"I Almost Wanted to Touch It": Flow and Learning in Game-Based History Education with Augmented Reality for Early Elementary Students

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Highlights:

- Mobile, augmented reality, digital game allowed students to have an immersive, *in situ* history learning experience.
- Students experienced high rates of flow during gameplay.
- Student post-test performance on game-related content was stronger than on non-game content.
- Tailoring game design to meet needs of young participants proved successful.
- Peer scaffolding and enjoyment are improved when playing with others.

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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 and teachers built a customized game experience that was inserted into a school's traditional second grade curriculum. The researchers assessed students' flow rates, learning outcomes, and attitudes about gaming through observation, teacher and student interviews, class-debrief sessions, teacher-created assessments, and surveys. Findings indicate that high rates of flow occurred with most students, learning outcomes were positively influenced, and that serious game-based learning for social studies can be successfully implemented in early elementary grades. The researchers conclude with methodological and design recommendations for further game-based learning research within this age group.

Keywords: applications in subject areas; elementary education; multimedia/hypermedia systems; navigation; virtual reality

1. Introduction

1.1 Games for learning

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 (Steinkuehler & King, 2009; Van Eck, 2006). Other researchers have successfully demonstrated the motivational affordances of games by studying games' capacity for inducing a state of flow within learners (Bressler, 2014; Kiili, 2005; Sweetser & Wyeth, 2005). Finally, several researchers have specifically explored game-based learning (GBL) for history education and have shown that games can increase students' interest in history, understanding of societal structures, and historical facts and vocabulary (Admiraal, Huizinga, Akkerman, & Dam, 2011; Schrier, 2005; Squire & Barab, 2004; Squire, Giovanetto, Devane, & Durga, 2005).

Among the many possibilities of games for learning, researchers have identified "serious games" as being particularly worthy of study. These 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. A serious game offers a "magic circle" experience as described by Botturi (2010). During game play, participants enter a magic circle that is 1) tyrannical - requiring the players' full attention, 2) totalitarian - all rules of the game are to be followed by all players at all times, 3) egalitarian - no matter who a player was in real life, they are just a player inside this game and their gameplay is the only thing that makes them better or worse, and 4) safe - consequences of bad decisions within the game stay within the game, (p. 351). 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; Hoffman & Nadelson, 2010; Inal & Cagiltay, 2007; Kiili, 2005).

1.2 Flow as a measure of engagement in learning and games

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. A classic example of a flow-state is an athlete or artist who is immersed in the activity. In a learning context, serious games are designed to similarly immerse the players in a sequence of tasks or even an entire imagined world. Without flow, a game for learning may instead be "chocolate covered broccoli" (Bruckman, 1999) – the game-based wrapping does not mesh with the learning inside.

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 & Ahern, 1999; Custodero, 2005; Dickey, 2007).

1.3 Flow and learning

Research has shown that flow can be experienced during game-play and that this type of "deep absorption in activities has been shown to promote optimal learning experiences" (Admiraal, Huizenga, Akkerman et al., 2011, p. 1186). While in flow, gamers enter a distinct psychological state of enjoyment and concentration that is observable through both behaviors and brain activity (Klasen, Weber, and Kircher et al., 2011). Several studies have used flow as a means by which to study the relationship between learning and gaming (Admiraal et al., 2011; Bressler & Bodzin, 2013; Inal & Cagiltay, 2007). More recently, additional research has shown flow to be a definitive predictor of learning (Bressler, 2014; Brom et al. 2014; Hamari et al., 2016; Hou, 2015). All of these flow studies solidify that flow is a useful paradigm by which to study the gamer experience and more specifically, the game-based learning experience.

1.4 Augmented reality as a platform for game-based learning

One platform for designing game-based learning is augmented reality (AR). Augmented reality is the addition of computer-generated sensory information to a participant's interactions with their real surroundings. This additional information can take a multitude of different forms such as audio, text, images, video, or even GPS data; any of these can be used to transform a basic activity into a rich, engaging, serious game experience (Dunleavy, Dede, & Mitchell, 2009; Klopfer & Squire, 2008).

While several previous studies have utilized AR to examine GBL (Bressler, 2014; Bressler & Bodzin, 2013; Klopfer & Squire, 2008; Squire & Jan, 2007), most researchers have focused on STEM education. Squire and Jan (2007) found that the place-based, augmented reality game focusing on environmental science, "*Mad City Mystery",* increased the scientific argumentation skills of students ranging in age from 4th grade through graduate school. Klopfer and Squire (2008) also argued for the potential of augmented reality, place-based gaming in a design-based research study that explored the implementation and design of their "*Environmental Detectives"* game. Bressler and Bodzin (2013) found that middle school students who played an augmented reality science game, "*The Case of the Stolen Score Sheets",* could experience flow and potentially a higher interest in science as well as enhanced collaboration skills. Bressler (2014) followed that initial study by measuring levels of flow and scientific practices of middle school students during a mobile augmented reality game, "*School Scene Investigators: The Case of the Mystery Powder*". Bressler found that students who played the game experienced higher self-reported flow rates and demonstrated higher levels of scientific practices. Bressler also defined a new category of mobile games in her study: INPLACE: Interdependent, Networked, Participatory Learning, Augmented, Collaborative Experience. By being mobile, these INPLACE "games can provide location-specific information and players can experience content in context," (p. 41).

