

## SANCTUARY: Asymmetric Interfaces for Collaborative Science Learning In Shared Space(s)

Jason Haas, Massachusetts Institute of Technology, 77 Massachusetts Ave. Cambridge, MA 02139,  
jhaas@mit.edu

**Abstract:** SANCTUARY is an interactive and participatory game that allows novices to experience approachable and collaborative exercises in 10th grade biology and math through the lens of ecological problem solving. The chief innovation is the development of asymmetric interfaces on a shared game space, providing different tools and different epistemological frames for each player on shared problems. Students can both become familiar with a way of knowing and be aware of different ways of knowing.

### Major Issues/Potential Significance

SANCTUARY is a multiplayer game designed to encourage science learning for 10th grade math and biology students, attempting to promote greater public understanding of science and interest in Science, Technology, Engineering, and Mathematics (STEM) learning. The design descends in part from Elliot Aronson's work on the Jigsaw Classroom (2011), principally in that it requires a group task to be completed by students with a group goal but with individual accountability (through specialized roles). The game is played by two co-located players on two tablet computers (iPads in this version). While both players are seeing the same simulated world, each player has a different set of tools with which to act in that world. The purpose is to elicit quality communication, arguments, coordination, and co-strategization (planning ahead for future turns) between participants. This is an advance over single-player or multiplayer learning game experiences, in which players are rarely required to verbally express and formalize their strategies during play. The project is also intended to provide a counter to a "one-size-fits-all" status quo in learning games.

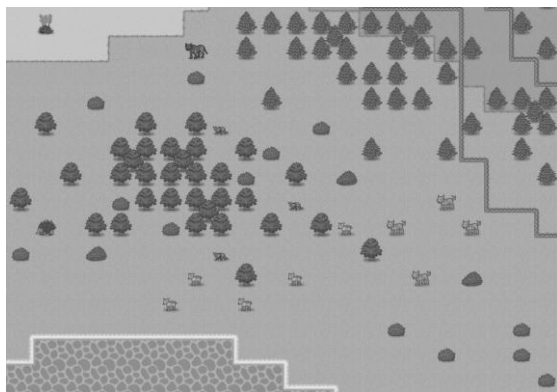


Figure 1. A remote shot of a playing field in SANCTUARY.

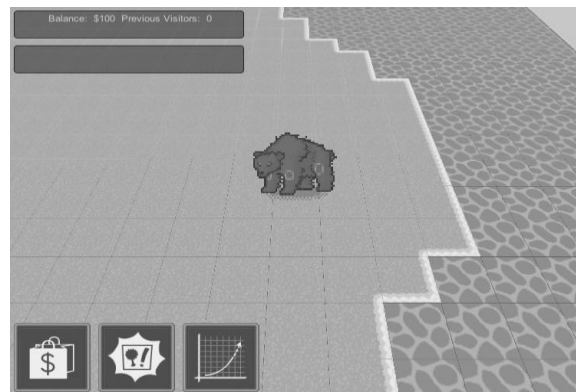


Figure 2. A look at a bear through the Mathematician's interface.

The ERIA Interactive group at the University of Wisconsin-Madison's Institute for Discovery has begun work on a very thorough simulation for environmental planning, *Trails Forward* (see Shapiro et al., 2011). The work of these groups though, is principally to help professionals and pre-professionals make careful decisions at the highest level. SANCTUARY aims to reduce the complexity to a manageable level for high school students, as well as to provide them with strictly collaborative goals. Several fantastic games for science learning for this high/middle school audience have emerged in recent years as well, such as Filament Games' *Resilient Planet* (2008) or ERIA Interactive's *Citizen Science* (2011). Single player games do not frequently allow for multiple perspectives on a play space due to insufficient budgeting or scope. Augmented Reality games and participatory simulations such as those developed by Klopfer et al. (2008) have experimented with role-based decision-making, but generally in large workshops that are hours long and require specialized technology. Finally, while this game aims to be located in the tradition of games with asymmetric interfaces, from lightly asymmetric (as in *World of Warcraft* (2004) or *Team Fortress 2* (2007)) to highly asymmetric (as in the *Artemis Bridge Simulator* (2012) or Carnegie Mellon's *Fusion* (2010)), none of these games are designed for science and mathematics learning, and it might be a considerable stretch to teach with them.

