Integrating Science and Technology for Enhancing Student Understanding of Global Climate Change

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Research Site and Participants

- An alternative high school, urban
  - 100% reduced lunch rate
- 22 diverse 10th to 12th graders
  - 4 White, nine African-American, 5 Asian, and 4 Hispanic
  - 8 English Language Learners (ELL), 1 homeless, 2 special education, 3 gifted, and 1 home bound
Overall Objectives

• Improve students’ understanding and knowledge of ecological
• Improve students’ understanding, awareness and involvement about global climate change
• Enhance student interest, motivation, and engagement throughout the quarter
Content: Place-based approach
<table>
<thead>
<tr>
<th>Topic</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOMES, CHANGE IN THE BIOMES OF MINNESOTA</td>
<td>MN-DNR BIOMES, WILL STEIGER CURRICULUM, DNR DATA FOR THE COUNTY</td>
</tr>
<tr>
<td>EVIDENCE OF CLIMATE CHANGE IN MINNESOTA</td>
<td>TREE RINGS, LAKE CORES, DIATOMS</td>
</tr>
<tr>
<td>PHENOLOGY</td>
<td>PLANTS, ANIMALS, PHYSICAL CONDITIONS</td>
</tr>
</tbody>
</table>
Pedagogy: Use of Technology

• Use of Social Networking technologies
• Structured reflections using Knowledge building website
• Creation of Audio-Visual artifacts
Pedagogy: Use of Active Learning Techniques

• Use of concept maps
• Use of Inquiry-based activities
• Progressively knowledge building and re-visiting concepts
Approach: Culturally Congruent

- Use of demonstration and modeling
- Incorporate historical and geographical perspectives (timelines, maps)
- Connect language arts to the scientific aspect
- Use of storytelling
- Use of mathematics in whatever quantitative aspects of the project might be relevant
Rationale

• Science in both personal and social contexts is highlighted in science education reform documents (American Association for the Advancement of Science [AAAS], 1993; National Research Council [NRC], 1996; Next Generation Science Standards [NGSS], 2012).

• Limited research on the role of awareness and activism in
  • understanding environmental problems
  • its relationship to the development of conceptual knowledge (Lester et al., 2006).
Rationale

• Students’ environmental knowledge derives from TV, the press, teachers, and parents (Jinliang et al., 2004).

• More recently, the trend has shifted to the more innovative media, such as social networks (Pempek, Yermolayeva, & Calvert, 2009).
Rationale

• Thus the urgency to integrate
  – media based design processes
  – social networks
Pedagogical Framework

• Environmental problems are socially constructed.
• Research based on constructivist principles provides
  – a coherent framework in which to theorize about learning,
  – a context for understanding socially constructed issues and knowledge

(Palmer & Suggate, 2004, p. 208)
Social Constructivism

Learning happens when the child is interacting with people in his environment and in collaboration with his peers. Then, these processes are internalized. (Vygotsky, 1978)
First, students construct their knowledge from their experiences in the world, then learning becomes most effective when they design artifacts and share with others (Papert, 1991).
Constructionism + Social Constructivism

**Social Constructivism**
Learning occurs first socially

**Constructivism**
Students construct their own knowledge internally

**Constructionism**
Student learning is most effective when they design artifacts and share with others

(SOCIAL)

INTERNAL

(INTERNAL)

(EXTERNAL)

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Theoretical Framework
Theoretical Framework

The understanding of individuals is developed through the social communication of ideas.

Each student constructs their own, unique meaning for everything learned.

Learning occurs ‘most felicitously’ when constructing a public artifact.
Constructionist Design Process
Social Networking Site

• User-friendly interface
• educational content
  – voting pools, discussion boards, blog posts
• social networking tools
  – text, photo and video sharing, status updates, and individual profile pages
Data Collection & Analysis

**Procedures (n=17)**
- Six Americas survey

**Procedures**
- A Paired-Sample t-test
- Descriptive statistics

**Procedures**
- Comparison and contrast of the quantitative and qualitative findings

**Procedures**
- Consider how merged results provide a better understanding

**Procedures (n=22)**
- Writing prompts
- Student video projects
- Climate Action Plan template
- Group progress reports
- Student blog posts
- Observational field notes

**Procedures**
- Constant comparative thematic analysis

**Procedures**
- NVivo 9.0

**Procedures**
- R 2.15

- Quantitative data collection
- Qualitative data collection
- Quantitative data analysis
- Qualitative data analysis

**Merge the results**

**Interpretation**

*Uppercase letters indicate that qualitative data sources used as the primary data sources while quantitative data source used as the secondary data source.*
Results