1.5 Augmented reality for game-based learning in history education

While earlier research has established the value of place-based or INPLACE augmented reality games for STEM learning, we are particularly interested in the potential of these types of games to create powerful learning experiences in the subject of history. *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 (Admiraal et al., 2011; Schrier, 2005). The additional information, possible flow-experience, and interactions between the learner and the history, *in situ*, can deepen the experience and potentially enhance learning outcome (Dunleavy, Dede, & Mitchell, 2009; Klopfer & Squire, 2008).

After an extensive search of the literature, we located only two published studies that examined history instruction utilizing AR and GBL. Both studies focused on middle and high school students. Admiraal et al. (2011) studied middle and high school students playing *Frequency 1550*, a game exploring the medieval history of Amsterdam, and Schrier (2005) examined high school students playing *Reliving the Revolution*, a game designed to help students learn about the American Revolution. The *Frequency 1550* study found that the students learned more about medieval Amsterdam history when they encountered fewer technology issues and when they were more engaged with competitive gaming. Schrier designed *Reliving the Revolution* as an, "activity integrated into a broader history curriculum that teaches students how to approach and evaluate complex social problems," (p. 2) and found that the game enhanced students' learning of historical facts while helping them to gain an understanding of historical methodology and assume alternative perspectives. There has been minimal, if any, research however that focuses on AR and GBL for history education with young elementary students.

1.6 Purpose of this study

The purpose of this study is to explore how a serious game, implemented using iPad-based AR, impacts history instruction outcomes for young elementary students. Our research questions were:

1. What flow experiences do young elementary students have while playing a serious mobile digital augmented reality game?
2. What relationship exists between young elementary students' mobile digital augmented reality game-based learning experience and their curriculum-specified learning outcomes?

2. Methodology

2.1 Setting and participants

To explore the application of game-based learning to elementary history education, we worked with three second grade teachers and their students at a private urban elementary school located in eastern Pennsylvania to develop and implement an AR serious game to run on a class set of iPads and address a topic in their history curriculum. The teachers taught a total of 39 students, ages 6-8. This convenience sample is appropriate for a feasibility study—is it possible to design a serious game for young learners to study history? The school was selected due its location in a historic district that preserves several buildings from the colonial Moravian era.[1] Second grade was chosen because this is the grade in which the colonial Moravian history unit is taught.

The class sizes ranged from 11-13 students, but two students were omitted from data collection and analysis (one due to absence, one declining to participate). The final sample, across all three classrooms, was 37 students. We assessed these learners at the start of our research to explore their attitudes towards games and game-based learning (see Appendix A for questionnaire). Similar to Bressler and Bodzin (2013), we adapted items from Bonanno and Kommers (2008). The mean across all classes was 4.45 (positive to very positive views), indicating that our population of students aligns with

[1] The Moravians are a Protestant religious group founded by John Hus in the early fifteenth century in the eastern European countries of Bohemia and Moravia. In 1740 a group moved to America, initially landing in Georgia, but eventually moving north to found the city of Bethlehem, PA in 1741. In 1742, the Moravians founded the school the participants of this study attend. The church still exists today and has expanded into many different geographical locations over the past two centuries. Bishop John Amos Comenius, a notablxe Moravian, is often referred to as the "father of modern education".

Prensky's (2006) description of young learners as having positive relationships with games for fun and learning. These findings also match well with Oblinger's (2004) description of a generation raised within a media-rich, technology-infused, and gaming culture.

All three teachers are veterans with ten or more years of experience in the classroom. They have varying levels of comfort using instructional technology, and no prior experience with serious game-based learning in history education. The lead teacher authored the existing, long-standing curriculum, a workbook-based sequence of activities that explore colonial Moravian history. The researchers consulted with the teachers to adapt portions of the unit content into a mobile digital AR learning game.

2.2 Design and development approach

This project employed a design-based research (DBR) approach (Barab, 2002). DBR is appropriate for developing innovative instruction or applying technologies where no or little previous work has been done. A mobile digital AR learning game is a novel instructional strategy for early elementary students, particularly for history education; no "best practices" for implementation or design have been established. In 2008, Klopfer and Squire utilized a similar approach in their "environmental detectives" study; however, no other published research has applied this strategy to an early elementary environment. Because a primary purpose of this study is to determine design considerations for successful real-world implementation, DBR's rapid adjustments to design and implementation in the field was critical. Throughout the project, the researchers collaborated with game-testers, teachers, and observers to continually make modifications to the game and its implementation. For example, video content was not received well in initial testing. Students in pilot sessions felt that videos "take too long" to watch and digest; students wanted to move on quickly. They responded more positively to images and brief text, so the next iteration of our game removed all videos. Later, during our first full class play session, it became clear that some children understood how to navigate using the satellite image right from the start, but most did not. After this first class struggled with geospatial orientation (matching the satellite image to their immediate surroundings), we modified the game introduction for the second and third classes to include a demonstration of map-reading and orientation. Once we added this brief "map orientation" to the in-class introduction, students' spatial navigation improved greatly—they found their way to their intended destinations more quickly and purposefully. A final example of a DBR adjustment made during this study revolved around adjusting an in-game non-player character's (NPC) dialog. After the first two classes continued to have difficulty locating a gravesite during one quest, we adjusted the NPC's dialog to simplify a location clue. As a result, the third class experienced less frustration with that particular quest. These quick adjustments, while often being minor tweaks to design, assessment, or instruction, helped streamline students' game-based learning experience and reduce barriers to flow.

