MAKING LEARNING MEANINGFUL: AN EXPLORATORY STUDY OF USING MULTI-USER ENVIRONMENTS (MUVEs) IN MIDDLE SCHOOL SCIENCE

Jody Clarke and Chris Dede, Harvard Graduate School of Education
Presented at AERA, Montreal, April, 2005

Contact: Jody_Clarke@gse.harvard.edu

Abstract: Many researchers are exploring the types of learning that occur in informal out-of-school technology use (such as videogame play), yet the content of these environments tends not to align to national standards for academic content. This paper presents research on how a multi-user virtual environment centered on content related to national standards and assessments in biology and ecology offers new types of immersive learning for engaging grades 7 and 8 students in learning science.

BACKGROUND/CONTEXT

> I'm not really into science that much. …Cause I don't really…I just don't like science. I do it, mostly cause we have to take the science class. Cause, it's not really fun…like, it's not going to help me when I get older. Cause I'm not going to be a scientist or anything, so I don't think I have to learn about science... (excerpted from our Profile of Marie, 8th grade student).

Marie's words speak to a challenge that is perpetually troublesome in education: How do we, as educators, make learning meaningful for students? The thesis that students are not making connections between what they learn in school and their lives outside school is not new. Lauren Resnick addressed this issue in her 1987 AERA presidential address and made a call for redirecting the focus of schooling to encompass functions of successful out-of-school learning (socially distributed, situated, contextualized, aided by tool use, and domain-specific).

Now, the world outside of school Resnick referred to in her 1987 address has evolved into settings pervaded by digital technologies (Howe & Strauss, 2000). Growing up around these technologies fosters different attitudes and aptitudes for the youth of today, sometimes referred to as 'millennials,' (Oblinger, 2003), as well as new possibilities for learning. If we look at the out-of-school activities of adolescents, we find that they are engaging in informal learning and virtual communities of practice around such topics as videogames, movies, music, and fanfiction (Steinkuhler, 2004). Adolescents' daily use of new devices and technology is shifting their lifestyles toward frequent mediated immersion, which is in turn shaping their learning styles towards "neomillennial" characteristics (Dede, 2005).

These emerging devices, media, and virtual environments offer opportunities for creating new types of "learning communities" for students and teachers, based on mediated immersion, This paper presents research on how one such multi-user virtual environment, River City, offers new types of immersive learning for engaging middle school (grades 7 and 8) students in learning science.

THEORETICAL FRAMEWORK

According to Dede (2005), over the next decade, three complementary interfaces will influence people's learning styles and how people learn:

- *The familiar "world- to- the- desktop" interface*, providing access to distant experts and archives, enabling collaborations, mentoring relationships, and virtual communities-of practice.
- *"Alice-in-Wonderland" multi-user virtual environments (MUVE) interfaces*, in which participants' avatars interact with computer-based agents and digital artifacts in virtual contexts. The initial stages of studies on shared virtual environments are characterized by advances in Internet games and work in virtual reality.
- *Interfaces for "ubiquitous computing,"* in which mobile wireless devices infuse virtual resources throughout the real world. "Augmented reality" interfaces involve research on "smart objects and contexts" in learning and doing (Klopfer & Squire, 2004).

Learning styles are defined as "cognitive, affective, and physiological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (Keefe, 1979). "Millennial" learning styles are media-based shifts in learning process that evolve from extensive use of the world-to-the-desktop interface (Tapscott, 1998; Howe & Strauss, 2000; Oblinger, 2003). For example, consider the World Wide Web (WWW). Its intricate web of hyperlinks and abundance of information induces learning based on seeking, sieving, and synthesizing, rather than on assimilating a single "validated" source of knowledge as from books, television, or a professor lecturing (Dede, 2005). However, the world-to-the-desktop interface is not psychologically immersive whereas MUVE interfaces and augmented reality are.

MUVE interfaces and augmented realities induce a strong sense of presence. The increased use of these technologies is causing a shift from millennial learning styles to "neomillennial" learning styles (Dede, 2005), learning styles that are influenced by mediated immersion. Immersion in virtual environments and augmented realities shapes participants' learning styles beyond what using sophisticated computers and telecommunications have generated thus far, with multiple implications for K-12 education (Dede, 2005). This paper will focus on immersion in virtual environments and their implications for middle school science.

