Extending Inquiry: Collaborative Learning with Immersive, Interactive Projection

Vanessa Svihla, Nicholas Kvam, Jeffrey Bowles, & Joe Kniss
University of New Mexico,
Matthew Dahlgren, BASIS Phoenix

Abstract

We report two studies that highlight how immersive, interactive projection technology supported collaborative STEM inquiry learning. The immersive experience was brief (15 minutes) but inquiry extended well beyond. In study one, this extension was provoked by a student noticing a pattern and leading the class to derive a formula. In study two, students graphed data from the dome, provoking questions about superficially-understood phenomena. We found pairing immersive, interactive projection with problem-based lessons provoked generative learning.

Immersive, interactive media

Relatively little research on learning with immersive projection (Apostolellis & Daradoumis, 2010)

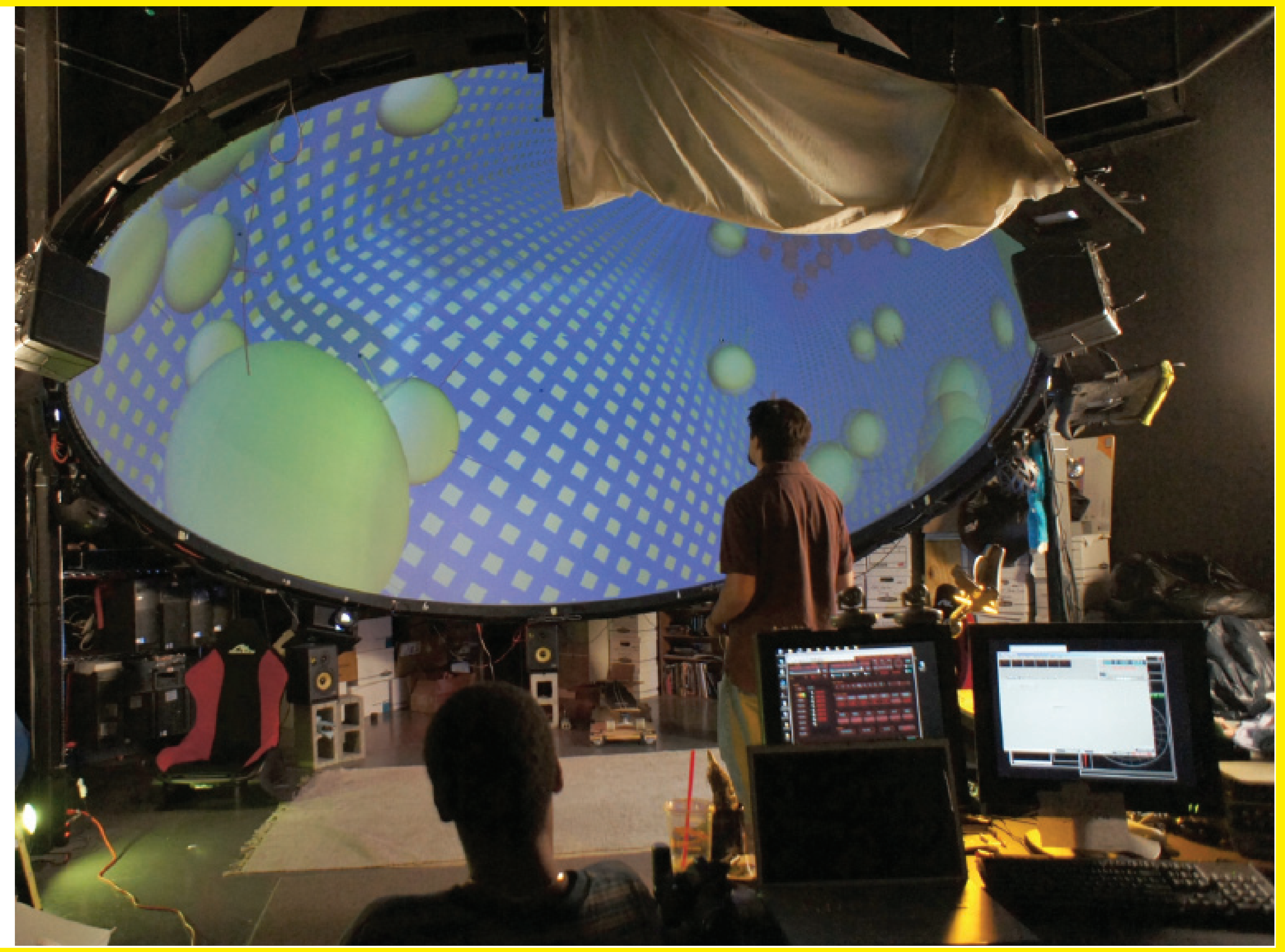
Benefits for recall (e.g., Sumners, Reiff, & Weber, 2008)