2.3 Game development, gameplay

For our augmented reality platform, we selected ARIS (www.arisgames.org) due to its inclusion of game-elements and geospatial features as well as its strong user-community support groups. The development of this game occurred over several months, moving from flow charts to storyboards to pilot versions and back again to iteratively explore game design elements and instructional content. The teachers acted as consultants on game content and design and provided regular evaluation and feedback through pilot testing. The implemented version of the game used in this study was the fourth major iteration of the game's design. The two key objectives during game development were, 1) to produce a game that seamlessly integrated curriculum content into game-play, and 2) to create a game that felt like a "real game" (i.e., a flow-inducing experience) and not "edutainment" (a less flow-inducing experience that typically gamifies curricular content—see Habgood & Ainsworth, 2011).

The last phase of development, pre-deployment, consisted of the three teachers playing the game themselves to both become familiar with the final product and to provide final feedback to the researcher. The resulting game, the *Moravian History Mystery*, is available for free through the ARIS application available on the Apple App Store.

Gaming is very often 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 ("teams") for gameplay. Each team was given one iPad and assigned an

adult chaperone to ensure safety as they navigated the school campus and to resolve any technical issues. Gameplay took place in two sessions embedded within the teachers' existing history unit.

The game required each team to complete a series of quests in order to "level up" and earn the rank of "Master Moravian Historian". The premise of the game was that all historical knowledge of the colonial Moravians had been lost and that the students must re-enact aspects of Moravian history and daily life to recover it. This premise also allowed us to isolate any adult interjection: we told the chaperones to deflect requests for assistance from students by responding, "I have mysteriously forgotten everything I once knew about the Moravians!" Each quest (see Figure 1) required players to navigate to a historical location within the historic district adjacent to the school's campus. Using the ARIS platform, the game drew upon the iPad's GPS capabilities to provide a dynamic display of students' current location within the historic district on a satellite image. As players arrived at game locations, interactive text and graphics displayed on their iPad screens. The interactions included chatting with a historical character, viewing a historical document or image, solving a problem, and/or collecting a virtual item. Within their teams, players were instructed to take turns being the "navigator" who holds the iPad and reads the game content.

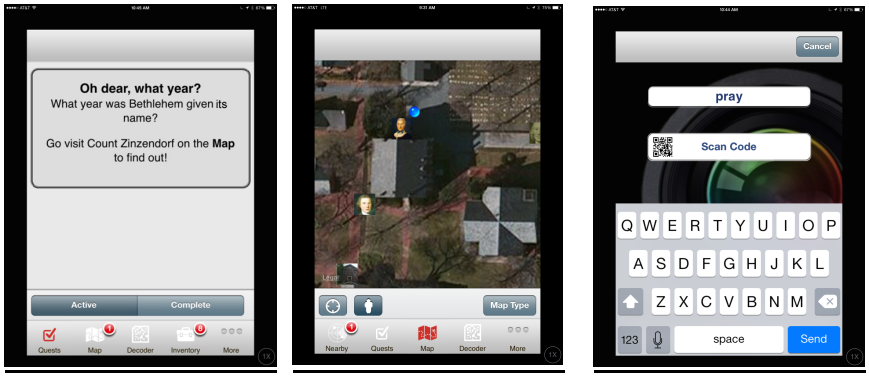

Figure 1: Screen shots from Moravian History Mystery (left to right): sample Quest; Map with both target icons and location identifier; Decoder

2.4 Data sources

The data for this study came from two research instruments plus a teacher-designed end-of-unit assessment and several qualitative sources (whole-class de-briefing discussions, interviews with selected students, teacher interviews, and researcher notes). Both research instruments were adopted from the literature and then adjusted for the level of our participants: we modified the language to be appropriate for early elementary learners, reviewed the items with external experts (an elementary education researcher and veteran elementary educators), piloted the instruments with elementary students (student volunteers from other classes), and then reviewed the final items for internal consistency.

2.4.2 Flow questionnaire

The flow questionnaire (FQ; see Appendix B) used Likert-type items to measure students' flow experience from gameplay. The FQ is a modified version of an existing scale (Bressler, 2014; Bressler & Bodzin, 2013). Under the direction of an elementary reading researcher, we simplified the language in the existing scale and substituted icons for the text prompts. Students completed the FQ immediately after each gaming session. The final FQ consists of 11 items and had a Cronbach's alpha of .884. This reliability was slightly higher than our source (Bressler, 2014; Bressler & Bodzin, 2013), who reported alphas ranging from .77 to .80.

