 1 (top) and Iteration 2 (bottom).

Figure 5. A conjecture map that shows development in our thinking about the game and curriculum materials in this paper. Black text shows original conjecture map, orange text shows revisions after Iteration 1, and blue text shows future revisions after Iteration 2.