MUVEs as a powerful means to study situated learning

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Abstract: This paper describes how multi-user virtual environments (MUVEs) can simulate immersive, collaborative learning environments intermediate in complexity between recipe-like lab exercises and real world inquiry situations. We offer the River City MUVE as a case study that illustrates how rich logfiles provide scholars and teachers with detailed data to understand learning processes, to diagnose suboptimal patterns of student performance, and to assess the knowledge and skills students have mastered. This aids curriculum design and theory.

Theoretical Framework

Research on how people learn suggests that learning and cognition are complex social phenomena distributed across mind, activity, space, and time (Chaiklin & Lave, 1993; Hutchins, 1995; Wenger, 1998). A student's engagement and identity as a learner is shaped by his or her collaborative participation in communities and groups, as well as the practices and beliefs of these communities (Wenger, 1998). Yet creating classroom activities that allow students to engage in authentic practices that involve communities of learning is challenging, especially when it comes to authentic practices of science (Chinn and Malhotra, 2002). For example, several investigators (Griffin, 1995; Young, 1993; Hendricks, 2001) developed curricular activities in attempts to validate parts of situated learning theory, but were forced to modify their research designs due to the difficulty of implementing situated learning within the constraints of a K-12 classroom. As an alternative to practices located within a school, bringing students to a local hospital to work with epidemiologists and doctors to study an outbreak of Whooping Cough might provide an authentic, meaningful, and motivating context for students to master scientific content and inquiry skills. Yet, this is not feasible for a myriad of reasons. Until recently, researchers have struggled to conduct research on natural and emergent learning situated in complex and authentic classroom practices in K-12 education.

However, an emerging alternative is to offer students simulated "Alice in Wonderland" experiences via mediated immersion in a multi-user virtual environment (MUVE). MUVEs are online digital contexts where multiple participants can communicate and collaborate on shared challenges. A participant takes on the identity of an *avatar*, one's digital persona in a 3-D virtual world, and communicates via text chat and non-verbal gestures. In a graphical virtual context, participants also interact with digital artifacts, such as viewing pictures or manipulating tools (e.g., an online microscope), and with computer-based agents. MUVEs are unique in their ability to keep minutely detailed records of the moment-by-moment movements, actions, and utterances of each participant in the environment (Ketelhut, Dede, Clarke, Nelson, & Bowman, in press). As such, MUVEs create a context that allows researchers to study emergent learning and cognition across activity, space and time.

MUVEs have been used in education to create online communities for teacher professional development (Bull, Bull, & Kajder, 2004; Schlager, Fusco, & Schank, 2002), to develop science-based activities while promoting socially responsive behavior (Kafai, 2006), to inculcate social and moral development via cultures of enrichment (Barab, Arici, & Jackson, 2005), to foster online communities for students to learn computer programming and collaboration skills (Bruckman, 1997), to engage interest in math (Elliott, 2005), and to develop skills in scientific inquiry (Clarke, Dede, Ketelhut, & Nelson, 2006). This paper presents a brief illustration of how MUVEs offer opportunities to study emergent classroom-based learning experiences intermediate in complexity between recipe-like laboratory activities and complex real world situations.

Situated learning theory is defined as embedded within and inseparable from participating in a system of activity deeply determined by a particular physical and cultural setting (Brown, Collins, Duguid, 1989; Chaiklin & Lave, 1993). The unit of analysis is neither the individual nor the setting, but the relationship between the two, as indicated by the student's level of participation (Greeno, 1998; Barab & Plucker, 2002). From this perspective, learning and cognition are understood both as progress along trajectories of participation in communities of practice and as the ongoing transformation of identity (Greeno, 1998; Wenger, 1998). Through participation in schools, students develop patterns of participation that shape their identities as learners, including the ways in which they engage in learning and hold beliefs about their abilities to learn. As a trajectory, an identity is not an object that one owns once and for all; it is defined over time, evolves, and has a momentum of its own. Identity is what gives a flexible continuity to the various forms of participation in which one is engaged (Eckert & Wenger, 1994, p. 17)

Learning and Research in the River City MUVE

The River City MUVE is a middle school science curriculum designed around national content standards and assessments in biology, ecology, epidemiology, and inquiry. Students work in teams of three to collaboratively solve the problem of why the residents of River City are falling ill. They travel back in time—in the virtual world—to the time period that bacteria were just being discovered. This enables all students to bring their 21st century expertise to a time period in which even the leading scientists were not aware of disease-causing microbes. As students move through the project, they advance through sessions chronologically. Each session represents a different season in River City (Fall 1878 – Fall 1879), allowing them to collect data on change over time.