2.4.3 Unit test

The primary assessment for examining students' learning outcomes was the pre-existing, teacher-created, end-of-unit test. The assessment consisted of 23 items, mostly "fill in the blank"

responses that emphasized fact-recall. For example, students had to identify “In which European countries did the Moravians originally live?” and “Who was the founder of Bethlehem?” Under Bloom’s revised taxonomy (Krathwohl, 2002), this assessment did not measure learning past the first level of “remember”. 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=11). The reliability of this assessment was evaluated using Cronbach’s alpha; the alpha was .89, which is extremely high for a teacher-designed test (Haladyna, 1994). The game related items were introduced, reinforced, and/or assessed during gameplay (e.g., the year in which was Bethlehem founded); instruction on non-game related items occurred solely during the traditional instruction: group reading, teacher presentation, class discussion, craft activities, and field trips.

2.4.4 Qualitative data sources

After each play session, the teachers led their classes in a post-game debriefing discussion, lasting for approximately thirty minutes. Following the end of the unit, the researcher conducted individual semi-structured interviews with six purposefully selected students. Interviewees were selected to provide deeper insight into phenomena that surfaced when analyzing the implementation data. Two students were selected from each class by examining flow scores, unit test scores, and field notes. The resulting interviewee group represented a range of flow scores and test scores. For example, one student was high flow/low test while another was low flow/high test (See Table 1).

Table 1
Distributions of student interviewees’ flow and test scores.

Student ID Number	Class	Flow Score	Test Score
5	1	4.55	54%
8	1	4.55	96%
15	2	4.18	91%
21	2	4.64	96%
28	3	5.00	89%
31	3	4.30	98%

In addition to these de-briefing sessions and interviews, the researchers conducted end-of-unit interviews with the participating teachers to elicit their perspectives on the gameplay, students’ responses to the game, and the perceived impact on students’ learning. The final qualitative data sources were course documents, archived materials from the design and development process, and observer notes.

All debrief sessions and interviews were audio recorded and transcribed. The entire qualitative data set was then analyzed, line by line, following the constant-comparative method (Glaser & Strauss, 2009). Emergent codes were checked against all previously analyzed data, and each theme was challenged by a search for counter-evidence.

2.5 Implementation

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. In addition, the encouragement of collaboration aligns well with an active learning approach.

The first day for each class began in the classroom with students completing the game attitudes questionnaire, a brief introduction by the researcher, distribution of the iPads, and then the initiation of gameplay. After observing the first day play session, this introduction was modified to include additional instruction on how to orient oneself spatially on the satellite map and how to interpret the representation of their personal movement on the map. Students and teachers consistently used the phrase, “follow the

blue dot", to explain the navigation process. After the introduction and distribution of the iPads, students headed outside to continue their play while being accompanied by their chaperone. Day two for each class started much more quickly with a simple redistribution of the iPads and matching teams with chaperones. Each outdoor segment of gameplay lasted between 45 and 60 minutes. During gameplay, chaperones acted as observers and rated observable flow behaviors and took field notes, which often included student quotes. 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. The researchers participated minimally in these discussions but did provide the teacher with a few suggested discussion questions ahead of time. The teacher was encouraged to lead the discussion as she normally would.

After all of the classes had completed gameplay, 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 gameplay (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.

3. Results

3.1 Flow experience

Students' in-game flow experiences were measured using the FQ administered at the end of the second day of gameplay (see Table 2). As shown in Table 2, the overall mean flow score of 4.55 (N=32) on a 5-point scale, leading us to conclude that students experienced high rates of flow during play sessions.

Table 2
Flow questionnaire results.

	N	Mean	Std. Deviation
Class 1	13	4.36	.35
Class 2	13	4.23	1.06*
Class 3	11	4.67	.38
Overall	37	4.41	.70

*Student #17 in class 2 had a very frustrating time with his partner who wouldn't share the iPad and reported all 1's on his Flow questionnaire.

The qualitative data provided additional support for this conclusion. Several students described losing track of time, as if a 45-minute gameplay session "felt like it was only ten minutes long," (10-C1D2-2)[2], while others expressed feeling completely immersed: "Sometimes, I felt like it was so real that I almost wanted to touch it, like shake the person's hand," (20-C2D1-13). Along with overt displays of joy while playing (e.g., "Level 2, YES!" [fist pump] (B1A-OS-51)), students also expressed a high level of self-efficacy: "I felt, I had confidence because I was getting really excited to go to the next person." (21-C2D1-5). The most telling indicator of students' engagement was the repeated requests from the students: "Can we play it again?"

By describing feelings of lost time, feeling challenged but capable, feeling intrinsically motivated, knowing what to do, enjoying the experience immensely, and being rewarded for progress (getting feedback), the students confirmed that they did indeed experience high rates of flow as described by

[2] Quotations are cited using the following format: (Speaker-Setting-Line). "00" indicates that the speaker's name was not recorded. Pseudonyms are used for all student names.

