

Using Learning Games to Teach Texas Civil War History to Public Middle School Students

Matthew William Fendt

Department of Computer Science

Baylor University

Waco, TX 76798

matthew_fendt@baylor.edu

Eric Ames

Department of Museum Studies

Baylor University

Waco, TX 76798

eric_ames@baylor.edu

Abstract—*The War of the Rebellion* is an educational video game designed to teach about the Battles of Galveston to 8th grade public middle schoolers in Texas. This game was compared to a textual information packet about the battles (designed to simulate traditional textbook learning) in its ability to increase learning gain and interest in the students. It was found that, while the performance on the posttest by the game participants did not show an overall increase compared to those that read the text packet, the question most closely tied to the gameplay showed a learning gain. Additionally, the students reported greater interest in learning about history and about the Civil War, and were more likely to want to share the learning tool with a friend compared to those that read the text packet. This indicates that a game developed in close collaboration with the educator that whose gameplay emphasizes important learning items can be an effective educational tool for students.

Index Terms—games, serious games, educational games, learning

I. INTRODUCTION

Video games have become commonplace in society, especially among young people. In 2015, the NPD group reported that 92% of children ages 2-17 play video games [1]. Educators have begun to explore ways to integrate learning into the games. Numerous researchers have integrated education games into the middle school educational setting, including into history classes. We designed a game, called *The War of the Rebellion*, to teach 8th grade public middle school students about the Battles of Galveston, to supplement their Texas Civil War history lesson. The game plays out in two stages. In the first stage, the player learns about the first Battle of Galveston by placing defenses in key locations around the port and the city. In the second stage of the game, the player learns about the second Battle of Galveston by using scouts to determine the location of the enemy defenses. The important points of emphasis were the Confederate defense of Galveston, their loss and counterattack, and the importance of the port in the war effort.

This learning game was compared to a textual information packet of information about the battles. Pre and posttests were given to participants to measure learning gains from the different learning tools. It was found that, while the overall performance on the posttest by game participants did not

exceed those that read the text packet, the question that was most closely associated with the game mechanics showed improvement. Additionally, the participants playing the game reported a higher interest in learning about history and about the Civil War compared to those reading the text, and they reported that they were more likely to want to share the tool with their friends. This lends support that educational games whose gameplay closely mirror the learning outcomes can be effective at teaching students and stimulating their interest.

II. RELATED WORK

Since we are targeting middle schoolers with our educational game, we sought out work on other educational games created to help teach middle schoolers. Squire et al. created a 3D simulation video game designed to teach electrostatic physics concepts [2]. In their game, the player moves around a maze placing charged particles to accomplish their goals. The intention of the game was to build stronger intuitions for electromagnetic concepts. The experimental group outperformed the control group on a posttest survey measuring learning gain. In the self-report section, the experimental group recalled experiences and challenges that allowed them to answer the test questions, whereas the control group only memorized the information, which hurt their recall. Interestingly, the players didn't care that the game was not visually impressive. They were just excited and enthusiastic to get to play a game.

Another experiment also validated this interest that students had in learning through gameplay. Sáez-López et al. used MinecraftEdu to explore historical sites in a middle school history class [3]. The educational game allowed for students to be “part of the learning environment, rather than being a passive recipient listening to someone with more experience.” Posttest survey had very high student self-report that the game improved their learning and was effective at facilitating their learning of historical content.

Two other research teams successfully deployed learning games in middle schools. Denner et al. sought to teach coding to middle school girls by having them program video games using Statecast Creator [4]. Though the students showed a wide range of skills when creating their game products, the game construction itself successfully translated into the students learning computer science concepts like conditionals

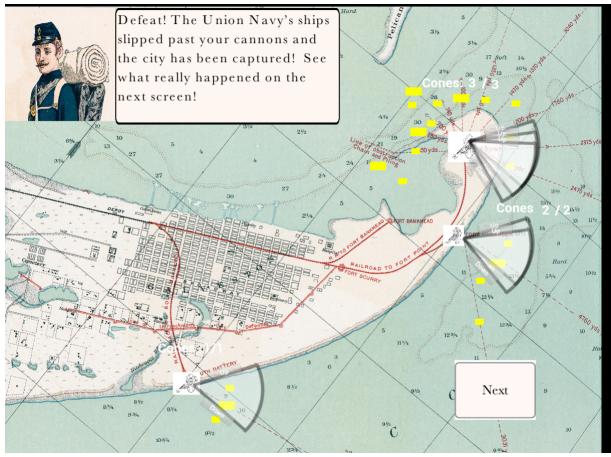


Fig. 1. The first stage of the game, where the player places defenses around the Port of Galveston in order to protect it from the attacking Union forces.

