Using a Computer Game to Introduce Scientific Argumentation to Students

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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.

References

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Theoretical Framework

Scaffolding scientific argumentation

- Teacher introduction of 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?

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.

	Year 1 (Iteration 1)	Year 2 (Iteration 2)
Teacher	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	
School	High school located in a small urban community About 48% of the school's students identified as low-income	
Student participants	Anatomy & Physiology elective course with mostly upperclassmen students • 49 students	Anatomy & Physiology elective course with mostly upperclassmen students • 39 students
Enactment materials	Curriculum lessons *The Golden Hour* game	Curriculum lessons *The Golden Hour* game Student sheet with CER scaffolding
Data collection & analysis	Teacher enactment data (audio recordings and classroom observations) • Transcribed audio files used to identify themes with a framework to characterize teacher instruction (adapted from McNeill and Krajcik (2008)) Student artifact data (students' written arguments/medical recommendations) • Scored using a task-specific rubric (adapted from McNeill and Krajcik (2012)); statistics were calculated in SPSS	

Figure 1. A screenshot from *The Golden Hour* depicting dialogue based on the CER framework at the end of Scene 1. Dialogue from in-game characters appears at the upper-left corner, and the player can choose a response from the options at the bottom of the screen.

The Curriculum Unit and Game

Why Dread 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).

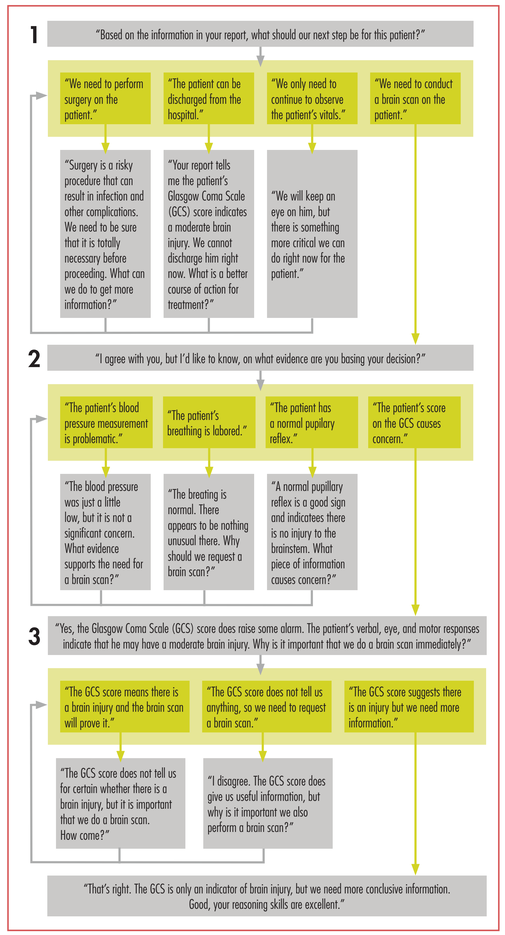

Figure 2. Flowchart of the dialogue between the lead physician and the player at the end of Scene 1. Text blocks in grey are speech from the physician and gold text blocks are dialogue options presented to the player. Throughout the dialogue, the physician prompts the player to choose the best (1) claim, (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.

Results

Teacher enactment data

When introducing scientific argumentation, the teacher supplemented the curriculum materials with:

- Explicit definitions of claim, evidence, and reasoning
- Modeling scientific argumentation with examples
- A rubric for evaluating a scientific argument

Student artifact data

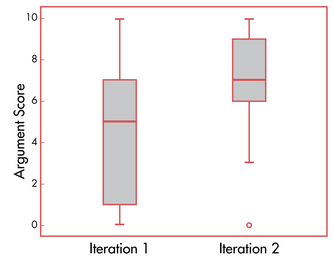

Figure 3. Box plots of student scores from Iteration 1 and Iteration 2 show a relative increase in student scores across the distributions and a narrowing of the range of scores during Iteration 2.

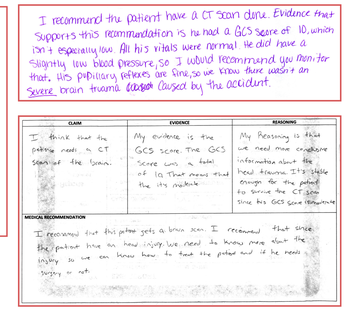

Figure 4. Example student artifacts that earned a score close to the mean of the groups for Iteration 1 (top) and Iteration 2 (bottom).

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.

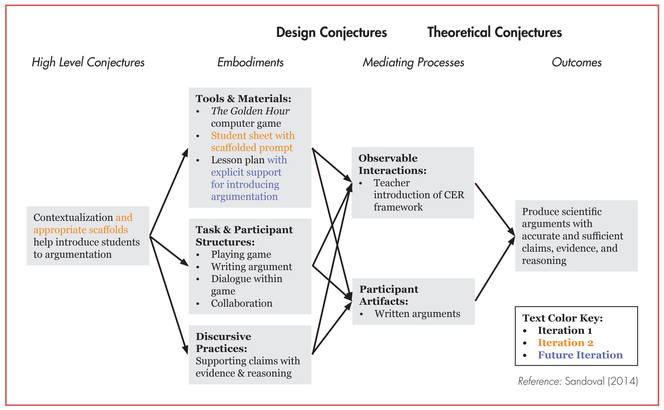

Figure 5. A conjecture map that shows development in our thinking about the game and curriculum materials in this paper. Black text shows original conjecture map, orange text shows revisions after Iteration 1, and blue text shows future revisions after Iteration 2.

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