Developing Ecological Stewardship in Elementary School Through Student Participation in Virtual Worlds

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Abstract: In recent years, researchers and classroom teachers have started to explore purposefully designed computer/video games in supporting student learning. This interest in video and computer games has arisen in part, because preliminary research on educational video and computer games indicates that leveraging this technology has the potential to improve student motivation, interest, and engagement in learning through the use of a familiar medium (Gee, 2005; Mayo, 2009; Squire, 2005; Shaffer, 2006). While most of this early research has focused on the impact of games on academic and social outcomes, relatively few studies have been conducted exploring the influence of games on civic engagement (Lenhart et al, 2008). This article will specifically look at how Quest Atlantis, a game designed for learning, can potentially be utilized to facilitate the development of ecological stewardship among its players/students, thereby contributing to a more informed democratic citizenry.

Keywords: computer games, virtual worlds, Quest Atlantis, civic engagement, citizenship, ecological stewardship, elementary science
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Introduction

Computer/video games and virtual worlds have emerged as a pervasive influence on American society and culture in a relatively short period of time (Mayo, 2009; Squire, 2006). Students of all ages engage these environments as much or more than they watch television (Buckley & Anderson, 2006; Entertainment Software Association, 2006; Mayo, 2009; Michigan State University, 2004) which has led researchers to examine motivational factors such as the desire to play, focusing on how computer/video games can be utilized to facilitate student learning in the classroom (Squire, 2006). Computer/video games and virtual worlds have been developed as models for improving the learning environment of students by implementing the types of clear goals and challenges that are presented to students through the gaming platforms, allowing for and challenging students to collaborate creating the potential for transforming learning in all types of settings, including schools (Gee, 2003; Shaffer, 2006; Barab et al. 2008; Barab et al., 2007). These virtual environments make it plausible to immerse students within networks of interaction and back-stories which engages them in problem solving and reflection in both real and in-world relationships and identities (Barab, 2008). This type of virtual-engagement represents what Gee (2003) identifies as empathetic embodiment of complex systems, where students develop an understanding of and appreciation for one or more aspects of the context of the virtual worlds in which they are engaged.

Many of the massively multiplayer online games (MMOGs) and multi-user virtual environments (MUVEs) provide students with the opportunity to role play, engaging them in a collaborative processes that facilitates participation and leads to problem solving, hypothesis generation and identity construction (Barab, 2008). These environments allow student players to
become engaged in an evolving discourse as members of a community of practice (Barab, 2008; Lave & Wenger, 1991; Squire, 2006). By creating experiences of legitimate peripheral participation (Lave & Wenger, 1991) which emphasize conceptual understanding as a means to address authentic situations (e.g. taking on the role of a scientist, a politician, engineer, etc.), students come to a new way of knowing different from the more traditional, didactic approaches to curriculum and instruction (Barab, Hay, Barnett, & Keating, 2000; Brown, Collins, & Duguid, 1989). By balancing academic content, legitimate peripheral participation, background narratives, and game rules, these virtual worlds can be utilized to support disciplinary-specific learning in content areas such as science, social studies, and civics (Barab, 2008).

Much of the current research has focused on how games and virtual worlds impact academic and social outcomes (e.g. aggression, violence), while relatively little research has been conducted exploring the impact of games and virtual worlds on civic engagement and society (Lenhart, Kahne, Middaugh, McGill, Evans, & Vitak, 2008). Citizenship, democracy and education are inextricably bound to the life of a nation (Bennett, Wells, & Rank, 2008). Schools work to prepare or help students build tools that enable them to play an active role in society as engaged, educated participants. An educated citizenry will contribute their skills and talents to preserve a democratic society. According to John Dewey (1916), community participation is a key to this maintenance. This community participation consists of individuals united through common interests, goals and ideas, but also allow for “free and full interplay” (Dewey, 1916, p. 83) with those who assert differing viewpoints and perspectives. This is the point of education, to nurture the development of individuals who can think and critically analyze, contributing to a democratic society.

In recent years, post-industrial democracies have acknowledged a crisis in student civic
engagement, noting a lack of participation in elections and other traditional civic activities as students mature into adulthood (Bennett, Wells & Rank, 2008). However, while recognizing that students have become disengaged and disconnected from current political practices, most post-industrial democracies have continued to frame their conceptions of citizenship without regard to changing social identities and new and emerging ways of learning, (e.g. gaming, social networking and the internet) among young people (Bennett, Wells, & Rank, 2008). According to the Civic Mission for Schools (Gibson & Levine, 2008), while schools are the main source of civic education today, they fail to account for how students view citizenship roles differently from their parents. This disconnect suggests the need to extend educational methods for citizenship beyond traditional textbooks to include “critical engagement with issues and community involvement” (Bennett, Wells & Rank, 2008, p. 4) in order to fully engage students in becoming democratic citizens.