The River City MUVE

Multi User Virtual Environments (MUVEs) enable multiple simultaneous participants to access virtual contexts, to interact with digital artifacts, to represent themselves through "avatars," to communicate with other participants and with computer-based agents, and to enact collaborative learning activities of various types. The River City MUVE is centered on skills of hypothesis formation and experimental design, as well as on content related to national standards and assessments in biology and ecology (http://muve.gse.harvard.edu/muvees2003/). Students gain knowledge through immersive simulations, interactive virtual museum exhibits, and "participatory" historical situations. Students learn to behave as scientists while they collaboratively identify problems through observation and inference, form and test hypotheses, and deduce evidence-based conclusions about underlying causes.

The River City virtual "world" consists of a city with a river running through it; different forms of terrain that influence water runoff; and various neighborhoods, industries, and institutions, such as a hospital and a university. The students themselves populate the city, along with computer-based agents, digital objects that can include audio or video clips, and the avatars of instructors (Figure 1). Content in the right-hand interface-window shifts based on what the participant encounters or activates in the virtual environment (Figure 2).

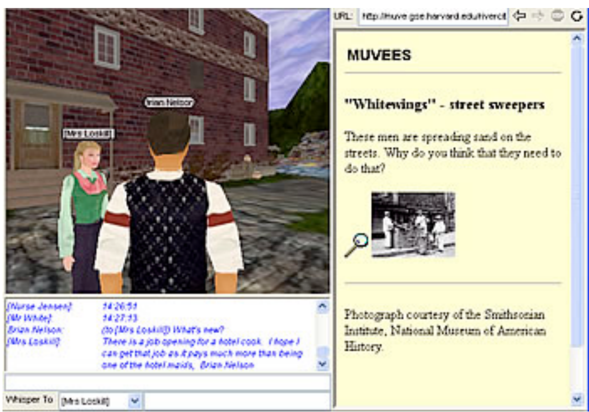

Figure 1

Figure 2

In River City, students work in teams to develop hypotheses regarding one of three strands of illness in the town (water-borne, air-borne, and insect-borne). These three disease strands are integrated with historical, social and geographical content, allowing students to experience the inquiry skills involved in disentangling multi-causal problems embedded within a complex environment. At the end of the project, students compare their research with other teams of students in their class to delineate the many potential hypotheses and causal relationships embedded in the virtual environment.

The principal questions guiding the study framework were:

1) How, if at all, does using a multi-user immersive medium in their science class shape students' ideas about learning and engagement in science?

2) What types of *neomillennial* learning styles emerge from students' experience using a multi-user immersive technology in science class?

METHODOLOGY, PARTICIPANTS AND DATA SOURCES

This exploratory study took place in an urban K-8 school in the Northeast with high proportions of English-as-a-second-language (ESL) and free-and-reduced-lunch students. This research is part of a larger research project, *Studying Situated Learning and Transfer in a Multi-User Virtual Environment* (http://muve.gse.harvard.edu/muvees2003/). Twelve students in the seventh and eighth grade were identified for this study by their science teacher as representing a range of high and low engagement in their science class. This same teacher taught the curriculum.

Data was collected through participant interviews, transcripts of students' logs in the curriculum, and student drawings of their perceptions of "doing science" before participating in the curriculum. In-depth qualitative interviews were conducted four times: two before participating in the MUVE curriculum, one during the curriculum, and one after the curriculum ended. The interviews averaged 20 minutes and were tape-recorded and conducted at the participants' school during their free period. These interviews focused on exploring students' understanding and feelings about digital technologies, science, and using the MUVE. Interviews were transcribed verbatim. Data analysis happened in two stages. First, open coding techniques (Strauss and Corbin, 1998) were used to code the transcripts of individual students. Then a second round of coding was done to look specifically for *neomillenial* learning characteristics and motivation.

RESULTS AND DISCUSSION

In this section we highlight three cases that exemplify neomillenial learning styles that emerge from the data and enhance student learning and motivation.

How Immersive Presence Enhances Learning

"Immersion" is the subjective impression that one is participating in a comprehensive, realistic experience (Witmer & Singer, 1994). Immersion in a mediated, simulated experience (such as a virtual environment) involves the willing suspension of disbelief. This is best illustrated through the experience of "Marie," a female student in the 8th grade. Marie, when interviewed prior to using the MUVE claimed she did not enjoy science class and found it "boring." Yet, when describing her experience in the MUVE, she talks as if she is part of the world:

> We get to move and go places … traveling through the city… I am trying to figure out what is causing this sickness and we are using like we are talking to different people and we're like going places and we also had to test, yesterday, we had microscopes and had to test the water for bacteria and stuff. And we usually don't get to do that in regular science class. Like in class we are usually taking notes and doing work from the book.

