

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



Gillian Roehrig, Engin Karahan, Devarati Bhattacharya

STEM Education Center,
University of Minnesota, St. Paul



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

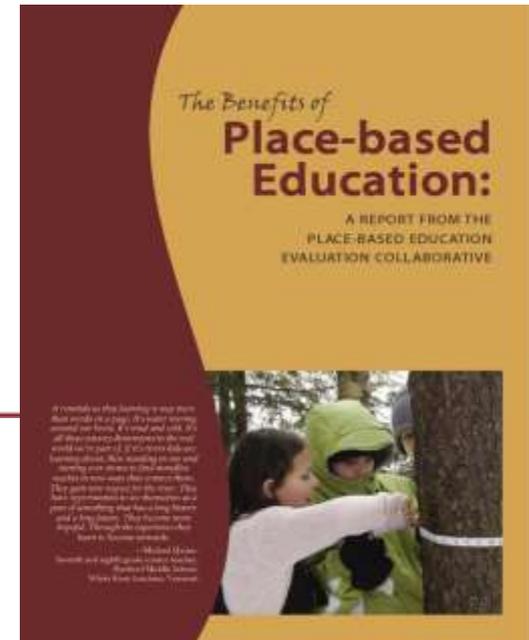
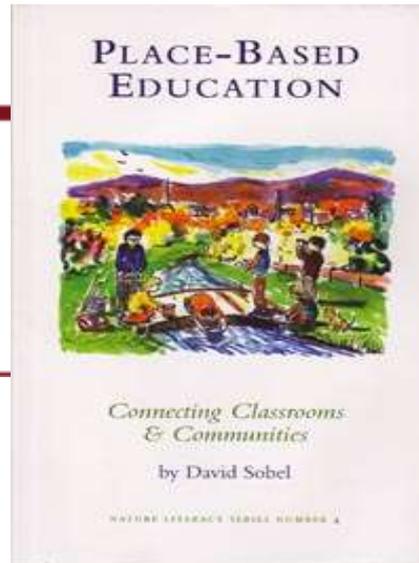
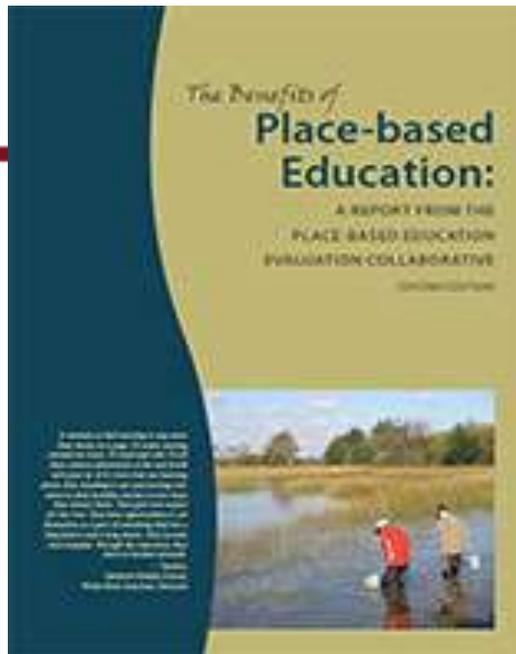


Overall Objectives

- 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





Place based GCC learning module

Topic	Activities
BIOMES, CHANGE IN THE BIOMES OF MINNESOTA	MN-DNR BIOMES, WILL STEIGER CURRICULUM, DNR DATA FOR THE COUNTY
EVIDENCE OF CLIMATE CHANGE IN MINNESOTA	TREE RINGS, LAKE CORES, DIATOMS
PHENOLOGY	PLANTS, ANIMALS, PHYSICAL CONDITIONS

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

Social



Internal

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)