While technology has been “blamed” for fostering isolation among users, the reality is youth who participate in video/computer game and virtual environments are often actively, and sometimes unknowingly, engaged in new forms of civic life that differs from that of previous generations of non-digital natives like their parents and other adults (Bers, 2008). This type of virtual civic engagement stems from students participation and immersion in a digital culture based on experiential learning and online knowledge sharing with others in their own classrooms and across the globe associated with social networking and digital media (Jenkins, 2006; Bennett, Wells, & Rank, 2008). The emergence and popularity of social networking and media sites such as Facebook©, LinkedIn©, MySpace© and YouTube© provides evidence of this type of virtual civic engagement. As a result, collaborative problem solving and the circular flow of ideas among peers (Jenkins, 2006) is often the norm within this digital native generation.
Gaming, likewise, becomes a major component within the range of social activities with a large percentage of youth participation (Lenhart et al, 2008). Multi-user environments provide the opportunity for students to take on the role of producers, as opposed to consumers, of knowledge (Jenkins, 2006; Bers, 2008). Participation in digital environments allows students to explore civic identities by participating in events and discourse related to civic issues in new and unique ways across global communities. This allows students to begin to understand the difficulties that arise from globalization (Bers, 2008).

In recent years, the emergence and growing popularity of the green movement is putting a new emphasis on issues like recycling, composting, and community-based gardening (Biswa et al, 2000) and bringing attention to the size and impact of one’s carbon footprint (Weber & Matthews, 2008). With this new interest in ecological stewardship, citizens are becoming increasingly concerned with their impact on the environment, not only in their local communities but across the planet. Through participation in local and digital/virtual environments, youth begin to see a juxtaposition of the worlds; the two worlds are mutually beneficial for learning new skills, so that students take their experiences within the digital environment and transfer them to their local situation where they can work toward long term solutions for environmental and social issues as actively engaged, real-world citizens.

Theoretical Framework

Contemporary viewpoints of the nature and philosophy of science are rooted in the notion that science is not simply the accumulation of a myriad of facts about the world, but rather it involves the construction of ideas and theories about how the world may be. This view allows for challenges, conflict, and disputes as opposed to common agreement on the nature of science (Giere, 1991; Popper, 1959; Kuhn, 1962). Multi-user, digital environments work to develop
these ideas by situating disciplinary content within broader contextual frameworks (Bers, 2008; Sadler, Barab & Scott, 2007; Barab, 2008). According to Papert (1980), the constructivist nature of these environments promotes higher-order learning because they engage the individual in creating personally meaningful artifacts that can benefit and be shared with others within a community. Through this reflection on external objects, internal knowledge is also developed (Papert, 1980).

*Quest Atlantis, (QA)*, builds and expands upon these constructivist principles through the framework of socio-scientific inquiry (Barab, Sadler, Heiselt, Hickey, & Zuiker, 2007). Socio-scientific inquiry engages students in “the process of using scientific methods to interrogate rich narratives about societal issues that have a scientific basis, yet whose solution claims with political, economic and social concerns” (Barab et al., 2007, p. 61). Based upon the three core concepts of narrative engagement (“context”), inscription construction/deconstruction (“resources”) and scientific inquiry (“practice”), *Quest Atlantis* allows students to utilize these core constructs to create compelling solutions to “real world problems.” The narrative of the virtual environment contextualizes the scientific content or problem, which, in this study, revolves around why the fish are declining in *Taiga*. Barab and colleagues (2007) see this contextualization as a mechanism to transform student learning from “facts or concepts to be memorized into useful tools to address significant issues” (p. 61).

The inscriptions, or resources, focus on the written or printed objects (e.g. charts, tables, graphs, schemes, diagrams, etc.). These allow the students to demonstrate and represent knowledge, as well as focus on data extrapolated from the larger narrative (Roth & McGinn, 1998). Scientific knowledge is often communicated through these types of simplified representations, or inscriptions, turning them into a conceptual tool that allows students to make
sense of the world and creatively solve problems (Barab et al., 2007). The scientific inquiry practices that exist within these gaming and virtual world environments allow students to utilize a dynamic approach towards asking questions, making and testing hypothesis and discoveries, and considering the impact of all possible solutions within the context of the community. *Quest Atlantis* makes use of this socio-scientific inquiry framework to gain insight into how virtual world environments and other computer games are leveraged to address all types of academic content. The focus of this study was analyzing how students learned science content, and developed their own ecological stewardship and civic engagement while engaging with *Quest Atlantis*.

