Blazing New Ground in Informal Education: Integrating Mobile Augmented Reality Games in Unlikely Places

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Abstract: Informal learning institutions are seeking new ways to integrate mobile technologies which offer visitors unique educational experiences. One way to do this is with augmented reality (AR) software, which allows players to use location-aware smartphones to play games featuring a digital overlay within a real-world context. AR experiences can highlight and contextualize ideas, while personalizing the visitor experience. This panel discussion features three distinct informal learning institutions (a wildlife sanctuary/working farm, a living history museum, and a botanical garden) each of whom recently developed and piloted its own AR game using TaleBlazer (an augmented reality authoring toolkit for iOS and Android smartphones). The panel session will include a brief overview of TaleBlazer, case studies of the pilot projects developed by each institution, and dialogue between panelists and the audience on the unique challenges of integrating AR in unlikely informal learning places.

Background:

Over the last decade, as mobile technologies have proliferated the consumer market, their ubiquity has begun to offer "just in time" educational possibilities previously unavailable to the general public. Visitors to informal learning institutions, pursuing spontaneous autonomous threads at their own pace and from their own unique perspectives, can use smartphones to access information about a given topic (object or place), contextualize and "curate" objects within broader themes, and individualize their experiences based on personal interests. Data from 2012 suggests that 45% of adults (Rainie, 2012) and 31% of 14-17 year-olds (Lenhart, 2012) now own smartphones, a trend spurring institutions to develop digital materials which capitalize on BYOD opportunities to offer individualized interactive experiences for their visitors. For informal learning environments, especially those whose experiences are highly immersive and generally "low-tech" by their very nature, the challenge arises in integrating the benefits of technology in a pedagogically and contextually sensitive way. This panel will explore the challenges and opportunities faced by three relatively "low-tech" informal learning institutions seeking to offer a particular BYOD approach, specifically augmented reality (AR) software, into their visitor experience.

Panel participants include:

1. MIT Scheller Teacher Education Program: a research lab developing and researching Augmented Reality software platform. *(moderator)*

2. Old Sturbridge Village: a living history museum recreating life in rural New England between 1790-1830.

3. Drumlin Farm Wildlife Sanctuary: a working farm and wildlife sanctuary promoting an awareness of the interdependence of people, land, and wildlife through environmental education, stewardship of regionally significant habitat, and sustainable agricultural practices.

4. Missouri Botanical Garden: a center for botanical research and science education in St. Louis, Missouri.

The panel session will be structured to give the audience a window on the work being conducted at each site as well as the opportunity to participate in a discussion of broader themes of augmented reality and informal learning. The session will be structured as follows:

- introduction to AR (generally) and TaleBlazer software *(5 minutes)*
- each institution's brief case study of an AR implementation pilot project, and its challenges *(10 minutes per institution, total 30 minutes)*
- questions from moderator for panelists *(10 minutes)*
- questions from audience for panelists *(15 minutes)*

TaleBlazer Software and Prior Research

Augmented reality (AR) provides users with a digital layer of information within an existing real-world context. As players move around the real world, their location-aware smartphones trigger interactions with virtual characters, objects and data. AR games often utilize a narrative structure to contextualize content, and can allow players to take on "roles" to jigsaw information among players and support positive interdependence (Klopfer, 2008). Augmented reality games are not domain-specific, and cover subjects as diverse as the American Revolution (Shrier, 2005), the illegal wildlife trade (Perry & Nellis, 2012), and political protests on college campuses in 1960s (Squire, et al., 2007)

A small number of AR toolkits exist which allow designers to create or modify their own AR games. Players can then download game files to their mobile devices to play location-based AR games in real-world locations. In this growing space, software including 7Scenes, ARIS and FreshAiR allow non-programmers to create (and play) their own location-based AR experiences. For the past decade, MIT has been among those both developing AR games and its own AR authoring toolkits, as well as conducting research evaluating best practices and seeking to understand the affordances and limitations of this evolving technology within an educational context.