and code grouping. Additionally, Simpson and Clem used the commercially available game called *Restaurant Empire* to teach middle school students to Wyoming educational standards [5]. The students self-reported that they learned a great amount about technology and careers from the game. Simpson offered two insights for researchers: anticipate on-demand learning moments and make sure you have the structure and support to keep students on task.

III. GAME DEVELOPMENT

We supervised two undergraduate students in the development of *The War of the Rebellion*. One was a computer science student, and the other was a museum student who researched the maps and images to use in the game. The game was developed in Unreal Engine 4. There were two stages to the game.

In the first stage, the students were given introductory text about the battle and the importance of the Port of Galveston. The player took the role of the Confederate army and placed defenses around the port. The game board that the players used was an image of a map from the Baylor Texas Civil War map archive and the pictures of the units were drawings from that era. The players were able to select from a predefined set of locations based on actual defenses. The player also could place artillery of different calibers and firing arcs, again based on the historical defenses. The artillery also had to be oriented in a certain direction, so the player needed to try to provide comprehensive defensive coverage. When the player was done, they submitted their unit placement, and they were told whether or not the defense was successful. The success or failure of the student's defense was based on the way the Union attack actually unfolded, both by land and sea. If the player was able to position their artillery to cover enough of the attacking angles, then they were successful. The player was then given a description of the battle and the aftermath of the battle. See Figure 1 for an image of this stage of the game.

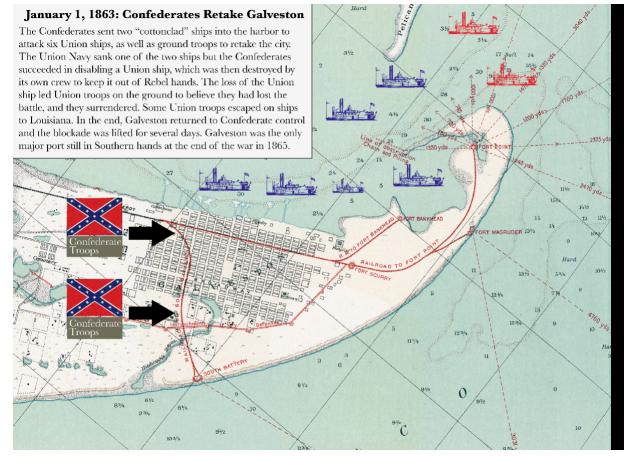


Fig. 2. After each stage of the game, the player learns what happened in the actual battle.

In the second stage of the game, the player controls the attacking Confederate army. The port was concealed in a "fog of war." They were given a limited number of scouting units to reveal the port's defenses. After they were done scouting, they chose to allocate their troops to attack a set number of locations, one troop per location. If enough troops survived, then they successfully retook the port. The troop survived if there was not a defensive unit there, which was revealed if the player chose to send a scout to that location. The player was again given a description of the battle and the aftermath, like in Figure 2.

An information packet was also created to serve as an alternative method of instruction to the game. This packet was created by our teacher collaborator, was two pages, and discussed the Battles of Galveston with text and pictures in a similar method to a textbook. It contained the same instructional content as the game.

IV. SURVEY DESIGN

The 10 question survey used for the pre and post test evaluation was designed in collaboration with the local middle school history teacher who paired with us on the project. Each question was worth one point. The focus was on the importance of the Port of Galveston for the Confederate army, the two battles for the port, and the aftermath of the battles. The same questions were used in the pre and posttest survey. There were also three posttest survey questions measuring their increase in learning about history and in learning about the Civil War as a result of the learning tool, and also how likely they were to recommend the tool to a friend. An excerpt of the tool is shown in Figure 3.

