Using a computer game to teach scientific argumentation

NABT 2015 in Providence
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What is Project N EURO N?

- Educators, scientists, and graduate students
- Curriculum development
  - Inquiry-based
  - Connect to standards
- Teacher professional development
- Research
Curriculum Unit and Game
Why dread a bump on the head?

Unit Overview

L1: What is traumatic brain injury?
L2: What does the brain look like?
L3: How does a CT scan help diagnose TBI?
L4: How to build a neuron
L5: What happens to neurons after TBI?
L6: Exploring the data behind brain injury
L7: What can we tell others about TBI?
The Golden Hour Game

• A curriculum-integrated game
• Supports scientific argumentation
• Contextualizes learning
As the “super” medical student, the player must...

Scene 1: EMS
- Respond to 911 call
- Check vital signs
- Assess consciousness

Scene 2: CT Scan
- Review brain anatomy and function
- Interpret CT scans
- Identify TBI location and type

Scene 3: Surgery
- Conduct brain surgery

The Golden Hour Game
After each main scene, students complete

- Summative report of collected data
- Multiple choice dialogue (CER)
- Open response scientific argument (CER)
**Claim, Evidence, and Reasoning**

- **Claim**: A statement that expresses the answer or conclusion to a question or problem
- **Evidence**: Scientific data that supports the claim
- **Reasoning**: The justification that links the evidence to the claim

McNeill & Krajcik (2012)

*Supporting Grade 5-8 Students in Constructing Explanations in Science*
Research Study
Theoretical Framework

• Scaffolding scientific argumentation
  – Teacher introduction of argumentation [do you mean more of the modeling of what an argument is and then having students take over responsibility?]
  – Features of curriculum materials and learning environments [do you mean educative curriculum materials?]

• Game-based science learning
  – Contextualized learning environments

– Is it possible for you to put in any references here that you are pulling from?
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 influence the quality of student arguments?
Research Methods

- Design-based methodology [reference]
  - Iterative development of educational materials
- Case-study of one teacher over two years of enactment [reference]
# Participants & School Context

<table>
<thead>
<tr>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td><strong>School</strong></td>
</tr>
<tr>
<td>- High school located in small urban community</td>
</tr>
<tr>
<td>- About 48% of students identified as low-income</td>
</tr>
<tr>
<td><strong>Teacher</strong></td>
</tr>
<tr>
<td>- One teacher</td>
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<tr>
<td>- 10+ years of teaching experience</td>
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<tr>
<td>- Attended PD for the curriculum unit and game</td>
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<tr>
<td>- Used the curriculum unit with <em>The Golden Hour</em> game for multiple years</td>
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<tr>
<td><strong>Class</strong></td>
</tr>
<tr>
<td>- Anatomy and Physiology elective course</td>
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<tr>
<td>- Year 1: 5 class periods; Average 23 students/class</td>
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<tr>
<td>- Year 2: 4 class periods; Average 21 students/class</td>
</tr>
<tr>
<td><strong>Students</strong></td>
</tr>
<tr>
<td>- Mostly upperclassmen</td>
</tr>
<tr>
<td>- Year 1: 49 participants</td>
</tr>
<tr>
<td>- Year 2: 39 participants</td>
</tr>
</tbody>
</table>
## Enactment Materials

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
</tr>
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<tbody>
<tr>
<td>• Curriculum lesson plans</td>
<td>• Curriculum lesson plans</td>
</tr>
<tr>
<td>• <em>The Golden Hour</em> game</td>
<td>• <em>The Golden Hour</em> game</td>
</tr>
<tr>
<td></td>
<td>• Student sheet with CER scaffolding</td>
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</table>
I recommend the patient have a CT scan done. Evidence that supports this recommendation is he had a GCS score of 10, which isn’t especially low. All his vitals were normal. He did have a slightly low blood pressure, so I would recommend you monitor that. His pupillary reflexes are fine, so we know there wasn’t an severe brain trauma caused by the accident.

---

Complete this page AFTER you have submitted the report above and spoken with Dr. Picotte in The Golden Hour game. To complete your report, you must write a scientific explanation to answer “What should be done next for the patient?” Use the table below to organize your information. Under “Medical Recommendation”, use this information to write your full scientific explanation using complete sentences. Be sure to: make a CLAIM, provide EVIDENCE and explain your REASONING.