Offers a situated experience (e.g., Dede, 2009)

Recent advances add multi-user interactivity

Research Question

In what ways might an immersive experience reconfigure and extend inquiry learning?



Methods

Materials & Design Process

Interdisciplinary design team -- including teachers -- with expertise in learning sciences, computer science, chemistry & mathematics

Participants

Domestroids: Undergraduate students enrolled in mathematics for elementary teachers (n=9)

ClimateDome: Undergraduate students enrolled in secondary science teaching methods (n=8)

Data

Video & audio records, artifacts of student work, field notes

Analysis

Interaction analysis, coding, pre/post comparisons

First iteration of a longer design-based research project aimed at refining technologies for learning and building grounded, localized, theory about engaging students in collaborative disciplinary design practices, such as posing questions, designing investigations, modelling data

ClimateDome

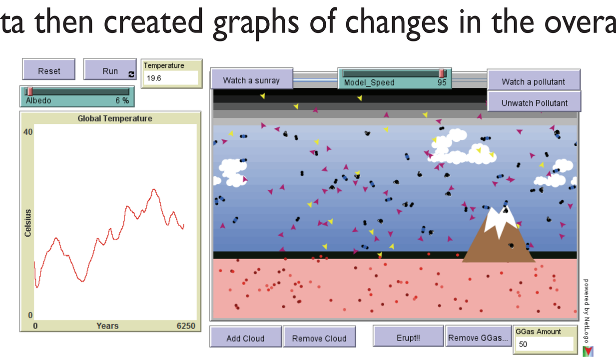
Web-based Inquiry Science Environment (WISE) unit on Global Climate Change (Svihla & Linn, 2012), NetLogo models of the greenhouse effect

Immersive model of greenhouse effect, control the CO2 with Wii-mote

Roles: CO2 specialist, model engineer

Proposed experiments to be conducted in ClimateDome

Exported data then created graphs of changes in the overall heat of the system



Pre-dome session (70 minutes)	Dome session (40 minutes)	Post-dome session (40 minutes)
Students participated in a previously tested WISE unit on climate change	Roles chosen; students planned experiments with "lights up" (15 minutes) then carried out experiments (25 minutes)	Students finished the WISE unit on climate change and worked with datasets from ClimateDome