STEM
EDUCATION CENTER
UNIVERSITY OF MINNESOTA

Constructionism

Internal



External



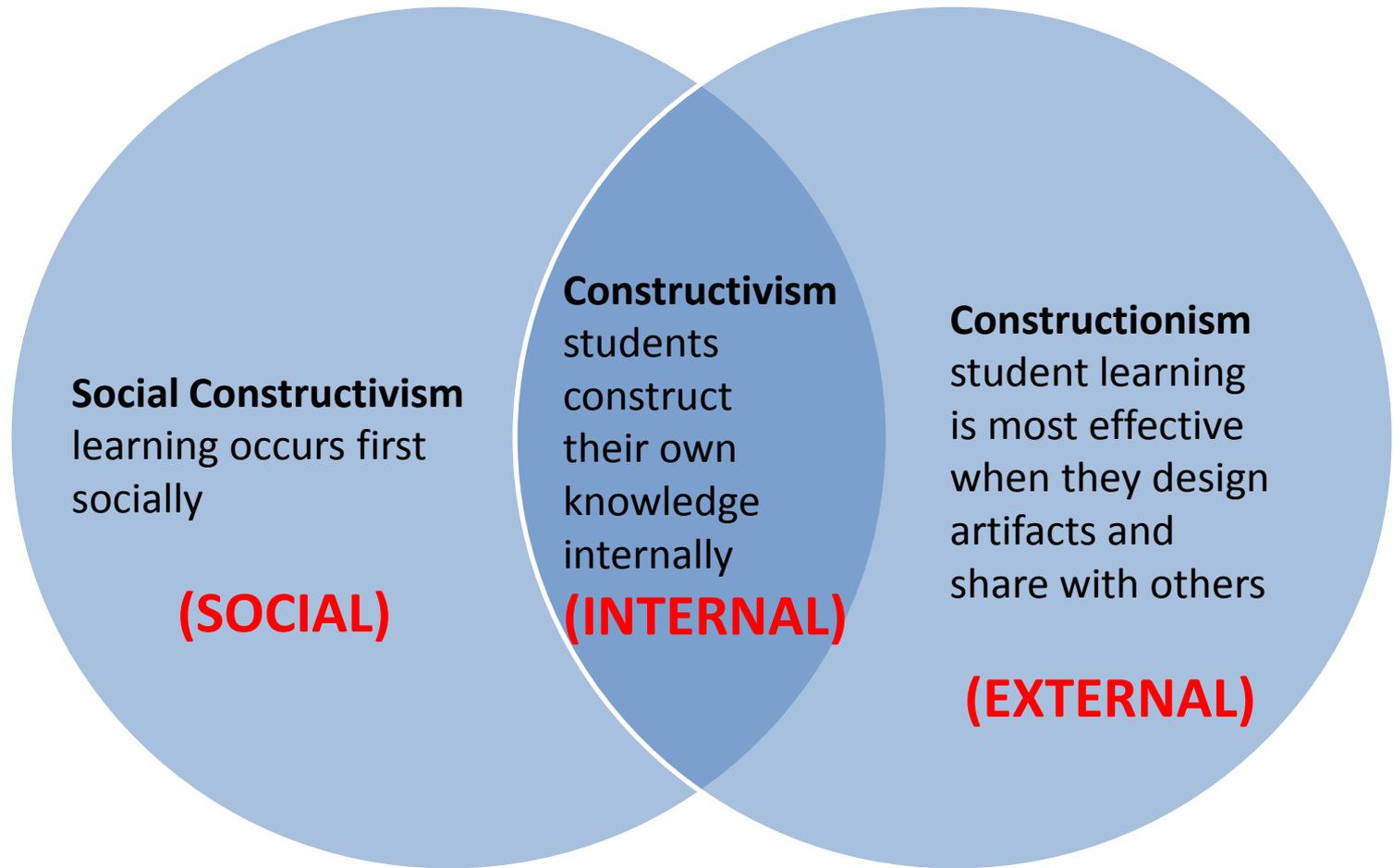
Constructionism

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)