Csikszentmihalyi (1990). However, the qualitative data also provide some insight as to possible barriers to flow, such as direct sunlight making the iPad screen difficult to read, geospatial disorientation making navigation difficult, non-responsive GPS triggers, and reluctance to share the iPad with their partner. While these issues were a recurring theme within the qualitative data, only one pair of students appeared to be permanently removed from the "magic circle" of the game: recorded the lowest flow score of any group (2.5) and expressed frustration during the post-game de-brief.

3.2 Learning outcomes

As mentioned, student learning was measured by a 23-item, teacher-designed end-of-unit test administered about two months after students had completed their game-play sessions. In examining the sub-scales of game related and non-game related items, both globally and in every classroom, students scored better on items connected to their gameplay (see Table 3). For example, only 69% of students got the following non-game related question correct: "Who founded Bethlehem?" In contrast, 97% correctly answered this game-related question: "Colonial Moravians did not live together as families. Instead, they, lived in groups called [fill in the blank]?" From this we concluded that the gameplay experience facilitated students' learning and/or retention of the assessed content.

Table 3

Unit test results by class

	N	Total Test Avg (SD)	Game related items	Non-game related items	Margin between game and non-game scores
Class 1[a]	12	67.3% (21.6)	71.0%	63.6%	+7.3%
Class 2[b]	13	92.2% (10.5)	93.5%	90.9%	+2.6%
Class 3	11	93.5% (9.2)	95.0%	91.9%	+3.1%
Overall	36	84.3% (18.6)	86.5%	82.1%	4.4%

[a] StuNum 7 was absent during the 2nd day of game play and StuNum 12's test score was not made available to the researchers.

[b] StuNum 17 had a very poor gaming experience due to partner issues—see Table 2.

In examining the data at the individual student level, we observed that this trend was consistent: across all three classes, almost two-thirds (61.1%) of students performed better on game content than non-game content. The trend of higher game related scores than non-game related scores was even more pronounced among lower-achieving students: dividing all students into those above vs. those below the test average, the lower-achieving students scored an average of 6.4% higher on game-related items than non-game-related items, compared to a difference of just 3.3% for students above the median (see Table 4). Of the 12 students scoring below the mean, only 3 had higher scores on non-game items than game-related items; of these 3, 2 had sub-optimal game experiences of either missing a game session due to absence (StuNum 7) or being frustrated by their partner (StuNum 17). This concomitant variation again suggests that the gameplay experience enhanced students' learning, particularly among students who were less academically successful overall.

Table 4

Unit test results: above vs. below mean

	N	Total Test Avg (SD)	Game related items	Non-game related items	Margin between game and non-game scores
Students below mean	12	61.2% (14.9)	64.4%	58.0%	+6.4%
Students above mean	24	95.9% (4.5)	97.5%	94.2%	+3.3%

The relative strength of in-game learning process was supported by the teacher interview data. One teacher provided an example of a student who performed unexpectedly well during the gameplay and whose end-of-unit test was much stronger on game-related content than non-game-related content.

> **Teacher:** [StuNum 6] 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] outside…he seemed to be involved and excited about the game which was good. (T1-TD1-171-173)

The teacher connected the benefits of game-related learning to performance on the test: "It helped them to give input and remember back to things in the game and then they were able to make more connections." These conversations led us to further explore the qualitative data for themes regarding learning.

3.2.1 Recall, comprehension, and curricular expansion

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. In some cases, these discussions reached well beyond the planned curriculum. During one post-game debrief session, a class discussed a quest in which they had to figure out the sequence of constructing the Moravian community's places of worship. This was a topic they had not yet covered in regular class instruction. 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.

> (2,13,5-C1D2-19-27)
> **Teacher:** And you had to get them in order. Do you remember the order of the buildings? What was the first one? Henry? Do you remember?
> **Boy 1**: The oldest?
> **Teacher**: The oldest one. What was it called? Or do you remember how it was spelled?
> **Boy 1**: [spelling out loud] S-A-A-L?
> **Teacher**: S-A-A-L, good. And…the way we say that is Saal [pronounced it correctly with a z sound]. Saal, the 's' sounds like a 'z'. Good. Greg, what was the second one built?
> **Boy 2**: Old Chapel
> **Teacher**: The Old Chapel and [pause] Gillian?
> **Girl**: Central Church!
> **Teacher**: Central Moravian Church, right! And we'll get to go visit the Saal soon because we'll be going to the Museum and you'll see how they went from having their chapel in a room and the reason why they had to build a bigger church was the Chapel and then a bigger one. So you'll be able to understand why better once you see that small Saal and then why they had to keep building bigger churches…

In five instances, the students initiated discussions during classroom debrief sessions that expanded the conversation beyond recalling facts of Moravian society into larger questions of societal structure. In one of these five instances, the conversation shifted beyond the planned curriculum and into a discussion of social norms. In this case, after recalling the fact that women and girls were required to wear certain colors to indicate their position as single or married, one boy remarked that this practice was "sexist". This statement triggered an exchange that demonstrated a heightened level of thoughtful engagement and curiosity:

> (00-C1D2-71-86)
> **Teacher:** Pink. Right, right. So, they were able to just look at the women from far away and say, "oh, she's in the Sister's House or she's in the Married Women's House, or she's in the Widow's House. They knew what choir you were a part of, but the women weren't as lucky - they didn't do that with the men. They should have had to wear a ribbon or something don't you think Mrs. Oltman? [laugh]
> **Boy:** That was being...uh.... a little sexist!