For Marie, River City becomes a physical place that she has visited. This example indicates how immersion in a MUVE enables learning that is situated in an authentic context and activity (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991; Greeno 1997) where students are able to move from passive observers of scientific content to shapers of a scientific experience.

Immersion is also important in the process of identity exploration. The evolution of an individual's or group's identity is an important type of learning for which simulated experiences situated in virtual environments are well suited because virtual identity is unfettered by physical attributes such as gender or race or labels such as "smart" or "behavior problem." Virtual environments based on popular games or simulations for adolescents illustrate how participants experiment with the identities they present (Turkle, 1995; Steinkuehler, 2004; Black, 2004). Simulations in virtual environments increase the value of these explorations by providing realistic feedback on how the real world responds to various patterns of individual and group behavior.

Immersion and Identity

The case of "Larruge" illustrates how virtual environments allow students to shed their identity as "student failing science" and take on the identity of a scientist. Larruge is a 12-year-old male in the 7^{th} grade who has a history of failure in school (he is repeating seventh grade this academic year), has given up on himself as a learner, poses classroom behavior problems, and has low feelings of self-efficacy. However, the very first day his team entered the MUVE, Larruge started organizing his teammates:

> hey philip since were team mates we need too decide where to meet so we can work together okay w/b

This is atypical, advanced behavior, since students usually spend the first day in River City becoming acclimated to the world and learning to how to talk to the residents of River City. His second day in River City, Larruge organized his team again:

> Yo where are you guyz im at the hospital come ok so we can work to gether

He then shared information that he found, well before many classmates were doing so, even those with much higher academic performance:

> hwy I think that poeople get better in the winter

In his pre-interview, Larruge said he was often "bored" in science class. In the post-interview, for Larruge, River City was so "fun" that he did not feel like he was "in class."

> Like, we were learning stuff without trying a lot. So, I learned what a thing was, what's it called, not an observation but..[an inference]. Yeah. It's um the what you think is happening when you make an observation.

Although he said he was "learning stuff without trying a lot," later in the post-interview, Larruge said he was "trying so hard to figure out why they were getting sick." He further elaborated that he felt like a "scientist":

> Oh, I don't know, I guess that um the reason I liked it I guess cause you know I got to be a scientist in it. (Laughs). So, I ain't really that smart either so it was kind interesting.

While Larruge still does not think he is "smart," he did say he felt "a little more" different about his ability to do science. Not only did he want to go to science class, but it "got students thinking" and "interested in science." "Thinking more" provided a challenge--it was not too easy—and also gave a sense of ownership for what his team "thought" about the problem.

Larruge liked working in groups because usually in science they do "independent work":

> …we worked better in groups because you know some of us got information here and some of us got information there and it was easier to find out like our hypothesis.

Larruge, who is typically bored by science class, was actually annoyed when one of his teammates, Tk2, was distracted. He later said that technology in school "could be" important,

> but in a way it wouldn't because some students got really distracted during the game. Like Tk2 did. It depends what kind of student it is too. If they get distracted easily.

In his first interview, Larruge said, "once in a while you are going to get confused in science." However, when talking about his experience in River City, he said, "I didn't not understand anything. I don't think so. I didn't have a hard time with it." Larruge "felt like a leader...It was a miracle (laughs). Yeah [I think I did a good job]." This is the same student who, when asked to draw a picture of science class in the pre-interview, drew himself sleeping in class and stated, "I'm slow at this stuff."

From Follower to Critical Thinker

Another illustrative case of how immersive presence enhances learning can be seen in the movement of "Shorty" from follower to critical thinker. Shorty is a 12-year-old female in the 7th grade. She does not think she is good at science and finds it boring. She also tends to be a follower rather than a leader. However, logfile analysis shows that Shorty moved from the periphery to a central role in her team's experiment. She felt like a scientist "because we had to figure out things and ask questions and use our brains and really think hard." Actively solving the problem made it easier to "understand" and helped her comprehend concepts such as "hypothesis" and "procedure":

> ...it helped me understand hypothesis and procedure better ... I knew what they were but then this project it was easy to write a hypothesis and procedure for. Ummm because there was more data than sometimes you don't have a lot data and there was a lot because you could ask a lot of people and talk to a lot of people.