STEM
EDUCATION CENTER
UNIVERSITY OF MISSISSIPPI

Constructionism + Social Constructivism

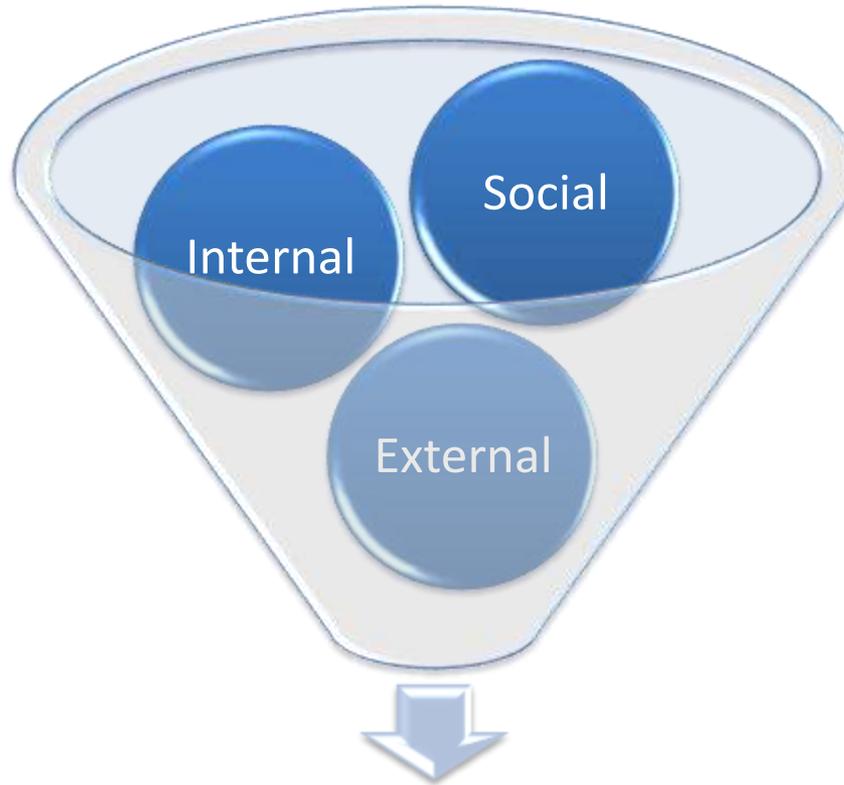


STEM Education Center



UNIVERSITY OF MINNESOTA
Driven to DiscoverSM

Theoretical Framework



Theoretical Framework

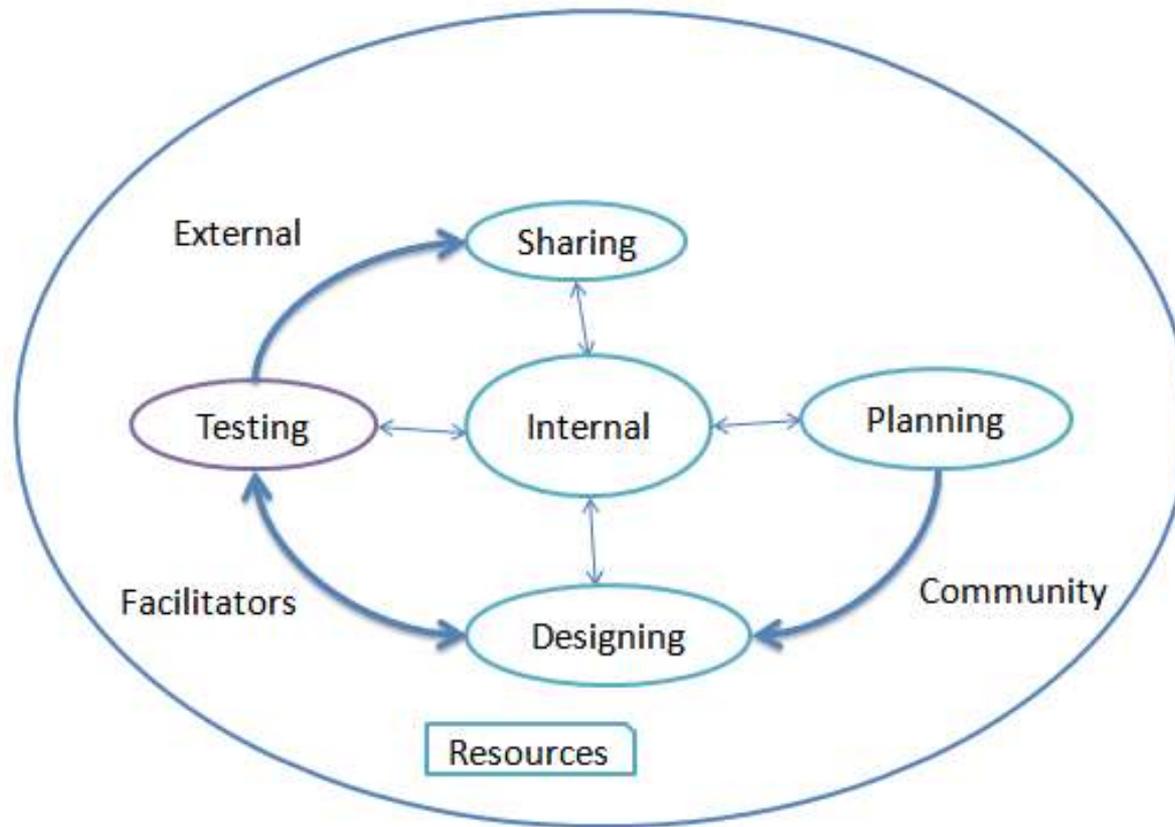
The understanding of individuals is developed through the social communication of ideas