The framework of pedagogical praxis (Shaffer, 2004) utilizes the ideas of situated learning first developed by Brown, Collins, and Duguid (1989); this notion of situated learning was later expanded upon by Lave and Wenger (1991), who begin with the premise that “under the right conditions, computers and other information technologies can make it easier for students to become active participants in meaningful projects and practices in the life of their community” (p. 1401). Praxis-based educational models, such as digital environments, are designed to encourage experiences where students learn through engagement and participation (Bers, 2008; Shaffer, 2004) as opposed to the more traditional knowledge based models that focus solely on subject specific content. Pedagogical praxis further develops Lave and Wenger (1991) notion of communities of practice by incorporating legitimate peripheral participation (Shaffer, 2004) and Schon’s model (1985, 1987) of reflective practice which suggests that one must “think in action” (p. 1402) through these experiences. According to Schon (1985), individuals who make a connection between knowing and doing through reflection are able to “combine reflection and action, on the spot, … to examine understandings and appreciations
while the train is running” (p. 27). Multi-user digital environments provide students with the tools to engage in this form of legitimate peripheral participation where conceptual understanding, in both disciplinary content and practices, in authentic situations is valued.

Citizen models, reflecting global civic and environmental engagement, demonstrate what is described by Westheimer and Kahne as participatory and justice-oriented forms of citizenship. A participatory citizen is actively engaged in his/her community and is working to solve social and environmental problems (e.g. pollution in the rivers). Citizens who take a justice-oriented perspective identify the various social, behavioral, and environmental problems, the structures that perpetuate these problems, and the actions that are needed to change the patterns that contribute to the replication of problems over time (Westheimer & Kahne, 2004).

While commercial games such as World of Warcraft, SimCity, and Second Life are environments that can potentially nurture the development of ecological stewardship and civic engagement, this study will focus on the use of an educational game, Quest Atlantis, developed by education and learning science researchers, to examine how students learn (or do not learn) science content and how interaction with one’s environment impacts (or does not impact) the player’s sense of ecological stewardship and civic engagement.

This work contributes to a developing body of research that examining the impact of using computer/video games and virtual worlds within educational settings (e.g. Nelson, Ketelhut, Clarke, Bowman & Dede, 2005; Barab et al., 2007; Squire, (2006); Neulight, N. Kafai, Y., Kao, L., Foley, B. & Galas, C. (2007)) It also contributes to the research base on using multi-user virtual environments (MUVEs) through the examination of how students learn science content within the Quest Atlantis environment and how they are able to translate these experiences to their own lives, becoming civic and ecological stewards of their communities.
Quest Atlantis

*Quest Atlantis (QA)*, developed at Indiana University, is a multi-user virtual environment that combines strategies used in commercial gaming environments while integrating lessons from educational research on learning and motivation. The immersive gaming environment is designed for students (ages 9-14) to engage in forms of play that allows them to explore social responsibility within the context of both fictional and non-fictional realities while promoting the civic engagement of its participants (www.questatlantis.org). Student engagement is accomplished through a compelling narrative. The back-story focuses on the problems of a mythical world called *Atlantis*, where students encounter issues similar to the challenges faced in their own experiences on Earth. *Atlantis* is described to the participants as a planet experiencing a myriad of social and environmental issues. Students are invited by a group of concerned *Atlantan* citizens to help them solve some of these crucial issues. The story plays out with the 3D world as well as in novels, comic books, and a global community of participants. The game platform provides an immersive context for the students to engage in real-world inquiry through the fictional world, *Atlantis*.

The 3D world provides the platform of engagement for students, who teleport to virtual locations within *Atlantis* to perform educational activities known as *quests*, talk with other students and mentors, and build virtual personae in real-time. The virtual personae, or avatars, can be customized to reflect the student’s own identity through their choice of hair and skin color, clothes and other accessories such as hats, glasses and backpacks. Students, through their avatar, respond to *Quests* (developmentally appropriate activities with task descriptions and goals) in order to help the Council of Atlantis solve some of their problems and restore lost knowledge within *Atlantan* society.
Groups of Atlantans, known as the Council, are determined to restore Atlantis back to its previous magnificence by enlisting the help of student questers from Earth. Questers teleport to Atlantis via OTAK, the computer designed by the council. Upon entering the Quest Atlantis environment, students are free to visit a number of virtual worlds, each with their own unique theme, and council member supporting it (e.g. Ecology World with its environmental awareness focus headed by Council Member Lan). Each world is made up of several villages with their own quests. The quests within the worlds and villages are connected to academic standards, both at the national and state level, and to social commitments such as environmental awareness. Students are invited to bring their own experiences, families, and cultures to help them solve the problems of Atlantis. Quests within the world can vary, ranging from simple simulations to complex application problems.