V. EXPERIMENTAL DESIGN

We went into a local public middle school 8th grade history class to conduct the experiment. One session of class period was reserved for the students to complete the pretest, use the survey tool, and complete the posttest. Several machines were set up in the classroom with the game installed. Since

3. What strategy did the Confederate forces use to defend Galveston during the first battle of Galveston?

Place forts at strategic points around the bay with cannons that can fire many different ranges
Cut off railroad access to the city to keep Union from commandeering and using the trains
Mine the bay to discourage Union ships from entering
Move large numbers of troops from nearby garrisons in to protect Galveston

5. What strategy did the Confederate forces use to attack Galveston during the second battle of Galveston?

Scout ways to send large number of infantry into the city and focus their ships' attacks on Union navy ships
Brought in siege guns to shell the city for two weeks until it surrendered
Contact Confederate sympathizers to capture the local commander and force a surrender
Cut off the city's fresh water supply so all that they had was salt water

6. What effect did the battles of Galveston have on the rest of the Civil War in Texas?

It was one of the few Confederate ports by the end of the war, which allowed material to continue to arrive by sea
It was the first time the Confederates had regained a naval city in Texas, which provided a significant boost to Confederate morale
An important Union general, Nathaniel Banks, was killed during the second battle
A large number of Union ships were destroyed during the second battle, crippling Union aggression in the Gulf of Mexico

9. How did the Confederate forces use scouts in the second battle of Galveston?

To determine troop placement and number of troops at Union defenses
To parley with Union forces to negotiate a surrender
To sabotage the city's food supplies
To set fire to the Union's ammunition depots

Fig. 3. An excerpt of the pre and posttest survey. The increase in posttest scores of this survey was used to compare the effectiveness of text versus an interactive game on student learning.

the students were minors, their parents had to sign a form providing consent and the students had to sign an assent form. The students were given a brief overview of the experiment, then were randomly assigned to either the reading or the game based on their seating. They all took the pretest to measure their baseline knowledge of the Battle of Galveston. The students who were assigned the game went in waves as the computer stations opened up. The game took about 10-15 minutes to complete, and the information packet took only a few minutes to read. After the students were done with their instructional tool, they were allowed to complete the posttest.

Two central hypotheses, based on the experimental design, were tested:

Hypothesis 1: The participants playing the video game will show a greater improvement score on the post test compared to the pre test than the participants reading the text packet.

Hypothesis 2: The participants playing the video game will show a greater interest in learning about history and the Civil War and also want to share the learning tool with their friends, compared to the participants reading the text packet.

VI. EXPERIMENTAL EVALUATION

56 students took the pretest, and 33 students completed their treatment, took the posttest, and filled it out correctly. Due to

the time constraints of the class period, not every student was able to finish the experiment, so their data were removed. Of the students that completed everything, 17 students played the game and 16 read the packet. To evaluate Hypothesis 1, the improvement on as a result of the treatment, a one-tailed t test was used to measure the difference between the posttest and pretest questions answered correctly. The individual questions were also analyzed using Fischer's exact test to see if students performed differently on a question by question basis due to the treatments.

To measure Hypothesis 2, the increase in interest for learning about history and the Civil War and also enthusiasm about the learning tool itself, a one-tailed Mann Whitney U test was run on the ordinal Likert scale data. The participants could answer on a 5-point scale: much less interested, less interested, no change, more interested, and much more interested.

VII. EXPERIMENTAL RESULTS AND DISCUSSION

When measuring the learning gain as a result of the treatment, the participants who read the text packet showed a 3.7 point improvement and the participants who played the game showed a 2.6 point improvement. This shows that, overall, the students who played the game did not show a greater improvement than the students who read the packet, $p = 0.91$, $t = 1.76$. It is hypothesized that a weakness in the experimental design could partially account for this result. Since the text packet was short and the participants could take the posttest survey as soon as they were finished with the treatment, the participants might have had the knowledge fresh in short term memory when taking the posttest. The concern here is that the posttest for the control group may not measured the participant's ability to deeply understand and internalize the information. The game took 10-15 minutes to complete, so there was a greater delay in evaluation for the experimental group compared to the control group. If we reran this study, we would make sure the participants in both groups had an equal amount of time before the evaluation of the posttest.

Fischer's exact test was run on each individual question, comparing correct/incorrect on the posttest for both the packet and the game. One question, "What strategy did the Confederate forces use to attack Galveston during the second battle of Galveston?" showed a statistically significant difference in the participants who played the game versus those that read the packet, $p = .0007$. This question was crucial since they were identified to be one of the most important questions for the teacher and were those around which one of the two stages of the game were built. The conclusion here seems to be, like we did with our game development, learning games should be created in close collaboration with the instructor with gameplay emphasis on the most important concepts.

