Moravian History Mystery: A Mobile, Digital, Augmented Reality, Game-Based Learning Experience for Young Elementary Students

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Abstract: This mixed-methods study explored the use of an augmented reality, location-based, iPad game to enhance the learning experience of young elementary history students. Utilizing the ARIS platform and a design-based research approach, researchers built a customized game experience that was inserted into a school's traditional second grade curriculum. Students' flow rates, learning outcomes, and attitudes about gaming were assessed through observation, teacher and student interviews, class-debrief sessions, teacher-created assessment tools, and surveys. Findings indicate that high rates of flow occurred with most students, learning outcomes were positively influenced, and that students generally have a positive attitude about game-based learning. This study also suggests that serious game-based learning for social studies can be successfully implemented in the earliest elementary grades. The researchers conclude with methodological and design recommendations for further game-based learning research within this age group.

Introduction

The national movement toward curriculum standardization and high-stakes testing has taken a toll on social studies instruction in terms of instructional time and energy (Fitchett & Heafner, 2010). Teachers are expending more creative energy and allocating more instructional time on higher priority subjects such as reading and math (Zhao & Hoge, 2005; Lee, 2008). This trend is particularly acute in the early elementary grades. In a study of elementary teachers in Indiana, VanFossen (2005) stated that "Cries of 'back to the basics' of reading and math, and the implementation of high-stakes state testing, have only served to focus further attention and resources on reading and mathematics as the twin engines driving the elementary school curriculum" (p. 377). Because of this lack of attention to social studies, many teachers have moved away from traditional social studies teaching techniques such as field trips, project work, service learning, or extended research (Ellis, 2007), all of which consume far more instructional time and teacher energy than they feel they can currently afford. Social studies marginalization (Fitchett, Heafner, & Lambert, 2014) discourages time-consuming methods, such as projects or field trips, and encourages transmission-driven methods, such as worksheets and textbooks (Kisiel, 2003; Ransom & Manning, 2013). This approach fails to align with the National Council for the Social Studies' recommendations for instructional methods (NCSS, 2010), and points toward a generation of disengaged, unprepared citizens.

In parallel with elementary teachers' declining emphasis on social studies, elementary students also lack engagement with social studies. Zhao and Hoge (2005) observed that students find social studies boring, not relevant to their own lives, and don't recognize the importance of understanding the world around them. Many of these same students who are disengaged in the classroom, however, are deeply engaged in other activities outside of school such as video games and mobile technologies. Prensky (2006) suggests that the current generation of learners is different from previous students; they are digital natives, and they often find their in-class experience "boring" when compared to the exciting and engaging digital games they experience outside of class. Despite the widespread adoption of mobile technologies by children (NPD Group, 2011), few researchers have deeply analyzed student interactions with mobile devices such as iPads to determine what learning benefit they have, if any (Falloon, 2013).

The 2013 Horizon STEM report identified games as an emerging technology for education. More and more educators are progressively recognizing the potential power of games for learning with regards to motivation and improved learning outcomes. Several researchers have successfully shown that games can improve the learning outcomes of students (Van Eck, 2006; Steinkuehler and King, 2009). Other researchers have successfully demonstrated the motivational affordances of games by studying games' capacity for inducing a state of flow within learners (Sweetser & Wyeth, 2005; Bressler, 2014). Finally,

several researchers have specifically explored game-based learning for history education and have shown that games can increase students' interest in history, understanding of societal structures, and historical facts and vocabulary (Admiraal et al., 2011; Squire, Giovanetto, Devane, & Durga, 2005; Schrier, 2005).

Flow, as described by Csikszentmihalyi (1990), is a phenomenon within participants' perception: they are immersed in an active experience and (relatively) inattentive to activities and events outside of their focus. It is characterized as a state of enjoyment and high engagement. It is most likely experienced when an ideal level of challenge meets an ideal level of participant skill. Flow bridges both gaming and learning contexts, as the flow-inducing experience could be a learning task or a game event. The presence of a flow-state within participants indicates motivation and engagement; and during flow, learning becomes autotelic. Additionally, because flow can result in higher levels of motivation to persist in an activity, it can create more effective learning environments (Chan, 1999; Dickey, 2007)

"Serious games"—games that are complex, require player agency, and often have a social element—present excellent opportunities for educators to provide flow-inducing learning experiences for their students. However, as other researchers have shown with middle-school through adult populations, the level of difficulty must not exceed the skills of the students, technology must not present barriers to play, and children must be allowed to apply social/recreational game culture while playing learning games (Admiraal et al., 2011; Bressler & Bodzin, 2013; Inal & Cagiltay, 2007).