Student questers navigate their avatars through the 3D world and interact with other players via a text-based chat window and respond to non-player characters (NPCs) with structured dialogues where they propose solutions and communicate ideas about the problem they are solving. As students complete each quest experience, their final responses/solutions can be typed directly into the game space, or they can upload up to four files, including word processing documents, spreadsheets, presentations, movies, or any other file type. Quests are generally assessed by the supervising teacher who assumes the role of a non-player character such as Ranger Bartle in Taiga, or Lan, the council member in Ecology World. All correspondence about the quests is generated by the non-player character/teacher. A teacher can also assign questers to conduct peer reviewing or edits of their fellow classmates. Questers access their work and feedback through the 2D window space, which becomes their homepage complete with their electronic portfolios.
While students interacted with their teacher and other non-player characters, there were no internal supports like an intelligent tutor to scaffold students’ construction of knowledge. In this study, however, students participants utilized a field notebook, developed by the researcher, to guide their *quests* in *Taiga*. This field notebook provided the students with scaffolds for note-taking as they progressed through *Taiga* and encouraged them to connect their game play to extensions into “real world” experiences and situations.

The focus of this article is on *Taiga*, one of the many worlds within *Quest Atlantis*. *Taiga* is a park located along two water-ways and inhabited by a variety of non-player characters including loggers, tourists, and indigenous farmers. The world also includes a fishing resort and park administration. *Taiga* is designed to help students learn about environmental science concepts such as eutrophication, erosion, water quality indicators and hypothesis testing through their interaction with these virtual characters and data concerning a declining fish population within the park’s rivers.

Student *questers* are invited to assume the role of a field investigator helping Ranger
Bartle solve his dilemma – the decline of the fish in the river. They begin their narrative immersion by interviewing the various stakeholders/non-player characters found in the park and identifying the possible factors contributing to the decline of the fish population. The non-player characters provide a diverse set of perspectives on the problem of fish decline for the students to analyze.

Students collect water samples, analyze data and formulate a hypothesis that is based upon their understanding of the scientific evidence, along with their analysis of the stakeholder’s perspectives of the problem. After proposing an initial solution, students are allowed to travel to the future to see the impact of their ideas on Taiga. Depending on their choices, the students will encounter different scenarios that are reflective of their choices. Upon returning to the present, student questers are given the opportunity to revise their solution into a nuanced argument which balances the scientific evidence with a greater understanding of both the political and economical impact on the community. The success of the student within Taiga is dependent upon their understanding of 1) water quality indicators such as pH, dissolved oxygen, nitrates and phosphates; 2) the processes of eutrophication and erosion; and 3) the dynamic relationship between the indicators, the processes and the outcomes within the Taiga water-ways.

Study Context

Context: School and Students

This study occurred in three fifth grade classrooms (n=50) of two urban schools, Chamberlain Elementary and Edison Elementary, part of the Northeast Public School System\(^1\) in the United States. Northeast Public Schools is a large urban district that faces many of the problems plaguing urban centers including poverty, low academic achievement, English Language Learner (ELL) issues, high-risk students, and lack of student engagement. Both

\(^1\) All names of schools, teachers and students are pseudonyms.
schools struggle to meet their annual “Adequate Yearly Progress” (AYP) and are often
categorized as being either failing or needs improvement schools. Both Chamberlain and Edison
fall in the “Needs Improvement” category in English Language Arts and “No Status” for
Mathematics in the statewide Assessment System used to determine AYP under the federal No
Child Left Behind (NCLB) legislation. Neither school met its Annual Yearly Progress (AYP) in
English Language Arts. However, Edison met AYP for Mathematics, while Chamberlain did not.
Both of these schools have predominately Black and Latino(a) populations, which account for
seventy to seventy-five percent of the school populations. Chamberlain is also linguistically
diverse with over seventy languages spoken at home.

Methodology

Data Sources

This study involved a multi-tiered, mixed model approach that allowed for both broad
understandings of classroom practices and specific analysis of outcomes. Data were collected
from multiple sources reflecting perspectives of the researcher, teachers, and students
participating in the Quest Atlantis project (Lincoln & Guba, 1985). These sources included both
pre- and post- assessments and not only focused on science content, but incorporated or took into
account process skills and types of engagement in areas such as ecological stewardship. The
data sources included pre- and post- semi-structured interviews of a subset of students (n=20),
detailed journal notes of informal and formal conversations between the researcher and students.
Other data sources included videotapes interactions of student participation, student products and
end-of-project student artifacts (e.g. field notebooks and reports), classroom observations by the
researcher, and an archive of online chat dialogues from student interactions within the game.

