TaleBlazer: designing location-based augmented reality games for education

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Abstract  
In this position paper we describe the work the MIT-STEP lab has done around location-based augmented reality (LBAR) games for education. We have designed LBAR games to teach science topics and skills, and we have developed a platform to enable students and teachers to design and build their own local LBAR games. As we move on to the next generation of this tool, we lay out a number of questions whose answers will be key to successfully integrating LBAR games into educational experiences.

Keywords  
Education, mobile, games, location-based, augmented reality, science, teachers, students

ACM Classification Keywords  
K.8 [Personal Computing]: Games  
K.3.1 [Computer Uses in Education]: Collaborative Learning  
D.1.7 Visual Programming

General Terms  
Educational technology, mobile games, location-based augmented reality
Introduction
At the Scheller Teacher Education Program (STEP) lab at MIT, we have been designing and testing new technologies for use in formal and informal education for more than 10 years, and among these technologies have been mobile games and simulations for learning. Mobile games are especially suited to contribute to education thanks to their social, contextual, and ubiquitous qualities [1]. The lab has built both location-based mobile games for learning and also tools for others to author location-based augmented reality (LBAR) games, with much of our recent work focusing on teachers and students designing their own LBAR games.

Background
The first of STEP’s LBAR games, Environmental Detectives, was an outdoor game in which players using GPS-guided handheld devices tried to uncover the source of a toxic spill by interviewing virtual characters, conducting large scale simulated environmental measurements, and analyzing data. Research on this and other similar games has shown that this mode of learning can successfully engage students from a variety of grade levels [3]. Situating the game in a relevant physical location while providing additional scientific and narrative information via the handheld allows students playing the game to take on the role of a scientist solving a real world problem. It engages students in an authentic community of practice of scientific investigation [7], albeit with both virtual and real co-investigators.

Later work centered on designing and building a platform called MITAR that enabled non-programmers – including teachers and students – to design and implement their own LBAR games. The desktop software let users select a map of their game’s real-world location, and then place virtual objects and characters around the map in order to tell a story or present a challenge. Such games could then be downloaded onto a GPS-enabled smartphone so that players could walk through the real-world context for the scenario, while encountering additional pieces of information and NPCs at relevant points. This type of “lightly augmented” mixed reality game immerses people in the real world, encouraging them to notice things about their environment they may not ordinarily pay attention to, and engaging them with real issues in their community, which are important facets of place-based and community-based education [6].

One implementation of the MITAR platform was a middle school after-school program called Community Science Investigators (http://education.mit.edu/projects/csi-community-science-investigators). Teachers facilitated groups of students to research science issues in their community that the groups determined they were interested in – from recycling to invasive plant species. Students designed and built AR games to educate members of their community about the chosen issue, and they completed service-learning projects that took steps toward solving the problems. Early observations and teacher feedback suggests that students were engaged in the projects because they chose issues that they were interested in and were relevant to their everyday lives, while creating AR games empowered them to share their interests with the rest of the community in a fun and innovative way, all hallmarks of place- and community-based education. Students also got the benefit of designing games [2], learning the science
content in a deeper way than they might have otherwise and practicing skills such as complex communication and contextual writing.

TaleBlazer
After studying the various ways in which students can benefit from both playing and designing LBAR games, we wanted the next version of the platform to let users create richer, more interactive augmented experiences. Our new software, TaleBlazer, which is in development, takes advantage of our learning from previous LBAR software. The game creation software component is browser-based and requires no installation, to make it more accessible and easier to use in schools. It also features a more robust set of tools that enable more creative LBAR games. Two of the most important new features for building mixed reality games are programmable simulations and multiplayer capability.