Teacher: Exactly! Exactly. …Do you know what that means? What he said? That means they were sort of favoring the males because they didn't have to wear something that showed everybody what group they belong to. They only did that for the women.
Boy: That means judging the uh, judging the uh, judging them because they're a girl or a boy.
Teacher: Exactly. Very good. I bet your mom taught you this?
Boy: Yeah
Teacher: Well you just, I think the community was small enough…that they knew who was married and who wasn't probably. Small neighborhood. That's what we mean, they didn't have to do anything with their clothing that showed whether they were married or not or a young boy…I'm sure word just got around. Hey that that Joey, he's pretty cute. Is he married?
[laughter]

We also observed an unintended emotional impact: during the debrief, several students shared that they felt a connection to game characters. As one girl explained, "Something that really stuck in my head is that the Hotel used to be where her First House was and she really wanted to see it again…it made me feel so happy that we helped her," (00-C2D1-51). For these students, the gameplay was not a strictly a knowledge-building experience but something more interpersonal, imaginatively connecting with in-game characters.

These trends from the whole-class debriefings were echoed in the one-on-one interviews. The interviews took place almost 5 months after gameplay (November-April). The researchers waited until the unit had concluded and the tests had been graded before purposefully selecting the interviewees (see Table 1) and conducting the individual student interviews. Of the six selected interviewees, five were able to recall specific historical facts and names featured in the game. (See Table 5.) One student even demonstrated an understanding of colonial Moravian society by referencing the sheer amount of time spent in prayer. None of the students, however, referenced unit content that was not in the game nor did any make comments that went beyond the planned curriculum. This may have been due to the elapsed time between gameplay and the and a possible perception that the interviews were primarily concerning the game.

Table 5
Distribution of individual interview data regarding learning

Student ID Number	Recall Historical Facts From Game	Recall Historical Facts Not in Game	Demonstrated Understanding of CM Society?	Went beyond the planned curriculum
5	N	N	N	N
8	Y - 3	N	N	N
15	Y - 3	N	Y - 1	N
21	Y - 2	N	N	N
28	Y - 1	N	N	N
31	Y - 3	N	N	N

3.3. Learning preferences

3.3.1 Mobile digital game-based learning preferred over traditional learning

The six students participating in the one-on-one interviews all voiced a strong preference for this type of game-based learning experience over more traditional instructional methods. As on student stated, “Well, games are always more fun than just sitting at a desk and learning, and when the games are involved with learning, you learn stuff and you don't just have to sit there [and] listen at your desk,” (S31-I-36). The preference seemed be driven by the students’ desire to be active, both physically and

mentally. These students appeared eager to engage with the material and make decisions and were subsequently excited to share what they had "discovered".

> (S5-I-57)
> **Researcher**: …Why you think games should be used in schools?
> **Boy**: Cause sometimes it's a funner way of learning things
> **Researcher**: Ok, why is it more fun?
> **Boy**: Cause then you could like explore and …usually when we just learn from paper you just write it down

This idea of exploring content through interaction, rather than just receiving it via direct transmission from a teacher or textbook seemed to appeal to all six of the students that were individually interviewed. Additionally, a different student (S22) offered this comment during one of the whole-class debriefs: "Like it was more, I mean the game…it had like *more*; it wasn't just a whole page with um with just one…kind of Moravian" (S22-C2D1-112). Another student singled out the sense of agency she experienced during the game relative to traditional in-class instruction: "They gave you clues instead of just answering questions, they gave you clues" (S21-C2D1-128). The students seemed to relish the "demands" of the game not as "work", but truly as play.

The teachers, who were not experienced with game-based learning, also recognized differences between traditional instruction and this particular GBL experience. One teacher noted the heightened engagement surrounding game experiences. "I had a bunch of kids comment about having conversations with the people in the game, and that made it a lot more exciting than just reading about it" (T2-TD1-16). Another commented on the students' high level of persistence: "Only once did I hear both students in my group say, 'this is hard.' Student A eagerly helped Student B, and neither gave up. They both kept trying" (T3-TS-35).

In our interviews, both teachers and students indicated an appreciation for game-based learning and the game-related learning opportunities in their unit of study. Students preferred the game experience to traditional instruction, and teachers recognized the differences in the students' responses to game-based learning when compared to traditional instruction.

3.3.2 Mobile GBL is preferably social

Nearly all of the students expressed having a positive partner experience and a preference to "play with a friend" if they were able to play again. As one student put it, "I mean [it's] like more fun to do it together, we can explain what's happening to each other, and we can solve out problems together," (S15-I-55). All six of the students individually interviewed expressed similar opinions, and all of the students in class 3 together responded "easier!" when asked by the teacher if having a partner made the game easier or harder. Twelve of the sixteen groups demonstrated some form of peer scaffolding during play and all three teachers recounted examples of peer scaffolding by their students. Researchers also noted simple examples of peer scaffolding on several occasions including, 1) one student physically turning his partner to face North and thus become geospatially aligned with the iPad map, 2) one student teaching another how to zoom in on the iPad map, and 3) teammates actively discussing where to go next to solve a quest. Considering these observable scaffolding behaviors in concert with the students expressed preferences for "playing with a friend", the data supports the premise that playing with a peer is preferable for both practical reasons (to solve a problem) and for social reasons (it's more fun!).