Data Analysis
Data was triangulated in order to overcome any weakness or intrinsic bias arising from the use of a single data source. An interpretive approach was utilized to analyze the qualitative data sources (Denzin & Lincoln, 2000). The extensive data collected throughout the project provided an in-depth picture of how students re-conceptualized ecological stewardship and engagement over time. Through interaction analysis (Jordan & Henderson, 1995), data were coded by analyzing segments of video that focused on a specific topic of interest (e.g. science content knowledge, ecological stewardship). Further analysis specifically examined the student discourse and actions around ecological stewardship and environmental consciousness during game play, and how the game seemed to support (or not support) their civic engagement within the Quest Atlantis virtual environment. Codes that emerged during pre-coding and open coding during implementation were then further collapsed into an axial coding scheme. Additionally, these identified codes served as the foundation for the construction of written cases. Codes were checked for inter-rater reliability by another science education researcher, resulting in a reliability level of 0.8.

What was apparent in the data collection process was that student participation in the Quest Atlantis virtual environment represented a fluidity of mutual engagement and disengagement. The social construction of students’ knowledge was observed through their interactions with other students and with the game. It therefore became important to look at how students interacted with each other, making known the ideas and strategies they employed within the world to gain entry for their ideas within the community. With respect to technology and other artifacts used to support the students in playing the game, it was important for the researcher to look at how artifacts (e.g. field notebooks and reports) and technology use supported or constrained students’ participation in the activity. How were the students
occupying space in-world and voicing their ideas? How were these ideas incorporated into problem-solving? Were their ideas translated into practice in the students’ own real-world experiences or, if not, could they?

Students in each of the participating classrooms engaged in playing *Quest Atlantis* over 15-20 class periods of 45-60 minutes each. A purposeful sampling of the students was done to reflect the demographics of the school population. An attempt was made to select an equal number of male and female students. Of the students that were interviewed, eight identified as African American (four male, four female), eight were Latino(a) (three male, five female), one Caucasian (male), and two Asian/Pacific Islander (one male, one female).

While the data was extremely rich, this article will focus on two students, Rebecca and Keith, who most clearly articulated the impact of playing *Quest Atlantis* on the development of their own ecological stewardship and civic engagement in their communities. Keith was a ten year old Asian/Pacific Islander male student from Edison Elementary while Rebecca was an eleven year old African American female student from Chamberlain Elementary.

**Findings/ Results**

Through case studies, several themes surfaced that clearly illustrated the ways in which student discourse about notions of ecological stewardship emerged and evolved as students navigated the quests in *Taiga*. First, by playing the game students generally internalized and understood science content knowledge on topics of water quality, ecosystems and system dynamics. The students were also able to supply the researcher with well-developed science content answers while demonstrating a clear understanding of these concepts. While the primary focus of the *Taiga* experience was the acquisition of basic science content knowledge on water quality and ecosystems, the conversations and discourse that occurred between students, teachers
and researchers demonstrated that the students were also able to offer a more nuanced understanding of how the content they encountered within *Quest Atlantis* was connected to real-world localized water environments.

Secondly, students were able translate the science content and nuanced explanations they learned by playing *Quest Atlantis* to their communities, both virtual and real, whereby giving voice to environmental issues impacting their areas allowing them to begin efforts to solve these problems. These ideas emerged from analysis of both video and audio data collected during the student interviews and in-world experiences. This became particularly evident during the student interviews. The following section will provide further detail about how Keith and Rebecca illustrate these themes.

*Science Content Knowledge*

Analyzing the student responses during these interviews, there was a consistent trend of students moving from vague, non-scientific responses to more nuanced, data driven explanations using precise language and knowledge acquired from the in-world experiences. *Quest Atlantis*, and *Taiga* specifically, appeared to facilitate students’ learning of specific science concepts involving water quality and ecosystems within a problem based environment at the fifth grade level. This water quality and ecosystem knowledge was demonstrated through the written assessments where a t-test showed a significance (p ≤ 0.005) between the paired average (n=50) pre-assessment score of 25 ± 8 and the post-assessment score of 29 ± 8, where r=0.830. More specifically, Keith and Rebecca’s scores both improved ten points from pre- to post-assessment, with Keith improving from 24 to 34 and Rebecca improving from 29 to 39.

The water quality and ecosystem knowledge gained by the students from engaging in the

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2 Total score of the assessment was 40 points.
virtual environment was then applied to scenarios of their local environments in the interviews. Students applied their new knowledge and demonstrated notions of ecological stewardship and civic responsibility in their responses. For example, during the pre-engagement interviews, students were asked to determine if a particular water source was safe for their families to drink. Nearly all of the students interviewed (18 of 20) indicated that they would “look at it to see if it were clean to drink,” and offered no details as to how they would “look” to see if this were indeed true. Rebecca’s response was indicative of these students:

**Researcher:** Imagine that you found out that the river near your house, like the [winding] river was the source of your drinking water. What could you do to make sure the water was safe to drink for you and your family?