Based on our lab’s and others’ work in educational simulations (http://education.mit.edu/projects/starlogo-tng) and blocks-based programming [4], there is significant value in incorporating simulations into AR games. TaleBlazer incorporates blocks-based programming to allow users to write scripts that determine how objects and characters behave, while remaining simple enough for new programmers. This functionality allows game designers to create a dynamic layer on top of a real world location – agents can move and change state according to designated rules, and interact with other agents and even players. For instance, a student in a biology class could design an ecosystem including various species of plants and animals, program the relationships of these flora and fauna using scripting blocks, and lay out the ecosystem around their school’s building and playing fields. Players would then be able to explore realistic systems that bring the science content to life, at the same time interacting with the narrative in a meaningful way, participating in a deeper, more immersive mixed reality world.

Also as a result of much of our games research, we have seen the value of player interaction, both competitive and cooperative, which previously was difficult to implement in our single player AR games. Now that smartphones with Internet connectivity are more common, games created using TaleBlazer will take advantage of this connectivity to let players interact with and act upon a shared game world. As you walk around the real world, you can pick up and put down a virtual object in a new location, and other players will see the object in its new place. For example, if one player plants a virtual tree, or convinces 5 friends to plant virtual trees, that will affect the simulated ecosystem in the game, possibly pushing out other plants or providing homes for a new species of bird. This in turn will affect the gameplay for everyone, and may alter the outcome of the game’s narrative. Providing opportunities for players to work together, or against each other, in interesting ways makes both the play experience and the design experience more demanding and engaging [5].

Research Questions
Though we have begun research on the use of augmented reality games in education, the landscape is constantly changing as we develop new technologies and teachers and students embrace more varied modes of learning. These are some of the questions we hope to explore in our own future research, as well as collaboratively with others exploring this space:
1. **What tools do game creators need or want to create AR games for learning?** We are currently adding features to TaleBlazer that have proven useful in other types of activities, and we plan to study the affordances they bring. Taking this one step further, once students are familiar with the genre of AR games, what tools or functionality would be customizable enough to enable them to create any AR game they could imagine?

2. **How do youth learn content differently through mixed reality games?** We have seen that simulation-based and place-based augmented experiences are engaging for students, but how do these experiences change the way they learn science content or other subject matter, in terms of self-motivation, depth of content knowledge, inquiry skills, etc.?

3. **What skills do youth need to create (or learn by creating) mixed reality games?** Game design involves many disciplines, including content knowledge, technology skills, writing skills, metacognition, and more. Is there a certain level of these that makes it easier for kids to jump into designing AR games? Are these skills that kids can learn through creating their own games?

We have seen much potential for using AR games in classrooms, after-school programs, and informal educational institutions, but we are eager to learn more about the conditions under which they are most effective, and how students will use the platform and the games on their own. We think that the CSCW Mixed Reality Games Workshop will be a wonderful place to explore these questions with other experts, refine our own research agenda, and perhaps even connect with future collaborators.

**References**


Louisa Rosenheck Bio
Louisa Rosenheck is a Research Manager in the MIT Scheller Teacher Education Program. She manages the design, content, and development of educational games and simulations to be used with middle and high school students. She also oversees the research done on these projects exploring how mobile games can be used most effectively in both formal and informal educational settings. Recent projects include location-based augmented reality games, ubiquitous biology games designed for mobile phones, and a multiplayer online game for STEM learning. Prior to becoming a researcher at MIT, Louisa worked in public media and Web site production, and also taught ESL to children and adults of all ages. She holds a B.A. in Computer Science from Brown University and an Ed.M. in Technology, Innovation, and Education from the Harvard Graduate School of Education.

Josh Sheldon Bio
Josh Sheldon is a project manager and game designer at MIT’s Scheller Teacher Education Program. A former high school and middle school science teacher, Sheldon has an extensive background in developing curricular materials in the sciences and various forms of new media for science learning. In addition to freelance web and curriculum development, he worked at the JASON Foundation for Education, an innovative non-profit that focused on expedition-based science supplementary materials for middle schools. Sheldon holds a MA from Stanford University’s Learning, Design & Technology Program, and Bachelor's Degrees in Math and Physics from the Pennsylvania State University.