Shorty had learned about these concepts before, but having to solve a problem by visually seeing tacit information helped make abstract concepts like hypothesis and procedure more concrete:

> We actually got to see where everything is, where the dump is and the tenements and the scenic lookout where the pipe, the sewage pipe was going to the water. Yeah, because you got to do more and get more information and actually see the thing instead of just imagining it. You get to actually see it. It helps because we can ask people questions and they can tell us. Like they can talk to us and we got to walk around and see what the city looks like if it is dirty in some spots and really clean in other spots.

Shorty learned immersively by walking around, talking to residents, and noting tacit visual and auditory clues.

CONCLUSION AND IMPLICATIONS

Finding ways to engage middle school students in learning science is a national priority. These cases of students' learning demonstrate how immersive, situated learning can effectively engage middle school students in critical thinking about authentic scenarios in their science class. It is our goal to continue exploring how emerging interactive media enable for new, effective ways of teaching/learning in middle school classrooms.

REFERENCES

Black, R. (2004). Access and affiliation: The literacy and composition practices of English language learners in an online fanfiction community. Paper presented at the 2004 National Conference of the American Educational Research Association, San Diego.

Brown, J. S., Collins, A., & Duguid. (1989). Situated Cognition and the Culture of Learning. *Educational Researcher, 18*(1), 32-42.

Dede, C., and Ketelhut, D. (2003). *Design-Based Research on a Museum-based Multi-User Virtual Environment.* Paper presented at the American Educational Research Association National Conference, Chicago, IL.

Dede, C., Nelson, B., Ketelhut, D., Clarke, J., Bowman, C. (2004). *Design-based Research Strategies for Studying Situated Learning in a Multi-user Virtual Environment.* Paper presented at the International Conference of the Learning Sciences, Santa Monica, CA.

Dede, C. (2005). Planning for "Neomillennial" Learning Styles: Implications for Investments in Technology and Faculty. In J. Oblinger and D. Oblinger (Eds.), Educating the Net Generation, pp. 226-247. Boulder, CO: EDUCAUSE Publishers. http://www.educause.edu/educatingthenetgen/

Gee, J. P. (2003). *What videogames have to teach us about learning and literacy.* New York: Palgrave Macmillan.

Greeno, J. G. (1997). On Claims That Answer the Wrong Questions. *Educational Researcher, 26*(1), 5-17.

Howe, N., Strauss, W,. (2000). *Millenials Rising: The Next Great Generation*. New York: Vintage Books.

Keefe, J. W. (Ed.). (1979). Student learning styles: diagnosing and prescribing programs. Reston, VA: National Association of Secondary School Principals.

Klopfer, E., & Squire, K. (2004). Environmental detectives - The development of an augmented reality platform for environmental simulations. *Educational Technology Research and Development.*

Lave, J. & Wenger, E. (1991). Situated Learning: Legitimate peripheral participation. New York: Cambridge.

Nelson, B. , Ketelhut, D., Clarke, J. , Bowman, C., Dede, C. (2005). Design-Based Research Strategies for Developing a Scientific Inquiry Curriculum in a Multi-User Virtual Environment. *Educational Technology*, 45 (1), p. 21-27.

Oblinger, D. (2003). Boomers, Gen-Xers, and Millennials: Understanding the "New Students". *Educause Review, 38*(4), 36-47.

Resnick, L. B. (1987). Learning In School and Out. *Educational Researcher*, 13-20.

Steinkuehler, C. A. (2004). *Learning in Massively Multiplayer Online Games.* Paper presented at the International Conference of the Learning Sciences, Santa Monica, CA.

Strauss, A., & Corbin, J. (1998). *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. Thousand Oaks, CA: Sage.

Tapscott, D. (1998). *Growing up digital: The rise of the net generation.* New York: McGraw-Hill.

Turkle, S. (1995). *Life on the Screen: Identity in the Age of the Internet.* New York: Simon & Schuster.

Witmer, B.B., & Singer, M.J. (1994). *Measuring Presence in Virtual Environments* (ARI Tech Report No. 1014). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.