Each student constructs their own, unique meaning for everything learned

Learning occurs 'most felicitously' when constructing a public artifact



Constructionist Design Process

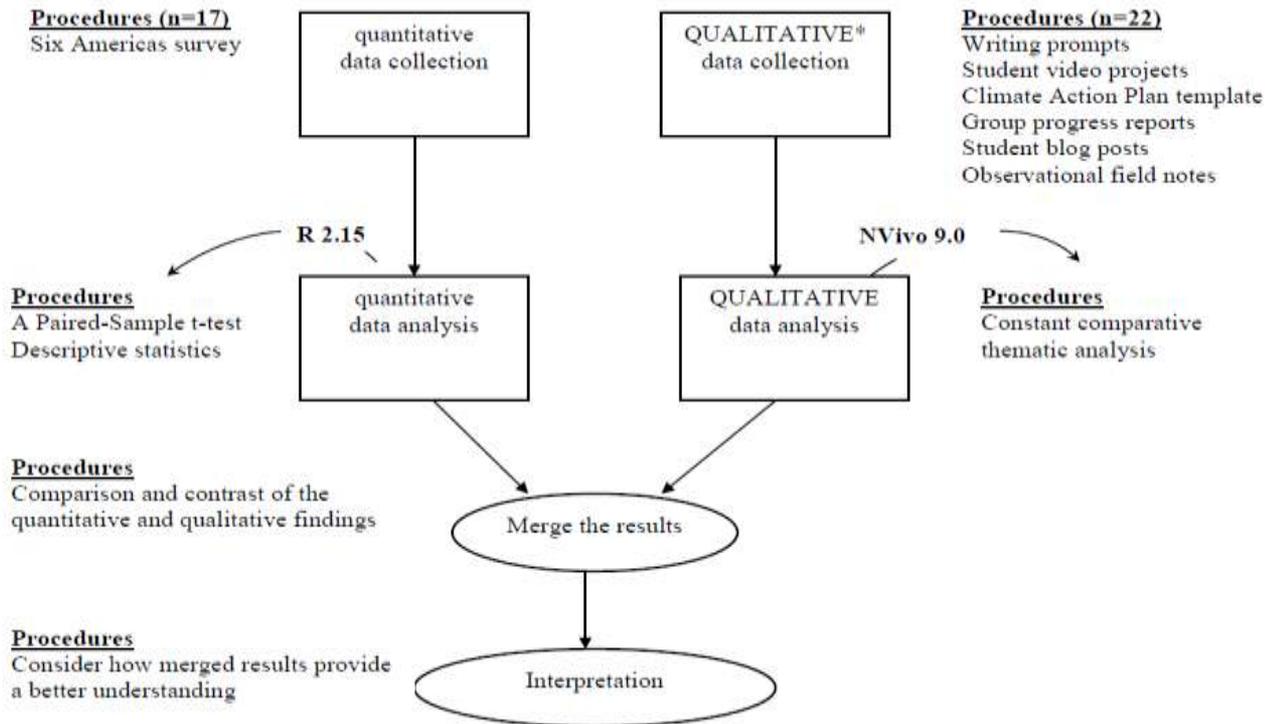


Social Networking Site

