

Advancing STEM Learning with Games in Civic and Cultural Institutions: A Play, Critique, and Discussion Session

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Designing Games to Advance STEM Learning

STEM (Science, Technology, Engineering, and Math) education has recently garnered much national attention. According to the National Science Board (2010), The United States lags behind its counterparts in STEM; only 16% of U.S. undergraduates declared natural sciences and engineering as their primary field of study compared to higher rates in China- 47%, South Korea- 38%, and the European Union- 25%. Science is seemingly not interesting to young people in the U.S.

Out-of-school, or informal learning is crucial for engaging youth and helps connect learning that happens in school settings to learning that occurs in other areas of their lives. In order to engage with science, youth need connection and translation between in-school and out-of-school learning through “ecologies” of learning. These ecologies can provide pathways of engagement across the spaces where young people develop (Ito, 2013). Cultural and civic institutions like the American Museum of Natural History (AMNH), The Field Museum of Natural History (FMNH), the Smithsonian Science Education Center (SSEC), and University of British Columbia comprise a handful of institutions that have contributed to creating these learning pathways through the development and implementation of innovative STEM games. Games, as part of a well-designed learning system, have an important role in advancing learning by providing deeper modes of engagement and providing a context for thinking through problems (Gee, 2008).

The members of this panel represent civic and cultural institutions using games to encourage, excite, and engage learners of all ages in STEM. Although the broad goals of STEM learning are similar across institutions, the methods, development and delivery of these games differ significantly. These diverse approaches of game development illustrate the multiple pathways available to STEM game development. This panel will explore what the driving ideas are for using and developing science games. What common themes arise? How are outcomes affected given different audiences, resources and limitations? Panelists will foster discussion with the audience and with each other on how games are being used, and how they might be used, to advance STEM learning using civic and cultural institutions as case studies.

Science Games for Learning: Play, Critique, and Discussion

Panel participants came from a range of backgrounds, including public programs in museums, game development, and research. The variety of the panelists’ experiences illustrated the different approaches to STEM game development complete with demos of playable experiences. At the start of the session, audience members were given the chance to play each institution’s games and were invited to engage in conversation with panel members and each other by sharing comments and asking questions. Questions tended to be project specific as each panel member demoed their STEM games at small stations within the room. In this first half, most of the questions asked were logistical (“*how do you play the game?*”) and pragmatic in nature (“*how can I bring this into my classroom.*”). The only problem with this format was that participants were able to hear about only one of four projects. To allow for the panel to talk more broadly, the session convened into a larger group discussion.

The discussion continued exploring themes of STEM game design, informal innovation in STEM education, and pros and cons of STEM learning in informal versus formal learning environments. The general narrative centered on where informal science education institutions fit in the broader educational landscape. In other words, since informal programs aren’t required to be directly applicable or formally tied to school systems how might this interesting dynamic play out? Another question asked touched on the idea of evaluating and measuring students’ learning in informal settings. Thought there are some possible methods of evaluation (badges, external evaluation, etc..) the bigger question was asked back to the audience, “*are there ways for informal learning institutions to collaborate in order to better evaluate and measure student learning?*”

The discussion here led to an emphasis that having less “formality” in informal programming could be thought of as both a good or bad thing. Good because it’s arguably easier for informal science education to be different, unconventional, risky, and innovative. In a way, there is less at stake when compared to designing learning

experiences for direct inclusion into school curriculum. A comment was made in the panel that science museums might be the perfect place to try out these sorts of initiatives where engagement via artistic work and new media are being explored. On the other hand, one way to look at informal science education is to see it at a disadvantage. Because this informality doesn't fit as nicely in the usual science education grant/funding culture (though it was brought up that the NSF has been good at having a go here) - discussion here led to the fact that this potential innovativeness is tricky. Determining the metrics to rigorously measure effectiveness is justifiably more challenging.