The newest version of MIT's software, TaleBlazer, diverges from previous software and others in this space with its use of a blocks-based programming language (cf. similar approaches in Scratch or StarLogo). The blocks-based scripting language provides AR game designers with a high degree of flexibility with which to embed models and complex game mechanics into their games. The goal is to enable the design of rich, dynamic games which (1) allow *authors* to craft experiences which closely align with the pedagogical goals of the institutions and (2) allow *players* to participate meaningfully within the games, taking actions and then seeing how their choices influence the game.

The efforts described by panelists extend closely related prior work in this field. Earlier research done in collaboration with the Missouri Botanical Garden demonstrates that students were able to make and play AR games in a semi-structured out-of-school settings. Research done in collaboration with the Columbus Zoo & Aquarium also demonstrated that youth who played educational AR games as part of a field trip shifted their views on issues (e.g., global climate change) as a result of playing an AR game compared to a comparable control group (Perry & Nellis, 2012). However, little research to date has evaluated the impact of AR games offered to "casual visitors" at informal learning institutions. In what ways can AR games impact visitors to informal learning environments? How do AR games differ among audiences of different ages (young children, teens, and adults)? How do visitors experience AR games within an "unexpected" context of a nature center, botanical garden, historical village, etc.?

AR Pilot Research Projects

In Fall 2012, MIT partnered with two institutions with long traditions of location-based informal learning. The goals of this collaboration were close partnerships to develop and pilot games for new locations, new audiences, and new approaches to utilizing the scripting capabilities of the software. In addition to this pilot work, MIT and the Missouri Botanical Garden also embarked on a new NSF grant, iCSI (informal community science investigators), aimed at engaging youth/families in AR games (and youth in AR game creation) at informal science institutions to promote public understanding of science, the role of informal learning institutions, and interest in STEM.

In designing AR games to engage visitors, each of these informal learning institutions faced a number of challenging questions, ranging from the most basic (What is the game about? Who is the target audience?) to the logistical (What real-world locations, animals, plants, objects or people will be part of the game? How long is the game? How large of a physical space does the game utilize?) to the more nuanced (How does a digital mobile game fit within the existing context of the institution? What style of game makes sense? What are the risks of using this game and how can they be best anticipated?).

The pilot institutions within this panel also share an interesting challenge in that each relatively "low tech" in two ways: (1) the presence of digital technologies onsite as part of the visitor experience is generally minimal and (2) the use of digital technologies among visitors is generally not *expected by visitors*. *So how do these institutions go about addressing these challenges and creating an AR game? What did they learn from piloting games? What aspects of the games worked well and conversely, what problems arose and how were they addressed? How were institutions able to observe what impact, if any, AR gameplay had on visitors' experiences? What were the benefits or costs for players? How did institutions leverage their existing real-world affordances in their AR games?*

Each of the three participating institutions will provide an overview of their AR experiences:

Dollars and Sense at Old Sturbridge Village

Old Sturbridge Village is one of the country's oldest and largest living history museums, depicting early New England life from 1790-1840 with historians in costume, antique buildings, water-powered mills, and a working farm. Visitors can view antiques, meet heritage breed animals, and enjoy hands-on crafts.

This AR project seeks to extend our mission statement which emphasizes the personal exploration of history. Making connections between the past and the 21st century world is vital to keeping our audience engaged. Our goal in creating an AR experience with TaleBlazer was to provide a fun, interactive experience with history for visiting high school students. We are focusing on high school students studying US History because it addresses a curriculum framework requirement that fits well into the historical period we portray ((1)Mass, USI.27). Furthermore, students of this age can reason abstractly, and understand that decisions that are neither "good" nor "bad" can influence outcomes and lead to various results. This game is based upon that fact. We also have observed that our high school audience often seems preoccupied with their smartphones while touring the museum, so it is hoped this game takes advantage of that interest to educate them while playing a game. This pilot will evaluate how TaleBlazer may enhance visitors' experience of our unique environment and well-trained historical interpreters, and provide the students with an enjoyable and educational experience.