<table>
<thead>
<tr>
<th>CLAIM</th>
<th>EVIDENCE</th>
<th>REASONING</th>
</tr>
</thead>
<tbody>
<tr>
<td>I think that the patient needs a CT scan of the brain.</td>
<td>My evidence is the GCS score. The GCS score was a total of 10. That means that the injury is moderate.</td>
<td>My reasoning is that we need more conclusive information about the head trauma. It’s stable enough for the patient to survive the CT scan since his GCS score is moderate.</td>
</tr>
</tbody>
</table>

**Medical Recommendation**

I recommend that the patient gets a brain scan. I recommend that since the patient has a head injury, we need to know more about the injury so we can know how to treat the patient and if he needs surgery or not.
## Data Collection & Analysis

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Analysis</th>
</tr>
</thead>
</table>
| Teacher instruction        | • Characterized teacher instruction with framework adapted from McNeill and Krajcik (2008)  
                           | • Focused on teacher introduction of CER                                  |
| • Audio recordings         |                                                                          |
| • Observations             |                                                                          |
| Student arguments          | • Focused on Scene 1 for this study                                       |
|                           | • Scored using a task-specific rubric based on McNeill and Krajcik (2012) |
|                           | • Analyzed with an independent samples t-test                            |
| Student post-tests         | • Scored and scaled                                                      |
|                           | • Analyzed with an independent samples t-test                            |
## Results: Teacher Instruction

<table>
<thead>
<tr>
<th>Aspect of introduction</th>
<th>Teacher enactment</th>
</tr>
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</table>
| Defining C, E, R       | • Defined C, E, R within the context of the game  
                       • Definitions were **incomplete** [what was missing? And are these two bullets for both years?] |
| Rationale for argument | • Explained: “Convince someone that [the student’s] suggested treatment would be the best treatment for the individual.”  (Iteration 1)  
                       • Provided no rationale to the class as a whole for why they were constructing a scientific argument.  (Iteration 2) |
| Modeling with an example | • Provided example argument  
                         • Identified C, E, R components  
                         • No evaluation of quality of experiment  
                         • **Across both years?** |
Results: Student Arguments

- **Zeros Included**
  - Iteration 1
  - Iteration 2

- **Zeros Excluded**
  - Iteration 1
  - Iteration 2
Table 2
Mean (M) and standard deviation (SD) statistics for each Claim, Evidence, and Reasoning component and total scores for students in Iteration 1 and Iteration 2

<table>
<thead>
<tr>
<th>Iteration</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iteration 1</td>
<td>49</td>
<td>1.45</td>
<td>0.87</td>
<td>1.63</td>
<td>1.52</td>
<td>1.31</td>
<td>1.45</td>
<td>4.39</td>
<td>3.36</td>
</tr>
<tr>
<td>Iteration 2</td>
<td>39</td>
<td>1.90</td>
<td>0.45</td>
<td>2.64</td>
<td>1.25</td>
<td>2.62</td>
<td>1.46</td>
<td>7.15</td>
<td>2.60</td>
</tr>
</tbody>
</table>
Discussion

Finding:
It is likely that the scaffolds in student materials in Iteration 2, contributed to the higher mean of argument scores in Iteration 2.

Changes to curriculum:
Student sheet with prompts that are scaffolded and faded. [need to clarify—how were the prompts faded?]
Finding:
The teacher used the game as a context in some aspects of the introduction to scientific argumentation. However, she missed opportunities to more explicitly integrate the game to contextualize and support instruction.

Changes to curriculum:
Provide explicit support for introducing scientific arguments and integrating the game
Conjecture Map

**Design Conjectures**

**Embodiments**
- **Tools & Materials:**
  - *The Golden Hour* computer game
  - Student sheet with prompts that are scaffolded* & faded**
  - Lesson plan & materials with explicit support for (a) introducing argumentation & (b) integrating the game**

**Mediating Processes**
- **Observable Interactions:**
  - Teacher introduction of CER framework

**Theoretical Conjectures**

**Outcomes**
- **Participant Artifacts:**
  - Students produce scientific arguments with accurate and sufficient claims, evidence, and reasoning

**Improved ability of students to engage in scientific argumentation**

**High Level Conjectures**

**Contextualization, appropriate scaffolds,* & explicit instruction**

*help introduce students to argumentation

**Task & Participant Structures:**
- Teacher enacts curriculum with game
- Students play game in pairs, engage in CER dialogue within game, write medical recommendations

**Text Key:**
- *Iteration 1*
- **Iteration 2**
- **Future Iteration**
Educational game developers and curriculum developers need to consider the synergistic interaction of game, curriculum, and teacher instruction when designing classroom interventions.
Acknowledgements

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• University of Illinois

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Thanks!

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