The potential of AR mobile games to create powerful learning experiences in the particular subject of history is significant and important to study. *Mobile* games allow students to be physically present at historical sites and *AR* can bring these places to life while providing historical context and meaning. The additional information, possible flow-experience, and interactions between the learner and the history, *in situ*, can deepen the experience and potentially enhance learning outcomes.

Purpose of this study

The purpose of this study is to explore how an AR iPad game impacts history instruction for young elementary students and their teachers. We will examine the potential of the game to create deep, engaging, and meaningful learning experiences for students. At its core, the intention of this study is to provide a "proof of concept" that this type of AR game based learning experience can be successfully developed with teachers and implemented with this particular age group. Additionally, this study aims to contribute to the literature on research methodology and game design with early elementary learners as little currently exists. For this study, researchers partnered with 2nd grade teachers at a northeastern United States private school located within a historical district. Specifically, the researchers examined:

1. What flow experiences do young elementary students have while playing a mobile digital augmented reality game?
2. What relationship exists between young elementary students' mobile digital augmented reality game based learning experience and their learning outcomes?
3. What are the attitudes of young elementary students and teachers regarding this type of game based learning?

Methodology

To explore the application of game-based learning to the social studies curriculum, the researchers worked with three second grade classes at a private urban elementary school located in eastern Pennsylvania. This convenience sample consisted of approximately 37 students ages 6-8, along with their classroom teachers. The size of each class was approximately 12 students but some data were not collected due to student absences or failures to complete the unit. This project employs a mixed methods and design based research (DBR) approach (Barab, 2002). A mobile digital AR learning game is a novel instructional strategy for early elementary students; no "best practices" for implementation or design have been established. A mixed methods approach allows the researcher to collect both quantifiable targeted data and rich emergent data and use the qualitative data to triangulate and contextualize quantitative findings (Maxwell, 2010).

The quantitative data for this study came from two research instruments and a teacher-designed end-of-unit assessment. The first instrument, the game attitudes questionnaire (GAQ), was administered prior to the gaming experience. The GAQ assessed students' attitudes toward gaming both in educational and non-educational environments using a Likert-type scale and also collected demographic information such as gender, age, and ethnicity. Similar to Bressler and Bodzin (2013), our study developed the GAQ by selecting items from the scale developed by Bonanno and Kommers (2008). The final instrument is comprised of 4 items and had a Cronbach's alpha of .864. The second instrument, a Likert-type scale flow questionnaire (FQ) was given to students immediately after each gaming experience. This FQ has been modified from existing scales (Bressler, 2014) to match the reading level and comprehension of a typical 2nd grade student. The FQ consists of 11 items and had a Cronbach's alpha of .884. The pre-existing, teacher-created end-of-unit test constituted the primary assessment tool for examining students' learning outcomes. The test consisted of 23 items, required mostly "fill in the blank" responses, and emphasized fact-recall. During the game development process, some of the post-test content was included in the game while other content was purposefully excluded. The result was two sub-scales: game-related items (N=11) vs. non-game-related items (N=12). The game-related items received attention during game play (e.g., the year was Bethlehem founded) while the non-game-related items were covered only during the traditional, in-class instruction by the teacher.

The qualitative sources included whole-class de-briefing discussions, interviews with selected students, and teacher comments. Both research instruments were adapted from the literature, but adjusted for the level of our participants: we modified the language to be appropriate for early elementary learners, reviewed the items with external experts, piloted the instruments with elementary students, and then reviewed the final items for internal consistency.

The game

Although a few different game platforms were considered, the ARIS platform (www.arisgames.org) was chosen due to its inclusion of game-elements and geo-location features as well as its strong user-community support groups. Initial versions of the game were play-tested by small groups of elementary students and elementary teachers and then revised based on feedback and observations. The "build, play-test, revise" cycle produced four beta iterations of the game prior to the final production version.