On the other hand, researchers observed instances when working with a teammate was frustrating for students. The most prevalent issues involved deciding where to go next in the game and sharing of the iPad. While this was a rare experience, it is important to note that these did occur. Only in once instance did teammate interactions seriously disrupt the gaming experience of the pair. In this case, one pair in the second class continued to argue over who should be holding the iPad resulting in one student completely disengaging from the game and the other student playing the game solo. Both of these students voiced their frustration during the post-game class debrief. The disengaging student explained himself this way: "I didn't like our team's sportsmanship. We were yelling at other" (S17-C2D2-53). In contrast, all other teams worked through their moments of frustration either on their own or with the help of the supervising adult. One student shared an example of working through a collaboration issue this way: "Me and Nick kind of went different directions and then…Nick went up and then we're like

no, that's not the direction and [he] started walking back" (S28-C3D1-134). The data also suggests that the trouble sharing was perhaps due to students being so immersed in the activity at that moment and not wanting to disrupt their flow experience.

> **Teacher 3:** He was really, he used the term 'in the zone', he was really in the zone when he was holding the iPad.
> **Teacher 2:** And I think that may have to do with the difficulty of when to pass it on. I'm in the zone and I'm - you know what I mean? I'm going with what's happening right now and it's hard to give it up then. [laughs]

The teachers also recognized that these struggles with collaboration were not unique to this gaming experience

> **Teacher 1:** I thought it was interesting because I saw the same sort of thing in the classroom with cooperative learning. If there's a child who has a very strong personality and likes being in charge they still wanted to be in charge, and they were the ones saying 'it's my turn [laugh] with the iPad' and you know I would have to say it's time to share the iPad because they wanted to have it all the time…so it was interesting, the same thing happens outside as inside in some instances. (T1-TD1-113)

The teachers pointed out an affordance of social play by creating opportunities for peer scaffolding.

> (T3,T1-TD1-156-159)
> **Teacher 3**: I had…intentionally [paired] a child who was advanced and one who really has to work hard to read on a second grade level…and that's why I think the pairs are really good because they were so good working together, and the one child who knew all of the vocabulary just *helped*. He wasn't taking over, he was just assisting with the reading and so the other child felt like he was doing a good job of reading, you know?
> **Researcher:** And do you think if he if those two had been paired together in a different, more um, say traditional activity in the classroom, that help would have been the same or different?
> **Teacher 3**: I really…because I know the child's personality, the one whose a little bit higher, he probably would have been a little pushier in the classroom…as opposed to the game…he was just enjoying the game so much…I really think that helped him be a helper…to succeed with the game.
> **Teacher 1:** And maybe because that was because he didn't know where the game would lead him. It was -
> **Teacher 3**: It was new to him too
> **Teacher 1**: Yeah

Although issues such as sharing and conflicting gameplay decisions occurred, it appears such issues did not rise to the level of disrupting a positive GBL experience. The data indicate that students and teachers both recognize the scaffolding and social benefits of playing in dyads and triads and strongly believe that these advantages far outweigh the difficulties.

4 Discussion

4.1 Serious games for social studies can be effective with young elementary students

The results of this study expand the age range in which serious games can be usefully implemented. Previous researchers have focused on secondary of middle level education (Admiraal et al., 2011; Bressler, 2014; Bressler & Bodzin, 2013; Dunleavy, Dede, & Mitchell, 2009; Klopfer & Squire, 2008; Schrier, 2005; Squire & Jan, 2007); our experience suggests 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 or even attainable by typical second grade curriculum and instruction. 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. The three teachers each recognized the difference between this experience and traditional social studies instruction for this grade:

- "History at this age, is difficult I believe because they are so into the here and now. I do believe it helped to spark their interest. It was also nice for them to know some information to give input as we continued learning. You hit very important information that they need to remember so hopefully the game is reinforcing that." (T1-TS-47)
- "Not only was the game a perfect enrichment activity, but the students who may be less focused in the classroom seemed to grasp and retain more information from this type of experience." (T3-TS-29)
- "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)

As referenced by all three teachers, it is important to consider that this game was *integrated* into a traditional curriculum unit and did not stand on its own as the sole source of instruction for these students on the topic of Moravian history. This study suggests that the impact of this game on learning outcomes may exist in a symbiotic relationship within the context of a full unit that includes other pedagogical approaches for instruction, including direct instruction. This study, however, also suggests that a successful GBL experience may enhance a student’s learning experience beyond the isolated gaming experience. Students may participate more fully in other elements of the unit and be more curious about the content as a result of gameplay. As one teacher put it:

> I feel like the game connected them to the history on a level that means something more to them instead of just reading it from the book. Because I knew, I knew they'd be excited about the game because it's a game, but I really feel like there was a solid connection there and I knew that they would love the game in the moment, I didn't expect it to carry through as much as it did. I mean I was pleasantly surprised that it did, like I knew they'd be excited that day, but then I thought it would be like, OK, we did it and now it's done, but that wasn't, at least for my group, that wasn't the case. (T2-TD2-82).