- 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

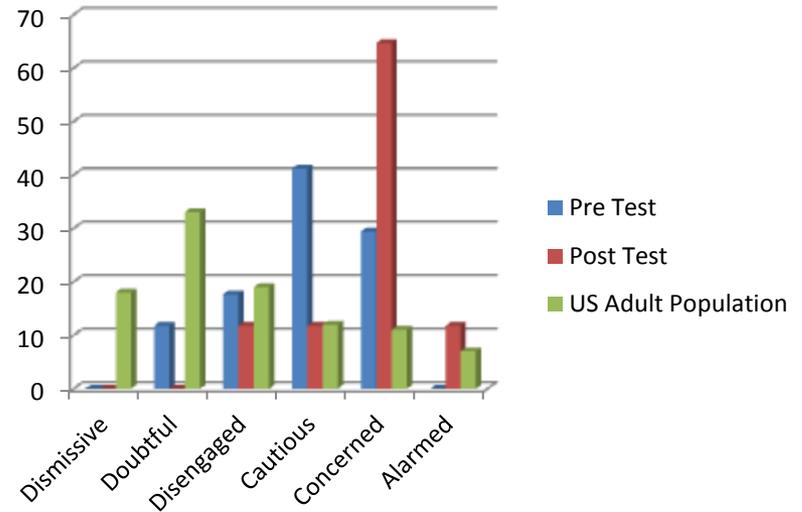
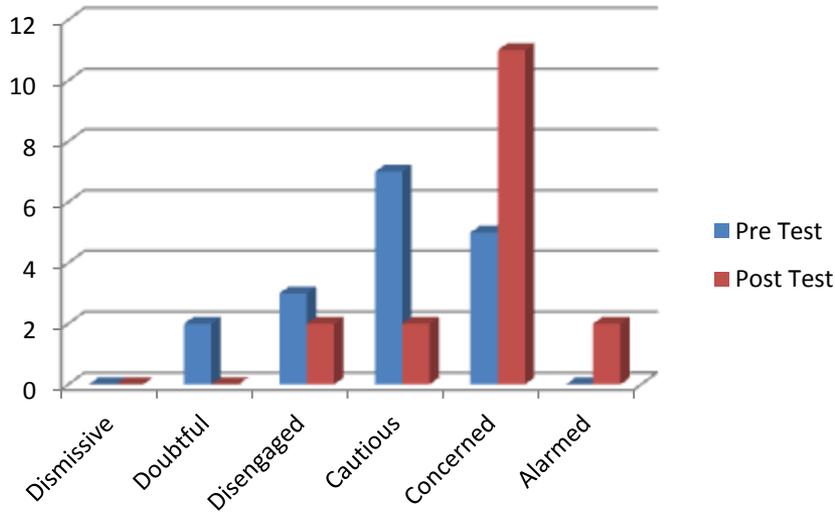


* Uppercase letters indicate that qualitative data sources used as the primary data sources while quantitative data source used as the secondary data source.