**Rebecca:** Well, I can look at the river and see if people are swimming in it…and then look to see if was polluted or something… and to look and see if there is mud and pollution and stuff… and people are swimming in it… then it probably wouldn’t be very good to drink out of… but if it were a fresh river and no one was swimming….there wasn’t any pollution and stuff it might be safer to drink…

**Researcher:** So is there anything you might do to see if the water was polluted? How would you know?

**Rebecca:** Like tests or something?

**Researcher:** Yes, are there any tests you might run?

**Rebecca:** You could take a cup and fill it with water to see if its muddy and then I would look to see if there were any things that clean out the water or if they just took the water out of the river….

In her response, Rebecca focused on people swimming in the river. She talked about pollution,
but did not account for the sources of the pollution, nor how she might have worked to eradicate the pollution. Additionally, she did not indicate how she would determine if there was pollution beyond taking a sample to analyze. When probed for specifics, the response remained similar - that the water was muddy and therefore polluted.

However, after Rebecca had completed the four quests within Taiga, her answers were different. In the post-engagement interview, Rebecca responded in a much more sophisticated manner with respect to the science content knowledge:

**Researcher:** Ok, so let’s say that you heard that the [winding] river near your house was where your drinking water came from. What might you do to see if the water was actually safe to drink?

**Rebecca:** Well, first I would get a water sample from the river and test it. The water could be really bad to drink because the water could have like, be like acid, and that wouldn’t be very good. I would also test for oxygen and other stuff… it could be… hmmm…. Nitrogen or phosphate or something, you know…kind of like the Mulus [the indigenous stakeholder non-player characters in *Taiga*] when I played in *QA*… they had that fertilizer stuff that got in the water…you know, up by that farm area near Norbe…. then the water gets all green and stuff…

**Researcher:** So what kinds of tests do you think you might run?

**Rebecca:** Well…. I’d like to see what is in the water….and like what the pH level was to see if there was acid since that is bad… and turbidity… you know.. the mud and how clear the water is ‘cause that makes a difference with the oxygen…

Rebecca was able to articulate that water quality testing would be central for determining whether the water was safe to drink. Additionally, she was able to identify specific examples
(e.g. dissolved oxygen and nitrogen/phosphate testing) and, in several instances, relate it back to her in-world experiences (e.g. the algal bloom from the fertilizer runoff). The types of water quality tests that she identified were the tests that she encountered, learned about and utilized in Taiga.

Researchers also asked the students to think about waterways in their own community; if they were polluted and how might this pollution impact living organisms. When questioned about how the students’ believed the waterways became polluted, all of the interview participants (n=20) recognized the impact of human activity on the environment through pollutants like boating, factory waste, human pollution and littering. Student responses were consistent between the pre- and post-interviews, however, in post-interview responses, students also addressed the impact of the pollution on food webs and river ecosystems. In the following response, Keith discussed how human activity impacted the turbidity of the river and ultimately, the food chain:

**Researcher:** How do you think the river became so polluted?

**Keith:** Well, people litter a lot in the city….and sometimes it gets in the water…and dirt and stuff, when ever they run or do other stuff… maybe cut down some trees or something… dirt gets in the water and then the turbidity changes…and you know… the dirt then makes the temperature go up…get hotter…and then the water gets warmer and that is not good…

**Researcher:** So, why is that not good? How does that affect the fish, plants and other animals along the river?

**Keith:** Well… I think that the temperature… it might sorta kill the ecosystem because of how the temperature is… you know the oxygen…it gets messed up
and there isn’t as much when the temperature is high...so then the fish, they like
die...the small fish die, and then the big fish die because they don’t have any food
anymore...and the food chain is sorta messed up... other animals might not have
anything to eat either...

Like Rebecca before him, Keith’s response reflected a nuanced scientific understanding of water
quality concepts and, in this instance, dissolved oxygen. This understanding and experience was
facilitated through his engagement with the Taiga community and reflection in action (Schon,

*Civic Engagement and Ecological Stewardship*

Examining the context of the students’ post-interview responses, what emerged was that
students made specific connections between the problems encountered in the virtual world
environment and those they saw within their own communities. They began to see themselves as
being able to actively engage in community building based upon the in-world experiences in
*Quest Atlantis*. For example, during the course of the post-interview, it became evident that
Rebecca saw herself as an engaged citizen who wanted to work as a change agent in her local
environment. Rebecca’s responses reflected that she was not only situating herself as a
participatory citizen (Westheimer & Kahne, 2004), but she was beginning to think about the long
term impacts of pollution in her community and was therefore moving towards a justice-oriented
citizen orientation (Westheimer & Kahne, 2004). She stated:

**Rebecca:**......and if there is no oxygen, then animals like the fish can’t live and if
there is too much fertilizer and stuff then the water will get all green, with... what
is it called... is it algae?