This idea that the gameplay had an impact on learning well beyond the immediate gaming experience is interesting and requires further study. Not only may these types of GBL experiences improve total curricular connection and understanding for students in general, but the data also suggests that that students who may not respond as well to traditional instruction do better with game-based learning.

4.2 Value of DBR

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. One teacher, referring to the difference between an early game version that included video and a later version that did not, described the iterative process of design and implementation this way: "I think it was really important because I was at the first [pilot session], which seemed good because I had nothing to compare to until you kept doing it again, and I was like, 'Wow, this is huge', I mean it was a huge difference," (T2-TD1-213). This study suggests that a DBR approach may be valuable to other researchers studying games and learning with young populations.

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 suggested 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 and learn the interface, the participants might be

more likely to stay in the magic circle and experience flow during their subsequent play session. While our observations suggest that this original premise is supported, the same theme appeared in the data collection: the students needed an opportunity to “practice” the flow survey; on the second day, the survey data was more reliable and students were able to better verbalize abstract experiences of flow. This pattern implies that 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.

Finally, the data supports the use of pairs or triads for gameplay to accelerate peer scaffolding and that students and teachers recognize this as a benefit of playing with others. With the sole exception of StuNum 17, all other students reported high rates of flow and described positive experiences working in their groups.

4.3 Game design implications

At the outset of this study, it was very important to the researchers 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 curricular content. It was predicted that a high level of engagement, driven by a true gaming experience, would impact the assessed learning outcomes. It would seem that, for this particular group of students, this prediction was correct: 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 end-of-unit test results reflected the relative mastery of content related to game-play, particularly for the lower-achieving students.

The results of this study and our experience making in-game adjustments lead us to make some initial observations and recommendations regarding game design and implementation for this particular population (2nd graders). First, geospatial skills require significant scaffolding. Once we added the map orientation segment to the in-class introduction, students’ geospatial understanding and navigation skills improved greatly. Second, reading requirements need to be both grade level-appropriate and not distracting to gameplay. Even if students were capable of reading something, they did not want to do a lot of reading—they wanted to keep playing! Third, video content is not received well because watching a video “takes too long” and hinders the young player’s eagerness to move forward in the game. Instead, images and brief text proved to be effective for their needs. Fourth, certain types of gaming activities are popular and well received, such as collecting items, typing codes, and figuring out sequences. Fifth, curricular content must be an active part of the game experience and not provided as "additional info". What the students need to learn is what they should also need to uncover as they complete a quest; it should not be something peripheral such as description during a character interaction or at a location. Our final observation and recommendation is that teachers provide valuable insights that should guide the game’s design process. Teachers know the students, the curriculum, and the setting in which GBL will occur far better than game developers. They also are more experienced at recognizing what is “working”, what is practical, and what needs improvement.

Overall, students were very forgiving of what they termed “glitches” and were eager to solve them and move forward. As long as the game was interesting and the students felt that the challenge was within their skill level was evenly matched with an ideal level of challenge, an intersection critical to experience flow, the students enjoyed their experience. When asked how she would feel if the game had been harder, one student responded that “It would make me feel like I couldn’t get through it all because it’d be too hard,” and that if it was too easy, she “could just blow through it and wouldn’t get any fun out of it” (S5-I-25). To this group of students, small “glitches” were fine as long as the intersection of skill and challenge was retained, keeping them inside their magic circle.

If the design process is successful, a flow-experience will emerge out of the confluence of the content area, the teaching approach, and the gaming experiences. Flow, as a product of the convergence of game design, content, and learning theory is observable and measurable. By measuring flow and learning outcomes, this study suggests that GBL can be successfully implemented at the early elementary level for history education.

Acknowledgments

The researchers would like to thank all of the students, faculty, staff, and administration at Moravian Academy for their support of and participation in this project. We express special gratitude for the second grade teachers for their time, expertise, and insight; they were invaluable collaborators. Finally, we also thank Drs. Sawyer and Garrigan for their expertise in improving the research design and reviewing this manuscript.

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Appendix A. Game Attitudes Questionnaire

Adapted from Bonanno and Kommers (2008). For our sample of 25 2nd grade students, this instrument had high reliability: Cronbach's alpha of .864.

	YES!	Yes	I don't know	No	NO!
I know I could play a game like *Club Penguin* or *Minecraft*.					
I like learning with games.					
I like playing games.					
I can figure out the best way to play a game by myself.					

Appendix B. Flow Questionnaire

	YES!	Yes	I don't know	No	NO!
I was in the zone.					
I thought the game was hard but not too hard.					
I knew what to do in the game.					
I knew what I wanted to do in the game.					
I felt like I could get to the next level.					
The game kept my attention.					
I could do what I wanted to do in the game.					
I felt like nothing else mattered while I was playing the game.					
Time went by quickly while I was playing the game.					
I really enjoyed what I was doing.					
I would like to play this game again.					