The game *Dollars and Sense* starts the player off as the Freeman Farm Family (the farm family was basic unit of 19th century New England life). As the player goes through the game the choices made will either lead their family to succeed or fail. Using both the in-game prompts as well as the museum's resources (costumed interpreters, signage, etc.) the player will make decisions to wade through 19th century life. Players will be introduced to 19th century modes transportation, market economy, division of labor, farm animals, trades men & women and a host of other characters.

Superhero Scientists at Drumlin Farm Wildlife Sanctuary

Mass Audubon's Drumlin Farm Wildlife Sanctuary is a flagship sanctuary, containing 232 acres of fields, forests, and ponds, and it is the only facility of its kind in Lincoln, Massachusetts. The property also features a sustainable working farm with crops and livestock, and a display of wildlife native to New England. Major programs include on-site environmental education and interpretation for general visitors and groups of all ages, an ACA-accredited day camp, a licensed nature- and farm-based preschool, outreach programs for schools and groups, and a community supported agriculture program and farm stand for the public. Drumlin Farm's educational mission reaches nearly 100,000 farm visitors and over 60,000 onsite and outreach program participants each year.

Superhero Scientists was developed to offer an engaging experience to young school age children grades 2-4 (with ability to extend to grades 1-5 with adult support) visiting the farm accompanied by adult caregivers. While families with preschool age children typically are content to walk the main "farmyard loop" trail to see the animals, those with older children (who are often repeat visitors) often ask, "What else can we do while we're here?" Providing an AR based game for visitors to download when they arrive is intended to spark their interest in exploring new parts of the sanctuary beyond the main loop (by guiding them to the "wilder" parts of the property over the course of the game). Equally importantly, it is an opportunity to engage them in a deeper virtual conversation about ecology, sustainability and conservation without requiring the presence of a staff educator.

Our target age group of grades 2-4 was selected to focus on the developmental level where basic scientific concepts of data collection, measurement, and maps and the ability to understand interrelationships within environmental systems (habitats, food webs, life cycles, etc.) are beginning to be established. Gearing the game towards family groups allows us to focus the game towards the reading ability of upper elementary age children, knowing that an adult will be present to help emerging readers decode the text and navigate the game interface.

Superpower Scientists puts the child in the role of scientists who are approached by different animals to complete a series of challenges. Each challenge takes the players on a journey around the sanctuary to make observations, assess different indicators, and respond to questions. For example, in the introductory challenge, a red fox who is visiting Drumlin Farm for the first time asks the scientists for help in finding a habitat. As players visit different hotspots on the sanctuary map, they are instructed to observe the environmental conditions around them and decide which habitat element (food, water, or shelter) the fox might find in that location. Points are awarded for each answer, with information provided to educate the players on both correct and incorrect choices. Completing the challenge brings the players to the site of Drumlin Farm's red fox display where they can observe live foxes up close and receive a "superpower" of virtual fox hearing (i.e., the ability to hear auditory clues in the game). This "superpower", which is a unique adaptation of foxes, can be used to assist them in subsequent challenges.

