Citizen Science: Civic Engagement That's More Than a Game

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Due to their pedagogical structure and widespread popularity, video games are growing in popularity as powerful learning tools and viable vehicles for supporting 21st century curricula (Mayo, 2009). In an attempt to address widening achievement gaps in United States, particularly in science domains, video games have been suggested as a learning tool that can not only spark student interest in science, but also facilitate engagement and learning through interactive in-game environments (National Research Council, 2011; Gaydos & Barany, 2012). The need to improve student performance in science domains becomes all the more pressing, however, once the negative repercussions that arise from a lack of science competency are considered. A practical understanding of science topics not only provides the tools for individuals to make civic-oriented decisions in their daily lives, but also enhances a citizen's ability to participate in a democratic society (Shen, 1975).

Citizen Science is a game designed to improve students' civic science literacy. Civic science literacy is defined as sufficient science literacy so as to enable individuals who are not engaged in science as a profession to make informed civic-oriented decisions in their daily lives (Shen, 1975). Though scientific analysis is often considered an activity reserved for those in science professions, Shen instead argues that knowledge of science and technology is necessary to maintain a working democracy. The goal in developing *Citizen Science* was to create a game that improved student/player interest in science as it relates to civic participation (Gaydos & Barany, 2012).

Researchers and game developers at [OMITTED FOR BLIND REVIEW] are using video games and new media to move scientific discovery from the laboratory to the broader community. With funding from the National Science Foundation and led by games scholar and researcher [OMITTED FOR BLIND REVIEW], *Citizen Science* has been designed to support civic scientific literacy and provide a game experience that can connect virtual worlds and scientific concepts with real-world issues and local practices. *Citizen Science* is a five-year research project that incorporates research and theoretical models from University of Wisconsin-Madison limnologist Stephen Carpenter (2011 laureate of the Stockholm Water Prize) in order to address the challenges listed above. Researchers are investigating how the online game *Citizen Science* is used in localized contexts to support teaching and learning in the areas of freshwater ecology, civic engagement, and scientific thinking--the implications of which can extend far beyond test scores in the classroom.

Background Information

Citizen Science is an online flash-based computer adventure game in which the player takes on the role of a youth who becomes concerned about the health of a local lake threatened by eutrophication. Based at Lake Mendota in Madison, WI, players uncover and solve pollution problems faced by Lake Mendota with the help of a fictional lake spirit and talking muskrat. The game goal is to restore the lake to a condition more suitable for human use. *Citizen Science* encourages students to connect ecology content to civic action (Figure 1). It is designed to introduce questions like, "What can I do to change things?" and "How can planting a rain garden help the lake?" The purpose of *Citizen Science* is to help players develop a conceptual understanding of lake ecology while giving them situated experiences confronting pressing ecological issues, conducting scientific inquiry to address these issues, and taking action in the (virtual) world to affect change. By focusing on the ecological needs of Lake Mendota as well as the surrounding community, the game is able to

Figure 1. Screen shot from *Citizen Science.*

bring together real-world issues and scientific practices.

As defined in Wiggins' and McTighe's *Understanding by Design* (2005), "a big idea is a concept, theme, or issue that gives meaning and connection to discrete facts and skills." The big ideas in *Citizen Science* relate across pillars in the *Framework for K-12 Science Education* (2011), including learning goals in scientific practices, crosscutting concepts, and domain-specific core ideas. The kinds of learning activities designed to surround the game will determine the kinds of frames students can use to investigate the larger essential questions (Table 1).

Big Ideas	**Essential Questions**
• Good argumentation requires the use of evidence to support points. • Using keywords like "because" and "although" in arguments can help build a case to convince someone of something. • Convincing arguments can help people change/adjust beliefs and make different choices. • Models can show us how different variables have an impact on a system. • There are many, many ways lake health can be supported. All require resources and/or groups of people to make specific choices, from planting rain gardens to lobbying for government support.	• What is a healthy lake? • What can be done to address the issues that are present when a lake is unhealthy? • What is the link between human behavior and the environment? • How can evidence-based arguments be used to communicate with various groups about lake ecology? • Why should people care about fresh-water ecology?