<table>
<thead>
<tr>
<th></th>
<th>Mean (μ)</th>
<th>Standard Deviation (sd)</th>
<th>P-Value (p)</th>
<th>Effect Size (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>40.24</td>
<td>4.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-test</td>
<td>49.88</td>
<td>4.73</td>
<td>4.287e-06</td>
<td>1.648585</td>
</tr>
</tbody>
</table>

![Bar chart showing differences between Pre- and Post-test results across categories: Dismissive, Doubtful, Disengaged, Cautious, Concerned, Alarmed.](chart1.png)

![Bar chart comparing Pre- and Post-test results with US Adult Population.](chart2.png)

- **Alarmed**: Highest Belief in Global Warming, Most Concerned, Most Motivated
- **Concerned**: Cautious
- **Cautious**: Disengaged
- **Disengaged**: Doubtful
- **Doubtful**: Dismissive
- **Dismissive**: Lowest Belief in Global Warming, Least Concerned, Least Motivated

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Integration of Social Network

• Catching up with instruction and keeping track of assignments

  – I think that this website was great because as some of us are mothers we can't always get to school and this website allows us to access our work from home or wherever there is internet connection. It's also really easy for me to keep track with what I did do already and what I've yet to do.
Integration of Social Network

• Reflecting their learning and learning from each other

  – To me using this website was interesting. It was interesting because we got to discuss our opinions and also got to see other people's responses on the question. I also liked the website because I liked talking about what I learned in class so far, when I had to talk about a certain topic that was asked from the teacher, it helped me refresh my memory about what we learned that week and so I know that I learned something that week.
Integration of Social Network

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  – In the last quarter we started to use the website, and for me its a great thing to have. It helps us get better at reading, sharing and comprehending.
Integration of Social Network

• Helps English Language Learners in different ways
  
  – I like technologies because sometime we need to find dictionary by sometime we don't understand the word we look the pictures for find something. we need to go to the website to do. I like to do technologies because sometime I watch movie and understand climate change. I understand without reading a lot.
Integration of Media Design

• Working as a team and celebrating end products
  – The video design project was quite fun and it also pushed some of us. The project itself was interesting. Gathering the information, pictures, and other sources was challenging in a way but seeing the final project was great.
  – We worked very well, and research, find pictures and videos, put them together. Then during class we really work on it and discuss about the project. I really liked when people praised our video after our presentation.
  – while making our video, all of us share the responsibility. We worked very well in our team.
Integration of Media Design

• Learning from others’ projects
  
  – In the short movie that you presented yesterday was a big eye opener for me. The things that I saw were things that I sometimes caught myself doing. All the running water, lights staying on, and all the other wasteful things that I have done. But I can make a stop to that by changing the way I go about things. I could use less water, change my light bulbs to energy efficient lights, start recycling, and just really go green. That short movie yesterday really gave me a different way to look at my own behaviors.
Implications

• **Social Presence**: Students’ perceptions of being and belonging in an online learning environment (Picciano, 2002) or their degree of feeling, perception, and reaction of being connected by CMS (Tu & McIsaac, 2002).
Implications

• Science education and the tools available to teach science are becoming ever more diverse in the current technological age. A technological tool needs to be supported by sound pedagogy and not left to being implemented as technology for technologies sake (Bull & Bell, 2008).

• Using appropriate technology tools with the right pedagogical approaches.
Media Products Example
QUESTIONS
What works

- Know where the student interests are
- Teach the science first
- Teach with data
- Use active learning techniques
- Accept controversy, ambiguity and missing evidence
- Its not all doom and gloom
Socioscientific Framework

Socioscientific Context: Minnesota River Basin
- Drivers of the Issue,
- Crop and Practices,
- Nutrient Fate and Transport to Streams
- Stream Ban Erosion
- Water Quality

Classroom Discourses
- Science Discourse,
- Personal Discourse,
- Media Discourse,
- Political Discourse,
- Cultural Discourse

Socioscientific Reasoning
- Recognizing the inherent complexity and multifaceted nature of the issue
- Analyzing issues from multiple perspectives
- Appreciating the need for ongoing inquiry
- Employing skepticism in the review of information

Decision Making Process
Future Implications

- Students from different locations on the river sharing
  o the data they collect,
  o narratives about their interaction with Minnesota river,
  o multimedia images and videos with their peers and the public.

- The main source for teachers to reach academic resources, information and updates about the professional development program.

- Broaden the positive impacts of the professional development program.
Results

Impacts of Constructionist & Social Constructivist Frameworks

Student’s Environmental Awareness

Effects of Environmental Problems

Causes of Environmental Problems
- Recent
- Future

Ways to Prevent Environmental Problems

Student’s Environmental Activism

on Nature

Personal/Individual Level

School/Community Level

National Level

Global Level