Evaluating STEM Games For Young Audiences: A Hands-On Workshop

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Abstract: Games and interactive media environments have been identified as promising tools for supporting STEM. This workshop includes facilitated guided play sessions through a curated group of games (mobile, web, and console), allowing participants to explore key aspects of games that teach a STEM mindset, including cooperation, trial and error, holistic thinking, and data visualization. Moderators will first present the challenges and opportunities supporting a STEM mindset through games, then model a playthrough of a selected game embodying key features. Participants will then be able to explore games on their own and with moderators before gathering again as a group to discuss their findings, where moderators will situate the discussion in the larger issues of STEM product design, implementation, and research.

Playful STEM Development

Games and interactive media environments have been identified as promising tools for supporting STEM (science, technology, engineering, and math) readiness and education, from the youngest of players to high-performing professionals and academics. A STEM educated child embodies the following attributes: problem-solver, innovator, self-reliant, logical thinker, and technologically literate (Morrison, 2006; Fisher, Bryant, Akerman, and Fischer, 2010).

Sometimes fostering a STEM mindset is as simple as giving a child the space to wonder, and the tools and encouragement to try out ideas. For example, Figure 1 illustrates the creation of a 4-year-old who was engaged in the world and play of *Angry Birds*. He created his own angry birds, and with the assistance of a giftwrap ribbon for the slingshot and strategic placement of toys and furniture around the room, he began to create his own "levels" and attempt to model the system he had participated with in the game.

***Figure 1*: Exploring with Angry Birds: A Kid Creation.**

Researchers from The Education Arcade at MIT propose that in any academic discipline, there are elements that are inherently game-like. This would include the sorts of questions that professionals and practitioners mull over, leading to "a-ha" moments (Klopfer, Osterweil, & Salen, 2009). According to the researchers, "for scientists it might mean constructing models of phenomena based on incomplete evidence, and then testing them (p.32)." The description of the STEM educated child aligns directly to the skills and behaviors applied by practitioners in STEM fields. By capturing the game-like experiences of experimenting, modeling, and discovering, games become tools for the STEM process that underlies content.

Children construct meaning not simply through the cultural and system representations that manifest in play, but by the process of play itself. And by asking how the world invites and even requires 'activity' on the part of the user, designers and producers can generate new worlds and environments that enable rich play and learning experiences. This should be applied not just to specific products and platforms (digital and analog games, interactive spaces, movies and storylines, etc.), but to the entire suite of products and platforms that make up a narrative world, and designed in such a way that deep exploration, user participation and activity, and creative boundary pushing of narrative world borders are not only allowed, but encouraged. Through these practices, deeper learning can take place. Thus, the experience of play in and of itself is at the heart of STEM educational experiences.

STEM Skills in Focus

With so many products proliferating the market, particularly those claiming to have educational merit, how can developers, educators, and researchers evaluate existing products to identify critical elements of STEM play? Beyond this, how can researchers and developers understand media needs, trends, and opportunities in order to further develop STEM supportive products and platforms? This workshop proposes to begin to address that need by equipping educators, academics, and developers alike to critically think about game spaces through a STEM skills focus framework.

The specific STEM skills (as discussed in Fisher et al (2010)) that this workshop will focus on are:

- *Cooperation*, sharing of and listening to ideas and providing constructive criticism. Operating in a scientific world means to be part of the community of scientists, particularly as a member of a team. To do this successfully, one must have cooperative social skills such as listening, turn-taking, and honoring each others observations.
- *Trial and error* (finding multiple solutions): Practicing trial and error means moving away from a process-oriented pedagogy and toward one in which the child explores different pathways to an answer. In doing so, the learner experiences a key part of the innovation process – failure – and that failure can lead to the right answer.
- *Fostering holistic, systems thinking*: Exploring the world as a series of interrelated parts is another key skill. Simulations are a key part of this skill, particularly when the child can manipulate the parts of the simulation to understand the role of the variables in the overall system.
- *Collecting and visualizing data*: While the goal is straightforward, we'll look at games that are unusual in their ability to visualize data, not just about flipping a coin repeatedly and seeing the results in a histogram.

Workshop Format

The workshop leaders come from different areas of educational development, implementation and research. Drawing from their experiences, each workshop leader will facilitate guided play experiences with groups of workshop participants. The first phase of the workshop will consist of facilitators presenting challenges and opportunities around supporting STEM mindsets through games and interactive environments. Facilitators will then model a critical playthrough of a selected game that embodies STEM mindset practices in some way. Participants will be given tools with which to learn to evaluate games and interactive media for STEM practices. Following the demonstration playthrough, workshop participants will split into three groups: mobile, console, and PC. Facilitators will provide guidance as participants do critical plays of other games and interactive media. The final phase of the workshop will be to regroup and discuss findings from the playthroughs, specifically noting trends and opportunities, and applying findings to broader issues of STEM product design, implementation, and research.

Workshop participants will complete the session having had the opportunity to play with STEM supportive products and evaluate them using the *STEM Skills in Focus Framework* described above.

Example STEM Games and Interactive Spaces for Participant Evaluation

Workshop facilitators will use games and media environments like those listed below in Table 1 to shape the play experience of session participants. This list is not exhaustive, but provides a foundation for understanding the variance in production quality and market prevalence of the products that will be evaluated by the workshop participants.