Overall, the organizations represented in this panel (and beyond), because of the special place in the culture of education represent a great collaborative opportunity. Logistically and strategically, informal learning spaces are a great place for the gaming academic and the education academic communities to pilot or baby step into new and innovative projects.

Games that were available for play were *Phylo the Trading Card Game* (University of British Columbia), *Pterosaur: The Card Game* (AMNH), *Shutterbugs: Wiggle and Stomp* (SSEC), and youth-designed ARIS games on soil science (FMNH). Following are descriptions of panel participants' games:

Phylo: The Trading Card Game (<http://www.phylogame.org>) is a crowdsourced game that is inspired by the premise "...children know more about Pokemon, than they do about the plants and animals in their neighborhood." (Balmford, A., *Science*. 2002, 295, pp2367). Since 2010, the project has built itself from the incremental contributions of thousands of individuals with different backgrounds; most notably those in the disciplines of life science research, graphic design, education, game development, computer programming, museum outreach, and intellectual property law. Currently, this has manifested itself as an online hub where moderated cards/decks and DIY cards/decks can be selected and printed; as well as a growing collection of "physically" purchasable decks, often sold in a revenue neutral (or outreach fundraising) manner, and generally hosted by an organization with a vested interest in biodiversity outreach. The core game mechanic is essentially an ecosystem building game, where players compete by building and modifying trophic (food chain) networks using playable decks of cards.

Pterosaurs: The Card Game. #scienceFTW was a 20-session after school program held at AMNH which used card games to teach high school students about science and prepare them to co-develop their own science learning game based on assets produced for a recent exhibition on pterosaurs. Using the open nature of an existing game, *Phylo*, the youth modded the core mechanics of *Phylo* for use during the Mesozoic period. The youth selected which pterosaurs to use in the game, designed the color scheme, created new cards with new features, selected the text for the cards, playtested to achieve a good game play balance, and created spreadsheets to ensure all of the cards worked and had the right values. By the end of the program, professional cards were developed for each youth to take home. A few months later, they were made available for free download for educators at amnh.org/pterosaursgame, for sale in the Museum store, and for sale online at shop.amnh.org.

Shutterbugs: Wiggle and Stomp (<http://www.ssec.si.edu/games/shutterbugs-wiggle-and-stomp>) is a free game aimed at children ages 3-7 available on the web, iPad, and Android devices. Smithsonian Science Education Center has been developing research-based science education curriculum for over 25 years. In 2013, SSEC added kindergarten to its standard-aligned curricular offering. *Shutterbugs* was designed to co-launch with the new kindergarten curriculum. Several goals and questions went into designing the game. First, SSEC sought to fulfill the goal of "broadening access" to Smithsonian collections and exhibits. In other words, how can SSEC, itself not a museum with its own collections, make the treasures of Smithsonian accessible to children across the globe? Secondly, how might a game accommodate the wide range of learning needs and abilities found in children at the kindergarten age. Finally, How can science concepts be introduced to kindergarten classrooms, where science teaching isn't always a priority? Careful user testing and agile design and development methods yielded an October 2013 launch that has since been featured in the iTunes education store and has won praise from teachers and parents alike.

Mobile Game Design with ARIS: This one-week pilot experience was meant to facilitate STEM learning for middle school youth through game design. Youth, ages 12-14, were tasked with creating ARIS games that translate soil science. A combination of game-like learning methodology, The Field Museum's integrative research approach, and professional game designers were used in this summer camp. The workshop started with modding ancient games found in the museum's collections. Youth were put in the shoes of an archaeologist, given information about the cultural context of these games and asked to make an educated guess on how they thought the game might be played. This taught the students about game theory and prepared them to work with game design experts to understand, analyze and share key scientific concepts through an ARIS game. Program participants worked in teams to produce mobile games that were played by museum staff, family and friends at the conclusion of the

program. These youth-designed ARIS games were also posted onto The Field Museum web pages (<http://www.fieldmuseum.org/schools/mobile-planet-2013-0>) and are publically available for play through the ARIS platform.

References

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