**Researcher:** yes...
Rebecca: That would be bad...the water would be dirty and people shouldn’t drink out of it at all or they might get sick... so I would want to make sure that I let people know that...and... and maybe even get them to help me clean it up so we could use it again....I like to fish, and if the fish are dead, I can’t go fishing....so that’s what I would do....

It was apparent from this brief interlude that Rebecca recognized the need for community action, similar to what she encountered in her Taiga experiences, and which demonstrated the type of empathetic embodiment described by Gee (2003). Through her experiences in Quest Atlantis, Rebecca came to understand how her participation in a civic community, including virtual communities like Taiga, was impacted by her choices and was reflected in the greater global community (Bers, 2008; Shaffer, 2004). This type of participatory citizenship (Westheimer & Kahne, 2004) encouraged community engagement around social and environmental problems, in this instance, impacted the quality of a community waterway. Taiga had created an opportunity for pedagogical praxis (Shaffer, 2004) where students, like Rebecca and Keith, were able to participate in communities of practice (Lave & Wenger, 1991) that allowed them to simulate the types of civic and democratic dynamics (Dewey, 1900/1956) that created opportunities for them to both reflect (Schon, 1985, 1987) and act on social and environmental issues.

This participatory citizen perspective emerged again through the conversations with Keith. By understanding the basis of the problems through legitimate peripheral participation (Lave & Wenger, 1991) in the Taiga community, students like Keith can begin to examine the structural causes of social and environmental issues and seek solutions. The newly grasped, nuanced scientific knowledge can lead to actions rather than a exhibiting a “divorce between knowledge and action” (Dewey, 1909, 41). Keith through this response demonstrated an
understanding of how he moved from this type of participatory citizenship to a more justice oriented citizenship in the example below:

**Researcher:** So if the animals don’t have anything to eat, what would you do?

**Keith:** Well… ummm…I think I might want to get people not to make pollution…like pick up their trash…and not throw stuff in the water…and maybe not cut down so many trees so that the dirt doesn’t get in the water and that way there is oxygen for the fish to breath…and then they can all live too…

**Researcher:** So how might you do that?

**Keith:** umm…maybe we could get everybody to go down to the river and clean it up….like maybe have a school activity where we do that….or maybe ask my family to help too…

Keith’s response demonstrated participatory citizenship because it reflected a desire to make changes in his environment. However, it also indicated the beginning of a type of justice oriented citizenship because he not only identified the types of behaviors that were contributing to the environmental problem, but he suggested mechanisms for change and solutions to the problem (Westheimer & Kahne, 2004). Both Rebecca and Keith’s responses built upon the types of citizenry models that are played out with the *Quest Atlantis* environment. *Quest Atlantis* seeks to engage students within the world, through participation in the community and by proposing solutions that address major environmental issues in ways that can improve the quality of life in their communities over time. By seeing the impact that they made within the virtual environment, students began to make connections and understand how they can use these same types of skills within their own communities, fostering a new sense of ecological stewardship
and civic engagement.

**Discussion**

The underlying story of *Taiga* in *Quest Atlantis* described a society experiencing social and environmental problems. Within this context, students became part of a community of practice (Lave & Wenger, 1991) that was working to solve issues that were similar to the types of problems indigenous to our own society. Building on the Dewey’s idea of linking school and society (Dewey, 1900/1956), learning environments such as *Quest Atlantis*, allow students to use the virtual world as a tool to support learning and engagement in epistemologically meaningful projects situated in legitimate “real world” experiences. The advantage of using pedagogical-based praxis models is that the open-ended nature of the environments allow students to have multiple types of experiences within the context of the same world (Bers, 2008; Shaffer, 2004).

In *Quest Atlantis*, and in particular *Taiga*, the underlying message was that students could all work towards solving environmental problems in order to create a better society for both current and future generations. By immersing the students in a high-tech virtual play-space, they acquired not only scientific knowledge, but also an understanding of civic responsibility through their participation in a virtual democratic community (Barab et al, 2007). Through their participation in *Taiga* and its communities of practice within the Atlantan society (Lave & Wenger, 1991), students began to understand the impact of their decisions on the virtual community. They could then apply those lessons to their own communities, recognizing how they could impact local change. This process reflected the framework of Westheimer and Kahne (2004), participatory and justice-oriented citizens.

The *Taiga* missions took on these citizenry models by engaging students with the citizens of *Atlantis*, in order to solve important environmental issues (participatory) and engaged them in
proposing solutions that encouraged changes in the behavior and practices of community members. This virtual civic engagement ultimately meant that community problems (e.g. the fish dying in the rivers of Taiga) were not perpetuated, but rather eradicated over time (justice oriented). Within the virtual world structure and through the game narrative, students were able to see the impact of their decisions on the Taiga community. By participating in this type of decision making within the virtual community, students developed the needed skills including an understanding of the types of questions and action plans needed to create change within their own communities. This was evident in the interviews with Rebecca and Keith, where they not only applied the science content knowledge acquired through their play, but discussed how they could engage their own community to tackle problems of water pollution in local waterways.