Table 1. Big ideas and essential questions in *Citizen Science.*

The curricular applications of *Citizen Science* are flexible and interdisciplinary and can link to standards related to water ecology, biology, environmental studies, social studies, language arts, technology, and civic engagement. While early studies show great promise for the use of *Citizen Science* as a learning tool, they also point to the importance of creating productive interplay between in-game and out-of-game experiences (Gaydos & Squire, 2012). The research around *Citizen Science* is particularly interested in the interactions between the game, the local environment, and civic action.

Implementation

In the project's fourth year, researchers focused on case studies with teachers and classrooms that use *Citizen Science* as a launching point from which to cover a variety of content areas. Specifically, the research team was investigating the following questions regarding curricular implementation of *Citizen Science*:

1. How do teachers use *Citizen Science* in a classroom context?
2. What kinds of activities do teachers use to localize the game content?
3. What kinds of teaching/learning practices are evidenced by teachers using *Citizen Science* as a curricular tool?

The focus of this presentation is a case study with teachers from The Learning Academy, a small environmentally-focused charter elementary school in a suburban district. Four teachers participated: two second and third grade teachers, and two fourth and fifth grade teachers. Classes worked independently for some elements of the implementation, and collaborated across grade levels for other elements. The teachers created curriculum units that utilized the game, and developed expansion activities that aligned with local school learning objectives, priorities, and culture.

The *Citizen Science* team supported teacher professional development by funding substitute days so teachers could workshop with each other and with project staff to develop expansion activities and unit plans. Teachers provided the research team with access to the classroom environment for observations during both gameplay and during expansion activities. This included both onsite activities and offsite field studies with the students. Teachers

provided copies of student work samples, teacher-developed pre- and post-assessments, other teacher-created works, and digital images of student activities. In addition, researchers interviewed students in friend groups to learn how students viewed the in-game and out-of-game activities, and to investigate the ways they applied content knowledge to their practices.

Evaluation of Implementation

Observations, classroom artifacts, and interviews were evaluated according to the research questions. Key findings can be understood in light of their implementation methods, whether related to the game-play, the other interdisciplinary activities that took place in the classrooms, or through out-of-classroom field studies that applied core game content to local environmental contexts.

Figure 2. Students playing *Citizen Science.*

Game Activity

Teachers created in-game support materials like game journals (Figure 2) in which students wrote down arguments and evidence discovered, noted new vocabulary, created goals for their next game-play session, and drew an image of something they experienced in the game that day. Teachers used these materials to guide larger group discussions at strategic points as the class played the game.

Interdisciplinary Connections

Some teachers used the narrative content of the game as a catalyst to connect content in other disciplines. For example, one teacher used the narrative to construct word problems for the students in their math lessons, and students wrote their own subtraction problems based on the narrative content. Another teacher used the big ideas of arguments and evidence to have students to construct new arguments. Teachers provided teams with sets of statements, and students worked together to construct arguments that matched the statement. Students rotated through the room to change groups and bring new evidence to bear on new argument statements.

Local Applications

Students that played *Citizen Science* at The Learning Academy did local walking field studies to investigate water sources in their neighborhood as well as went on a field trip to a nearby lake, where students tested water quality, conducted human impact observations, and learned about lake issues from members of a local lake support organization. Key game vocabulary became part of the students' out-of-game experiences as well, like eutrophic, turbidity, and clarity. They also demonstrated connections to larger game concepts, like ways that community members can impact lake and organism health through their interactions with the environment.

Conclusion

Research suggests that a player's interpretation of game content is situated in that individual's experiences, knowledge, local practices, identities, and discourse models (Devane & Squire, 2008). The big ideas encountered in *Citizen Science* to connect players to content in a variety of contexts. Many students interviewed didn't see a hard distinction between the content in the game, and the surrounding activities. Concepts and practices carried over in seemingly natural ways from in-game to out-of-game experience as evidenced by student discourse, teacher reflection, and classroom artifacts. Even for students in second and third grade, students were able to talk about connecting in-game content to larger local practices and contexts. The ways that *Citizen Science* became meaningful to the actions of the students were heavily rooted in the classroom curriculum and experiences facilitated by the classroom teachers. This indicates a variety of impacts for using the game as a teaching tool. At the simplest level, teachers can use the game to introduce or reinforce content that's already part of an existing curriculum and set of learning activities. At a more deeply integrated level, *Citizen Science* can be used as a part of an interdisciplinary set of activities that become locally contextualized.

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