Results

	Mean (μ)	Standard Deviation (sd)	P-Value (p)	Effect Size (d)
Pre-test	40.24	4.87		
Post-test	49.88	4.73	4.287e-06	1.648585



STEM Education Center



UNIVERSITY OF MINNESOTA
Driven to DiscoverSM

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 where ever there is internet connection. Its 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

- Reflecting their learning and learning from each other
 - 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.*
 - 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



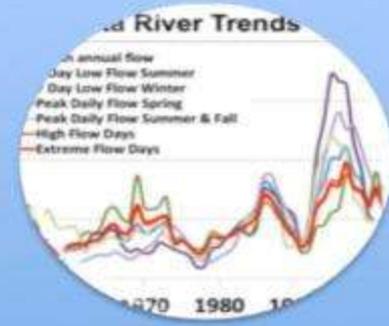
Socioscientific Context: Minnesota River Basin

- Drivers of the Issue,
- Crop and Practices,
- Nutrient Fate and Transport to Streams
- Stream Bank 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

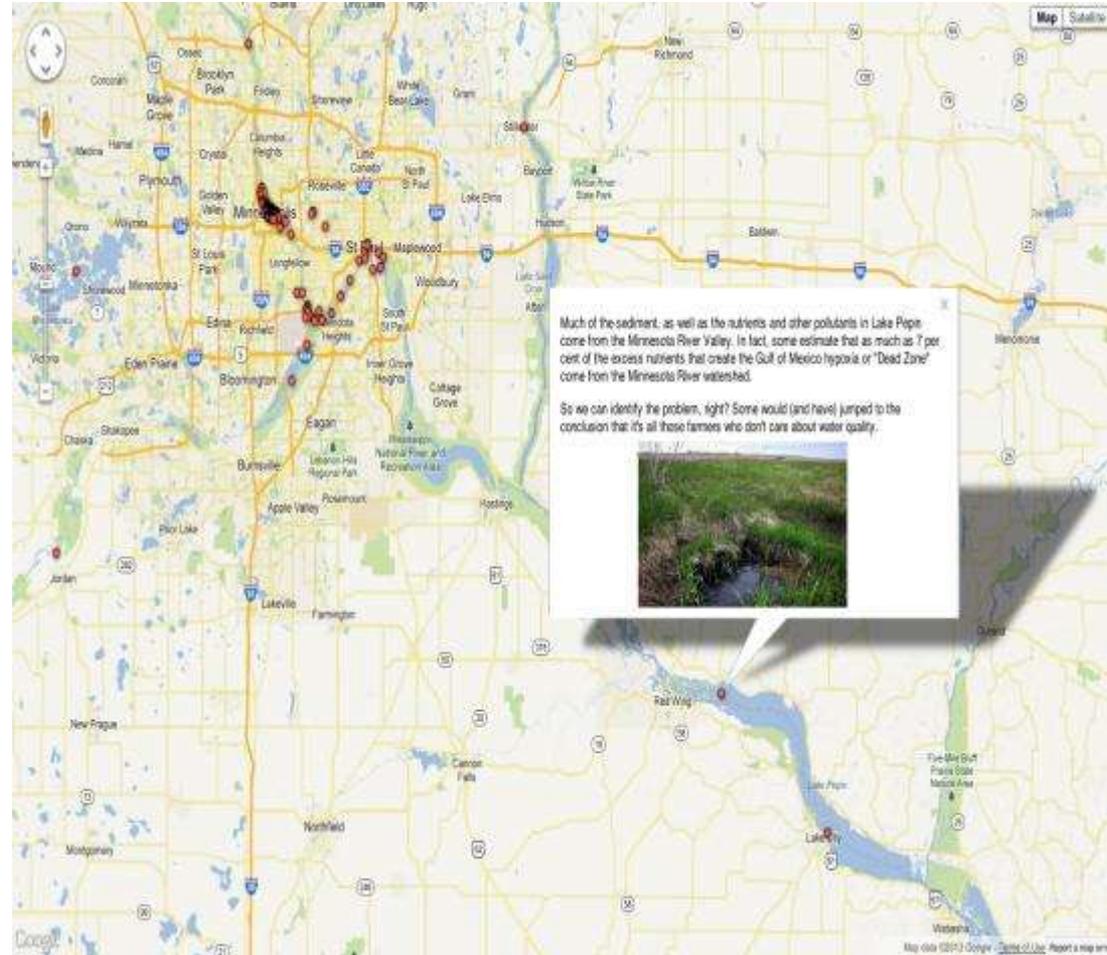
- Students from different locations on the river sharing

- the data they collect,
- narratives about their interaction with Minnesota river,
- 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