## Theoretical and Methodological Approaches

The player roles, by virtue of having a constrained set of tools, necessarily represent an epistemology and thus provide an epistemological frame (Shaffer, 2006) on the shared problem space of the game. Shaffer et al.'s (2011) Epistemic Frame Theory posits a frame that consists of the skills, identity, knowledge, values and epistemology of professional practitioners. The theory states that if students can internalize this frame, they will become practitioners in important ways. Shaffer (2006) likens epistemic frames to, "the proverbial 'hats' or 'glasses' we don as we take on a variety of identities or perspectives in dealing with different situations," saying that they, "may represent a ... tight linkage between practices and ways of knowing, but at the level of the local cultures developed by individual communities of practice." The biologist player has tools that allow him/her to perform quadrant sampling and tag and recapture studies, for instance, while the mathematician player has the ability to swap out creatures algebraically and to extrapolate future trends using statistical tools. The players must then engage in a third epistemic frame, that of the collaborative practitioners, in order to successfully complete the level together. For instance a level in the game has the goal of sustaining three wildflower species in the ecosystem despite an onslaught of predators. Players then come to understand what it is to know things as a biologist or a mathematician might, but also learn to be collaborative. This allows SANCTUARY to impact a neglected aspect of science and math education, teaching students collaborative skills, particularly problem solving *across* disciplines. The interactive nature of this game also makes it an exciting tool to share in a poster session, allowing the researcher to share this work in a hands-on fashion with fellow attendees.

## Findings, Conclusions, Implications

During the session, the results of a pilot study will be available for discussion. This study, the first phase of more involved Design Based Research (Brown, 1992; Collins, 1992; Barab & Squire, 2004) project, provides 10th grade students (or other high school students involved with the relevant coursework) with up to an hour of play experience in pairs, during which the players are observed, followed by a group interview about their experience. Special attention is paid to participants' genders and their grades in mathematics and science.

## References

- Aronson, E. & Patnoe, S. (2011). *Cooperation in the classroom: The jigsaw method*. London: Pinter & Martin.
- Barab, S. & Squire, K. (eds) (2004). *Design-based research: Clarifying the terms* [Special Issue]. *Journal of the Learning Sciences*, 13(1).
- Beck, I. L., McKeown, M. G., & Kucan, L. (2002). *Bringing words to life*. New York: The Guilford Press.
- Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of the Learning Sciences*, 2(2), 141-178.
- Collins, A. (1992). Toward a design science of education. In E. Scanlon & T.O'Shea (Eds.), *New directions in educational technology* (pp.15-22). New York:Springer-Verlag.
- Kafai, Y. B., Quintero, M., and Feldon, D., (2010). Investigating the "why" in whypox : Casual and systematic explorations of a virtual epidemic. *Games and Culture*, 5(1), 116-135.
- Klopfer, E. (2008). *Augmented learning: Research and design of mobile educational games*. Cambridge, MA: MIT Press.
- Shaffer, D. W., Hatfield, D., Svarovsky, G. N., Nash, P., Nulty, A., Bagley, E., Frank, K., Rupp, A. A., and Mislavy, R. (2011). Epistemic network analysis: a prototype for 21st-century assessment of learning. *International Journal of Learning and Media*, 1(2), 33-53.
- Shaffer, D. W. (2006). Epistemic frames for epistemic games. *Computers & Education*, 46(3), 223-234.
- Shapiro, R. B., Squire, K., and the Educational Research Integration Area (2011). *Games for participatory science*. Educational Technology.
- Squire K.D. & Jan, M. (2007). *Mad City Mystery: Developing scientific argumentation skills with a place-based augmented reality game on handheld computers*. *Journal of Science Education and Technology*, 16(1), 5-29.

## Software

- Blizzard Entertainment. (2004). *World of warcraft* [computer software]. Irvine, CA.
- ERIA Interactive. (2011). *Citizen science* [computer software]. Madison, WI. Available from [http://www.eriainteractive.com/project\\_CitizenScience\\_WebPlayer.php](http://www.eriainteractive.com/project_CitizenScience_WebPlayer.php)
- ERIA Interactive. (in development). *Trails forward* [computer software]. Madison, WI.
- Filament Games. (2008). *Resilient planet* [computer software]. Madison, WI.
- Liang, L., Lin, Y., Shan, Y., Dewhurst, S., Chang, E., & Xiao, M. (2010). *Fusion* [computer software]. Pittsburgh, PA.
- Robertson, T. (2012) *Artemis bridge simulator* [computer software]. The Internet. Available from [http://www.artemis.eochu.com/?page\\_id=35](http://www.artemis.eochu.com/?page_id=35)
- Valve Software. (2007). *Team fortress 2* [computer software]. Kirkland, WA.