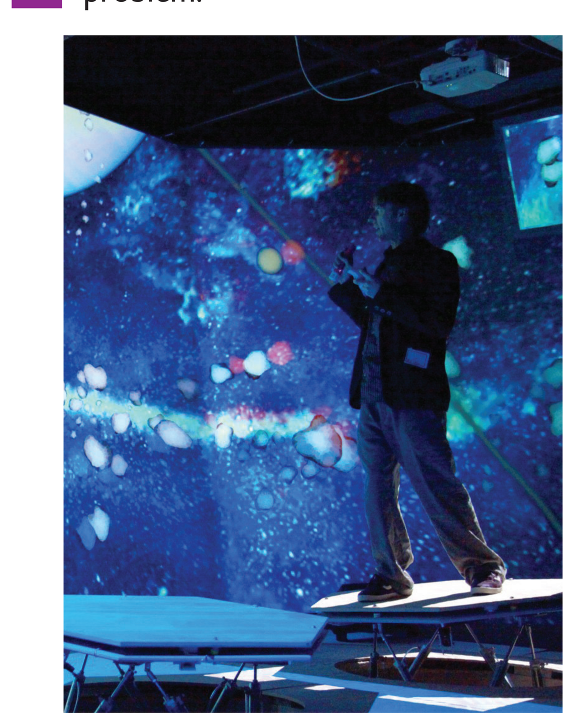
DomeStroids

TOP SECRET

Narrative context

Earth is doomed. There are a number of large asteroids headed our way and the only hope of saving the planet rests on a new weapon, based on the work of a biologist who connected his ideas about cell division to the asteroid problem.

Pre-dome session (40 minutes)	Homework	Dome session (50 minutes)	Homework	Post-dome session (10 minutes)
Mr. D introduced DomeStroids; worked in groups on cell division task	individually completed cell division tasks	Roles chosen & practiced; Mr. D guided them (15 min); they developed a formula	individually completed remaining asteroid tasks	Mr. D gave a brief lecture on sequences, with class discussion



Today you will be testing and experimenting with a new weapon the military has developed – the B612 Asteroid Splitter.

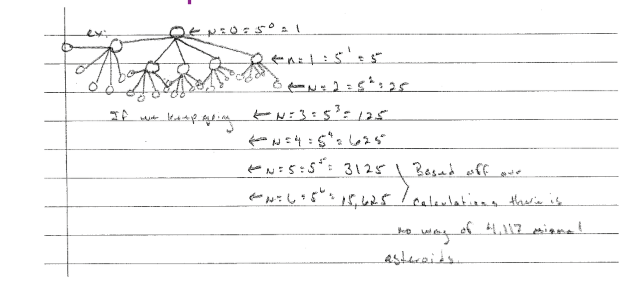
1) If we start with a fixed number of asteroids and split them one by one, how many times will we have to fire the weapon to get all the asteroids at minimal size? If even one asteroid that isn't minimal gets through…we are all doomed.

2) If we start with a fixed number of asteroids and split them one by one until all asteroids are minimal size, how many asteroids will there be?

3) The general wants to use the B6100 Asteroid DEMOLISHER-- it splits every asteroid within range of the weapon into 5 parts but there are only a limited number of charges. The general insists that his calculations show that after using all the charges there will be 4,117 minimal asteroids left and thus Earth's atmosphere will absorb them all. Math to the rescue again! Help convince the General that there is no way his calculations can be right. Keep in mind that he is not really great at math and will probably need a simple explanation. How could we use this formula to convince the general?

Results & Conclusions

Combining narrative context & immersive, interactive media reconfigured participation & disrupted habituated non-participation

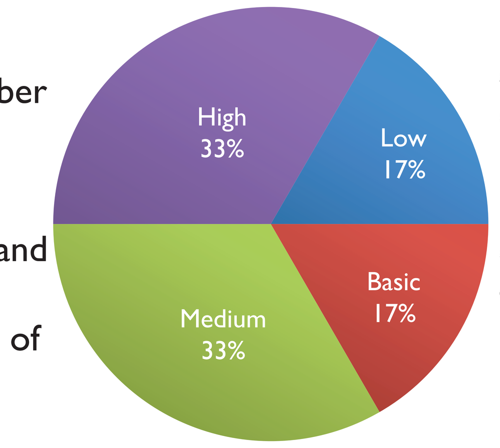


Mr. D: Wull:: 'cause one became three right so actually we only added (.)
Ss: Two
Mr. D: Two more so how many did we have?
Ss: 22
Mr. D: 22. Okay and then we did it again. We fired again. How many did we have after that?
Ignacio: So would there be a formula- would be like uh the number of asteroids minus (.) minus one when it splits into three
Mr. D: You're getting kind of the right ide-. I'm not sure what you're saying
Ignacio: Minus one times two
Mr. D: No not times two //
Ignacio: //plus two
Mr. D: (.) You're almost there you're almost there. (.) Can anybody help him out. What do you guys think the formula for this thing should be?