Unlike a canned lab, the curriculum focuses on the front end of the inquiry process by walking students through the steps of how one first determines a question that can be answered through scientific investigation. Students identify a problem about why people are getting sick and turn it into a question that can be investigated. They then design and carry out an investigation based on one of the three disease strands infecting the city (insect-born, air-born, water-born). Students participate in the curriculum along a trajectory from novice (scientist-in-training) to expert (research scientist), as they learn to develop questions, generate hypotheses, collect and analyze data, and make conclusions and recommendations that they share with others.

According to Greeno (1998), the power of situated learning is derived from a person learning to solve problems as part of a community in authentic context confronting these challenges. Part of the promise of MUVEs is their capability to create immersive, extended experiences with problems and contexts similar to the real world (Clarke, Dede, Ketelhut, & Nelson, 2006). To build collaborative skills, we have designed River City around a realistic problem that is too complex for one student to be able to solve alone within the given time frame. Team members are encouraged to distribute tasks and work together to solve the problem. Logfile analysis gives us a lens through which to study the extent and type of students' collaboration.

As mentioned above, MUVEs are unique in their ability to keep minutely detailed records of the moment-by-moment movements, actions, and utterances of each participant in the environment (Ketelhut, Dede, Clarke, Nelson, & Bowman, in press). These data form the basis of a personal MUVE history of each student that follows him or her from session to session, in the form of extensive log files—a feature impossible to replicate in a classroom-based experience. The level of detail in these records is extensive: the logs indicate exactly where students went, with whom they communicated, what they said in these interactions, what virtual artifacts they activated, and how long each of these activities took. Analysis of these log files allows us to understand patterns of behavior, such as development of community norms, conversational practices, and trajectories of participation.

We closely examined log files of three classes of students in the 7th grade (n=54), all taught by the same science teacher, in an urban public middle school in the Northeast. The level of analysis was the team of students, and we looked at each session as a separate "chunk" in order to understand how students' participation changed over time. In order to assess how students were participating, we developed a set of codes based on aspects of authentic inquiry and situated learning (trajectories of participation, conversational practices, community norms, confronting ineffective strategies and misconceptions, distributed cognition, cognitive apprenticeship, LPP) that are meant to foster curiosity, openness to new ideas, and informed skepticism: making observations, building and sharing ideas, coming up with questions that can be investigated (taken from NRC, 1996, AAAS, 1993 and Chinn and Malhotra, 2002). We are creating multiple, interrelated case studies (Yin, 2003) of students' participation by combining evidence from logfiles with data from pre-and-post measures, performance assessments, and -- in the case of ten students -- pre-and-post interviews. Prior to the implementation, we asked the teacher to rate their expectation of students' successes and motivation in the project. These indicate, at a rudimentary level, how the teacher perceives the student is participating in the class overall prior to the MUVE curriculum; in our case studies, this is compared to students' own perceptions (based on interviews and affective instruments) of their participation in the MUVE.

Findings and Conclusions

Interesting patterns about the types of learning processes and behaviors of students are emerging from the data. We are finding that the simulation fosters behaviors that are characteristic of situated learning and authentic inquiry. Limited by space, we briefly illustrate two. Further findings will be discussed in our presentation.

First, research has shown that students often do not engage in authentic science inquiry in schools (Chinn & Malhotra, 2003). However, we found numerous examples of students reasoning scientifically, making sense of causality, and building off each other's knowledge. The following excerpt presents one such example:

Cabra: a lot of people at the hospital have stomach pains and diarrhea
Rock: humm.. I think it might be a virus / bug

Rock: I'm sure of it,,, because a lot of people I have visited are coughing,,, and they sweat at night (might be a fever)
Cabra: yeah, and there are coughs too
Rock: yeah, it's probably a virus… temporarily, we'll call it that… okay??
Cabra: fine, but I got to do more water testing

Second, while research documents that learning and cognition is distributed, very few opportunities exist to document the kinds of informal supports students offer each other in the classroom. We are finding that students who do not typically participate in class, like Theo, provide help and support to others via increased participation:

Theo: hey lets meet at the school
Ri: WHERE IS THE SCHOOL
Theo: look at the things in the tool box then click the globe and click school
Theo: click river city map in the lower right hand corner

Our logfiles also document when students fail to reason scientifically, build knowledge, and offer supports. We are building cases of unrealized learning that suggest design heuristics to support situated and authentic inquiry.

Overall, MUVEs are a promising way to create situated learning experiences within K-12 education and to assess the complex forms of individual and group learning that ensue. In particular, the rich logfiles they generate provide scholars and teachers with detailed data to understand learning processes, to diagnose suboptimal patterns of student performance, and to assess the knowledge and skills students have mastered. In turn, this information can inform improvements in curricular design and develop insights about theory. Our design-based research illustrates early steps towards developing robust methodologies for studying situated learning under controlled conditions in which principled variations can yield knowledge about how context shapes collaboration and knowledge building.

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