Product Title	Producer	Platform	Description	Media
World of Goo	2D Boy	iOS, PC, Wii, Android	Physics-based puzzle game in which players build structures using balls of goo to reach a target. Information at http://www.worldofgoo.com/	Game
New Super Mario Brothers Wii	Nintendo	Nintendo Wii	Platformer multiplayer game that requires scaffolding and modeling for achieving goals. Information at http://mariobroswii.com/	Game
Little Big Planet, Little Big Planet 2	Sony Entertainment, Media Molecule	PSP, PS3	Play, create, and share game levels. Information at http://www.littlebigplanet.com/en/	Game
The Hidden Park	Bulpadok	iPhone	An augmented reality game that brings magical creatures into your local park. Information at http://www.thehiddenpark.com/	Game
PlaceSpotting	Martin Fussen	Internet	A Google map quiz. Available at http://placespotting.com	Game
Teletubbies	PBS Kids	Internet	Available at http://pbskids.org/teletubbies/teletubbyland.html	Game
Minecraft	Mojang	Internet	Open-ended world building game. Available at http://www.minecraft.net/	Game
Portal & Portal2	Valve	PC, Xbox	A first-person physics-based puzzle game. Information at http://www.thinkwithportals.com/	Game
The Incredible Machine	Disney	iOS	Solve puzzles by building engineered contraptions to accomplish objectives. Information at http://itunes.apple.com/us/app/the-incredible-machine/id440297659?mt=8	Game
Scribblenauts, Super Scribblenauts, Scribblenauts Remix	WB Games	Nintendo DS, iPad	An emergent puzzle action game in which players creatively solve challenges using nouns and adjectives. Information at http://games.kidswb.com/official-site/scribblenauts/	Game
Angry Birds	Rovio	iOS, Android, Internet, Other	A physics-based strategy game in which players use a catapult to launch birds and demolish targets. Information available at http://www.rovio.com/en/our-work/games/view/1/angry-birds	Game
LEGO Junkbot	LEGO	Internet	A platform puzzle game that uses LEGO pieces to reach the garbage. Available at http://tinyurl.com/ms3s	Game
Goldwalker	Humana, Inc.	iOS	Augmented reality adventure strategy game. Available at	Game

			http://itunes.apple.com/us/app/goldwalker/id372683234?mt=8	
Rock, Paper, Scissors vs. Computer	Created by Gabriel Dance and Tom Jackson	Online	A crowdsourced game that analyzes player input to make decisions on patterns of play. Excellent for visualizing artificial intelligence reasoning. From the NY Times, Available at http://tinyurl.com/4tf3oct	Game
Eyeballing Game	Woodgears.ca	Online	A geometry-based estimation game with visualization of player performance data. Available at http://woodgears.ca/eyeball/index.html	Game
Meanwhile	Written by Jason Shiga	iOS	Originally a book and now an app, based on Scott McCloud's principle of the infinite canvas. Information at http://zarfhome.com/meanwhile/	Interactive Boook/App
Little Big Planet Level Builder	Sony Entertainment, Media Molecule	PS3, PSP	Built in to the game, the level creator allows players to customize levels and challenges, and share with other players in the Little Big Planet Community. Information at http://www.littlebigplanet.com/en/community/	Game Creation Tool
Scribblenauts Level Editor	WB Games	DS, iOS	A visually supported modding tool for previously created Scribblenaut levels. Information at http://www.scribblenautsguide.com/page/Scribblenauts+Level+Editor	Game Creation Tool
Inform 7	Inform	Online	Interactive Fiction game creator. Available at http://inform7.com/	Interactive Fiction Creation Tool
Scratch	MIT Media Lab	Online	Visual programming tool and creation sharing community. Available at http://scratch.mit.org	Game Creation Tool

***Table 1*: Example STEM Games and Interactive Spaces.**

Workshop Leaders

The workshop leaders come from different areas of media design, implementation, and research.

Carla Engelbrecht Fisher

The founder of No Crusts Interactive, Carla Fisher is a game designer with a research obsession. Having spent more than a decade making children's digital goods, she's produced, researched, and consulted on a wide variety of commercial and educational products, from Web to mobile to console, including the Nintendo Wii and DS as well as the Xbox 360 Kinect. Before starting No Crusts Interactive, she worked for Sesame Workshop, PBS KIDS, and Highlights for Children. Carla is a published author as well as a recent PhD graduate of Teachers College, Columbia University, where she studies technology and its relationship with human cognition and development, particularly as it applies to children and games. She defended her dissertation, entitled "Adolescents, Video Games, and the Displacement Effect" in February 2012. Carla holds a master's degree in media studies from the New School University and has, on occasion, been known to twist balloon animals and hats.

Meagan K. Rothschild

Meagan Rothschild is a PhD candidate, Instructional Designer and Educational Programs consultant in Madison, Wisconsin. She currently works with the Morgridge Institute for Research in the Educational Research Integration Area, which specializes in designing and researching interactive digital media and systems for learning. Prior joining the Games, Learning, and Society group at UW-

Madison, Meagan served as the Instructional Designer for Cosmos Chaos!, a video game designed to support struggling fourth grade readers developed by Pacific Resources for Education and Learning (PREL). Her experience at PREL also included the design of a violence and substance abuse prevention curriculum for Native Hawaiian students, using an interdisciplinary approach that merged health and language arts content standards to support literacy-driven prevention activities. Meagan has six years of experience in the Hawaii Department of Education system. Meagan has a BA and MEd from the University of Hawaii at Manoa, with undergraduate studies in Hawaiian Language and special education, and a post graduate degree in Educational Technology. As a PhD student, her work now focuses on planning and developing multimedia environments that merge research-based educational principles with gaming strategies to engage learners.

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