Designed as a scaffolded problem-based lesson, this reconfiguration lead to generative, agentive participation & learning

High. Clear understanding of sequences and pattern; includes entire formula for the number of asteroids as a function of the number of strikes by the weapon.

Medium. Partial understanding of sequences and pattern; missing details; formula includes extraneous information or lacks explanation of reasoning

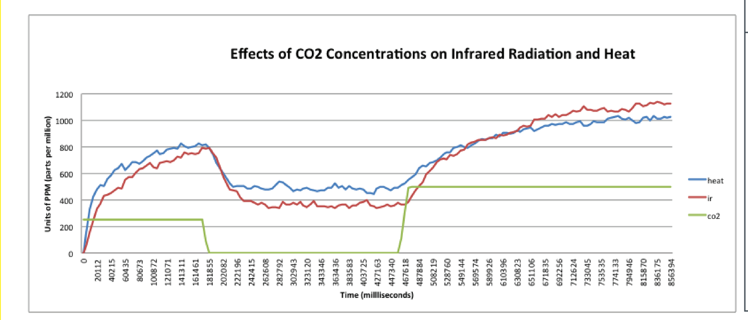


Low. No understanding of sequences or pattern demonstrated; formula is absent or incorrect.

Basic. Missing important details about sequences or pattern but includes non-trivial explanation; reasoning unclear; formula is absent or incorrect.

Planning and conducting experiments then modeling data surfaced questions

- Why was there more solar radiation than heat energy and infrared radiation?
- Why was there an increase in infrared radiation when the level of CO2 was increased?
- Why did the overall heat of the system increase when there was a higher level of infrared radiation?
- Why did variables changed together?



Pre-dome explanation	Post--dome explanation
All energy is provided to Earth by the Sun in the form of solar (or light) energy, also called photons. Energy is converted from light energy to chemical energy by plants! Light energy that is converted by plants is recycled by all other living organisms. Some energy that is not converted escapes through the atmosphere back into space.	Solar radiation from the sun enters the Earth's atmosphere and is converted into heat energy in the Earth's surface. This energy is then converted into infrared radiation which escapes the atmosphere. However, greenhouse gases such as CO2 bounce IR back to the Earth where it is again converted into heat energy, warming the Earth.

Next Steps

Compare immersive and online versions

Contrast science, mathematics and history versions

Explore how an immersive, interactive experience might launch or support an extended, project-based unit

Continue analysis of immersive, interactive media as *disruptions* that can serve to provoke generative learning even under heavily scaffolded problem-based designs/enactments

References & Acknowledgments

Apostolellis, P., & Daradoumis, T. (2010). Exploring Learning through Audience Interaction in Virtual Reality Dome Theaters. Knowledge Management, Information Systems, E-Learning, and Sustainability Research, 444-448.

Dede, C. (2009). Immersive interfaces for engagement and learning. Science, 323(5910), 66.

Rivet, A. E., & Krajcik, J. S. (2008). Contextualizing instruction: Leveraging students' prior knowledge and experiences to foster understanding of middle school science. Journal of Research in Science Teaching, 45(1), 79-100.

Sumners, C., Reiff, P., & Weber, W. (2008). Learning in an immersive digital theater. Advances in Space Research, 42(11), 1848-1854.

Svihla, V., & Linn, M. C. (2012). A Design-based Approach to Fostering Understanding of Global Climate Change. International Journal of Science Education, 34(5), 651-676.

Questions?

vsvihla@unm.edu, ndkvam@unm.edu

UNM

IDDEA lab

ARTS LAB

This research is supported by an Interdisciplinary Research grant from the College of Education in cooperation with the Office of the Provost, University of New Mexico. We also acknowledge prior NSF funding (PFI #917919) for the technology development, though the views presented are our own.