During gameplay, teams of two or three to complete a series of quests in order to "level up" and earn the rank of "Master Moravian Historian". Each quest requires players to navigate to a historical location. Using the ARIS platform, the game drew upon the iPad's GPS capabilities to provide a dynamic display of students' current location on a satellite image, with interactive text and graphics arising as students arrived at game destinations. This content could be the opportunity to view and converse with a historical character, view a historical document or image, solve a problem, input a typed answer, or collect a virtual item. Players were instructed to take turns being the "navigator" holding the iPad and reading the game content.

Implementation

Gaming is a social experience for children (Inal & Cagiltay, 2007), so to replicate a true gaming experience and to optimize opportunities for peer-scaffolding, students were grouped by their teachers into dyads or triads for game play. Each team was given one iPad and an adult chaperone. Each class had two game sessions less than one week apart to allow them to develop an adequate level of game "skill" to facilitate the potential for a flow experience. The groups were not discouraged from collaborating with each other, as the sharing of game knowledge is a cultural norm of children playing games. Each outdoor segment of game play lasted between 45-60 minutes. At a pre-designated time, chaperones collected the iPads and led their students through the flow questionnaire while still in the field so as to immediately capture the students' experience. After the outside segment was completed, students returned to the classroom to participate in a post-play debrief session led by the teacher. After all of the classes had completed game play, the teachers completed a short-answer online survey to gather data about their perceptions of the experience. This online survey was shortly followed by a group debrief session involving all three teachers and the researcher. The unit test was given to the students about two months after game play (winter break and many snow days occurred in between) and copies of the test

were given to the researcher. Six students were then selected for individual interviews with the researcher and a final teacher group debrief session was conducted.

Results

Flow experience

Students' in-game flow experiences were measured using a FQ administered at the end of the second day of game play (see Table 1). Analyzing qualitative data provided additional contextual information. Given the overall mean flow score of 4.55 (N=32), we conclude that students experienced high rates of flow during play sessions. Flow scores, observations, field notes, and session transcripts support this finding.

	N	Mean	Std. Deviation
Class 1	12	4.36	.36
Class 2	10	4.61	.39
Class 3	10	4.71	.38
Overall	32	4.55	.39

Table 1: Flow Questionnaire Results

Students described losing track of time, feeling challenged but capable, feeling intrinsically motivated, knowing what to do, enjoying the experience immensely, and being rewarded for progress (getting feedback)—all indicative of Csikszentmihalyi's (1990) characteristics of a flow experience. Many students also expressed an emotional connection to game characters suggesting a truly immersive gaming experience. As one student noted, "Sometimes, I felt like it was so real that I almost wanted to touch it, like shake the person's hand." (20-C2D1-13). The researchers and teachers were asked repeatedly by the students to "play again!" Although it seems clear that these students mostly had a positive experience playing this game, the qualitative data also provide some insight as to possible barriers to flow such as trouble seeing the iPad in direct sunlight, trouble understanding geospatial concepts, "glitches" with GPS triggering, and trouble sharing iPad with partner. While these issues were recurring themes, only in one instance did they appear to permanently disrupt the potential of flow. It seemed to this researcher that these students were very forgiving of what they termed "glitches" and were eager to solve them and move forward.

Learning outcomes

Student learning was measured by a teacher-designed end-of-unit test (see Table 2). Across all three classes, 65% of students performed better on game content than non-game content. Students who performed below 90% on non-game content (N=12) performed an average of 14.6% better on game-related content suggesting that students who may not respond as well to traditional instruction do better with game-based learning. This finding is also supported within the qualitative data. As one teacher relayed, "I have one little boy…that has a difficult time when we have cooperative group work. He usually just kind of falls to the back of the group and lets everybody else do the participating, and he was more involved with [the game] (T1-TD1-171-173). The student referenced scored 13.6% better on game-related content than on non-game related content.