Students developed a rich conceptual, perceptual and ethical understanding of the science of water quality through their participation in the narrative of Taiga. This allowed them to apply their knowledge to a real-world problem as opposed to simply acquiring scientific facts. Inquiry became the means by which the students engaged with science content and was the tool to solve the environmental problems of Taiga. This allowed for an appreciation of the underlying science content and the role that political and economic factors play in scientific decision-making (Barab et al, 2007).

Through the creation of empathetic embodiment (Gee, 2003), students came to understand the unique dynamics and complex systems that are found in within the context of Taiga, creating a mechanism for legitimate participation and an understanding of what it means to be an ecological steward within a community of practice (Lave & Wenger, 1991). Through the students’ recognition of the need for community action to protect their waterways, they demonstrated the ability to transfer the knowledge gained from their participation to their own
communities demonstrating both social responsibility and civic engagement. By creating opportunities for students to become active participants within their communities of practice (Shaffer, 2004; Lave & Wenger, 1991), *Quest Atlantis*, and other virtual worlds and games like it, build on the work of John Dewey (1900/1956; 1915), who saw the classroom as a student-centered community of learners.

The collaborative nature of *Taiga* and *Quest Atlantis* is reflective of the type of curriculum that Dewey (1900/1956) envisioned. The larger, global communities afforded by technology, allow students to view the world from broader viewpoint, accounting for a variety of perspectives and solutions to common problems. The knowledge that students construct from these interactions and the proposed solutions as represented in their interviews, demonstrated what Dewey saw as experiential learning, constructed in a social and technological context that is different from traditional epistemologies (Dewey, 1900/1956; Jenkins, 2006; Bers, 2008; Shaffer, 2004). The types of learning and development of ecological stewardship and civic engagement demonstrated by the students in this study confirmed that this type of interactive, virtual world approach could be beneficial when applied to educating students about civic engagement. Part of educating for a democratic society is making sure that students reach their full potential while contributing to the life of a democracy (Martínez Alemán, 2001). It is possible that in contemporary times, being environmentally friendly or ecological stewards, particularly with the emergence of the green movement, is valuable for ensuring a clean environment for many generations. How *Quest Atlantis* and *Taiga* addressed issues of ecological stewardship impacted how students perceived their own ecological and civic responsibilities. The students participating in *Quest Atlantis* environments not only learned about water quality and ecosystems as was demonstrated by their gains in scientific knowledge between pre- and
post-assessments, but were able to identify complex problems and phenomenon in their own local waterways suggesting mechanisms for implementing change and their development as an ecological stewards. This suggests that virtual worlds like Quest Atlantis can potentially provide inquiry experiences that allow students to engage in experiential learning (Dewey 1900/1956).

**Implications and Conclusions**

There are definite limitations of this study. The study was conducted in three classrooms in just two schools in an urban setting and focused on two students. Despite this snapshot view, this study begins to reveal the potential that this curricular instantiation can have on inquiry based scientific pedagogy and its potential to develop ecological stewardship and civic engagement for participants. While Quest Atlantis and Taiga appeared to accomplish this for the two students, as demonstrated by the interviews and the assessments, it was also clear that they could have benefitted from internal scaffolds or supports to help them take on these perspectives and guide them through probing questions. Games or virtual environments that seek to engage students in this manner will need to develop intelligent tutors which prompt students to think about the application of scientific concepts learned during game play to issues in their own communities. Virtual environments, like Quest Atlantis, allow students to “do science” in an immersive environment that encourages scientific debate and looks at the broader impacts of the scientific process within communities. Purposefully embedded scaffolds will help to bridge content with community engagement.

The goal of environments such as Quest Atlantis is for students to gain an understanding about what it means to participate in a democratic society. By allowing students to gain a sense of civic responsibilities and knowledge about what it means to be a good citizen who cares about
the world, the students begin to understand, beyond procedural aspects, what it means to be part of a larger global community. From a theoretical perspective, the pedagogical model of praxis allows one to begin to understand the relationship between activity and learning in context (Shaffer, 2004). By creating learning experiences that immerse students within legitimate science experiences, students begin to internalize scientific ways of knowing allowing them to, in turn, apply knowledge to new contexts and situations. Students participating in Quest Atlantis began to recognize their own role in being a voice for issues of the environment that impacted not only the ecosystems, but the larger world. Students acquired a clear understanding of science concepts around water quality, ecosystems and system dynamics. They were also awakened to the roles they played within their own communities and began to make a connection to how they could facilitate change as global citizens of virtual and real worlds.

References