Our goals for the project include:

- Fostering awareness of the connections between people, land, and wildlife in a fun and engaging way (learning without noticing that you are learning)
- Bringing a new dimension to our existing exhibits by incorporating the information presented in interpretive signage in the game, as well as our natural resources (natural features and habitats, resident wildlife/livestock, and farming operations)
- Exploring innovative methods to leverage technology in environmental education in ways that literally augment the learning experience without distracting from or competing with the natural surroundings
- Increasing the number of people that visit the more remote parts of the sanctuary
- Promoting repeat visitation (as players want to return to play more challenges and earn more superpowers)

Missouri Botanical Garden

The Missouri Botanical Garden and MIT have collaborated since 2007 on several AR-related projects. Initial work in the partnership was funded by a pair of NSF grants focusing on teacher-led afterschool projects linking upper-elementary and middle school kids with their local community. Examples of projects supported included local watershed initiatives, response to tornado strikes, and access to healthy food in the community. For each, the AR was intended to be one component of a larger project. For example, the watershed AR game was a "kick-off" event that raised important environmental considerations that helped guide ongoing stream monitoring efforts. The tornado project linked to GIS mapping projects that let students use breaking data for a tornado that struck their community the week before. The Garden has also developed games for use in school programs, such as a "Who Rules the Forest" investigation which guides students to meet different woodland creatures, with a goal of determining which is the most important part of the food chain. Along with this educational work, MIT and the Missouri Botanical Garden collaborated on iterative development of the underlying AR software. TaleBlazer represents a third iteration, developed in response to the needs and challenges faced by program participants.

As an informal science institution, the Garden sees AR as an opportunity to advance its mission to promote personal commitment to the environment as well as interest and engagement with science. To guide program planning in this regard, they have adapted Shields (2011) characterization of four dimensions of character education, approaching each from a science perspective:

1. *Moral character* generally refers to how people interact with each other. Issues of kindness, consideration, and empathy are key here. What does it mean to be a good person, and to see the value in others?
2. *Civic character* moves past the individual to describe ways in which people show their commitment to their community: Are they committed to improving the quality of life for themselves and others? Are they seeking to improve the local environment?
3. *Performance character* describes how people approach tasks: Do they work hard and persevere in their efforts? Are they focused on doing their best, or just getting by?
4. *Intellectual character* describes ways in which people approach information and ideas: Do they keep an open mind and weigh evidence? Are they willing to reconsider previously held beliefs in light of new information?

Each of these dimensions of character is supported in the game designs themselves and in the supporting program offerings. For example, performance character is promoted both by providing a challenging game environment and by supporting student persistence as they develop, debug, and refine their game designs.

Looking ahead, Missouri Botanical Garden will be deploying games developed with TaleBlazer to engage a "free choice" audience of tweenagers and parents. Games will be designed to link families to the Garden's extensive botanical research efforts in an engaging and kid-friendly manner. For example, imagine a family visiting the Garden on a Saturday morning. Typically a pre-teen kid will not find this an inherently motivating experience. However, by downloading an adventure app into a smartphone, the Garden grounds become a game space searching for an endangered species or perhaps plants used for food. By linking clues on the smartphone with

direct observation of relevant plants, the value of the Garden's otherwise static and unengaging exhibits is magnified. In an effort to expand engagement, the Garden is also partnering with other local nature attractions such as CityGarden and Forest Park to provide complementary game spaces. Throughout, research focuses on sustaining engagement and motivation toward virtuous behavior: Does a game motivate real-world action?

Moderator Questions

Questions will be drawn from the following (along with those that emerge during the session):

- Each of you work in predominantly "low-tech" atmospheres. What challenges do you face when integrating technology-based AR games into a "natural" or "historical" immersive setting?
- Participants visiting your locations have rich experiences simply by "being there." In what ways do you try to leverage the AR game experience to enhance visitor experiences? Are there potential pitfalls that you see? How do you try to address these?
- How do you envision and measure a successful implementation of AR?
- What was the most challenging aspect of incorporating Augmented Reality into your institution?
- How does AR engage your audience differently from other offerings?
- How does having visitors who are interfacing with technology impact the experiences of other visitors?

Endnotes

(1) Massachusetts State Frameworks specifically addressed include USI.27 Explain the importance of the Transportation Revolution of the 19th century (the building of canals, roads, bridges, turnpikes, steamboats, and railroads), including the stimulus it provided to the growth of a market economy. (H, E)

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