	N	Total Test Avg	Game related items	Non-game related items	Difference between Game and non-game	Percentage of students performing better on game related items
Class 1	12	66.7%	71.7%	62.1%	9.6%	81.8%
Class 2	12	89.4%	95.3%	91.7%	3.5%	50.0%
Class 3	11	92.9%	95.0%	91.1%	3.9%	63.6%
Overall	34	83.2%	87.6%	81.9%	5.6%	64.7%

Table 2: Unit Test Results

In the post-game debrief and subsequent interviews, students were able to recall historical facts from the game, including names of historical places and figures, and demonstrated an understanding of colonial Moravian society. The students were very eager to participate in the class debrief sessions with many hands were in the air as the teacher led the discussion. During one post-game debrief session a class was discussing a quest where they had to figure out the order in which the Moravian community built their places of worship. This was not a topic they had yet covered in regular class instruction. Students were able to recall, and spell, all three buildings in the correct order (2,13,5-C1D2-19-27).

Game attitudes

With an overall mean of 4.45, the game attitudes questionnaire (see Table 3) reveals that prior to playing our game, these students already had a positive opinion of games, felt a high level of self-efficacy towards games, and possessed a positive attitude toward learning with games.

	Mean	Std. Deviation	N
I know I could play a game like *Club Penguin* or *Minecraft*.	4.19	1.151	37
I like learning with games.	4.35	1.006	37
I like playing games.	4.81	.739	37
I can figure out the best way to play a game by myself.	4.43	1.168	37

Table 3: Game Attitudes Questionnaire Results

Discussion

The results of this study suggest that a carefully designed serious game can be implemented as a successful social studies learning experience for children as young as seven years old. These students were engaged and immersed in the subject of colonial Moravian history, a subject that may not seem relevant to the typical second grader. By bringing these historical figures “to life”, giving agency to the students, and placing history *in situ,* these students connected with the material that is typically deemed “difficult” to teach. As one teacher noted, "As we were reading through the information, they would make references to things they learned in the game or things they did in the game. I think that's a little bit empowering for them because they're like hey, we already know about this. Whereas before, they didn't know anything until we told them.” (T2-TD1-33)

Methodological implications

As mentioned earlier, a DBR approach allowed the researchers to make in-progress adjustments that appeared to be valuable in producing a positive gaming experience for students and teachers. Given the eclectic nature of games, the lack of GBL research with this population, and the dynamic nature of a real school environment, the responsiveness of DBR gave the researchers the agility in the field required to address the needs of students and teachers within their native environment. This study suggests that a DBR approach may be valuable to other researchers studying games and learning.

Another methodological consideration supported by this study is the practice of allowing participants, especially young students, to have two identical sessions of play, survey, and debrief. The original premise for having students play the game twice was supported by the idea that flow is more likely to be experienced when an ideal level of skill meets an ideal level of challenge. By providing students a “practice” opportunity to play this new game, the participants might be more likely to experience flow during their subsequent play sessions. While the researcher’s observations suggest that this original premise is supported, the data also suggests that having an opportunity to “practice” the survey was additionally valuable. The concept of being “in the zone” may be new to young students and thus the ability to articulate and self-report on this type of mental state may need to be learned.

Game design implications

At the outset of this study, it was very important to the researcher that this curriculum-based game “felt

like a real game" in order to maximize the potential for a flow experience. Thus, a strong emphasis was placed on fine-tuning the game interface, elements, and design while integrating historical content. It was predicted that a high level of engagement, driven by a true gaming experience, would transfer into the learning process. It would seem that, for this particular group of students, transfer did occur. Throughout the unit, students continued to express excitement for the topic of Moravian history and qualitative evidence suggests that this was due, at least partly, to their GBL experience. The results of this study lead us to make some initial observations and recommendations regarding game design and implementation for this particular population (2nd graders): 1. Geospatial skills require significant scaffolding, 2. Reading requirements needed to be both grade level and not distracting to game play (even if they were capable of reading something, they did not want to do a lot of reading; They wanted to keep playing!), 3. Video content was not received well in initial testing. Videos were perceived to "take too long". Students wanted to move on quickly, 4. Certain types of gaming activities were popular and well received such as collecting items, typing codes, and figuring out the right order, 5. Curriculum content needs to be an active part of the game experience and not provided as "additional info". What they need to learn is what they should also need to complete a quest and not something that adds description to a character interaction or location, and 6. Teachers provided valuable insights that guided the researcher's design process. As this study suggests, if the design process is successful, a flow-experience will emerge out of the confluence of the content area, teaching approach, and gaming experience even for our youngest learners.

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