For the posttest questions that asked about increase in interest in learning about history and the Civil War, and whether the participant would recommend the learning tool to a friend, the experimental group stood out. A graphical representation of these results are shown in Figure 4. A Mann Whitney U was run on the ordinal Likert scale data.

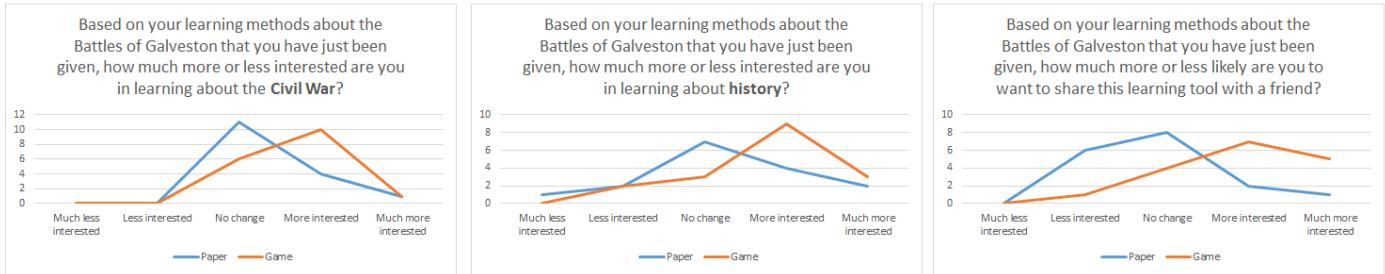


Fig. 4. The results of the posttest survey that measured participant interest in the learning methods. The participants playing the game showed a greater interest in learning about history and the Civil War, and were also more likely to share the learning tool with a friend. The larger area under the line to the right, the more successful the treatment.

For “Based on your learning methods about the Battles of Galveston that you have just been given, how much more or less likely are you to want to share this learning tool with a friend?” the game participants answered statically significantly higher, $p = 0.002$, $U = 58.5$. The Cohen’s d effect size was 1.112, which is between large and very large. For “Based on your learning methods about the Battles of Galveston that you have just been given, how much more or less interested are you in learning about the Civil War?”, and “Based on your learning methods about the Battles of Galveston that you have just been given, how much more or less interested are you in learning about history?” the game participants answered marginally significantly higher, $p = 0.065$, $U = 93.5$, effect size 0.553; and $p = 0.075$, $U = 95.5$, effect size 0.525. Both of these effect sizes are medium. A summary of these results are found in Table 1. These conclusions match the anecdotal data of talking to the participants and also the results found by Squire et al. The sole experience of getting to play in class greatly excited the students, whose enthusiasm seems to extend to a greater interest in the subject material. We the researchers did not think very highly of the sophistication of graphics or polish of the research game, but none of those limitations were noticed or detrimental to the students. This result is a strong indication of the power of learning games in motivating students to learn.

VIII. CONCLUSION

Video games are an attractive medium for educators to use as learning tools. Many young people play games on a regular basis and have grown up with them as sources of entertainment. Learning games have been used successfully in middle schools for educating students and building their enthusiasm for the subject matter. Our game, *War of the Rebellion*, was designed in partnership with a local middle school teacher to supplement learning for the Texas history section of an 8th grade history class. The game taught the students about the Battles of Galveston by allowing them to command troops in the attack and defense of the port. This game was compared to a traditional textbook analogue by having the students read a textual summary of the battles. It was found that there was no significant improvement in the increase in posttest scores of students that played the game

TABLE I
SUMMARY OF EXPERIMENTAL RESULTS

Summary of important statistical findings	
Improvement	p value
Question 5: What strategy did the Confederate forces use to attack Galveston during the second battle of Galveston?	$p = 0.0007$
“Based on your learning methods about the Battles of Galveston that you have just been given, how much more or less likely are you to want to share this learning tool with a friend?”	$p = 0.002$
“Based on your learning methods about the Battles of Galveston that you have just been given, how much more or less interested are you in learning about the Civil War?”	$p = 0.065$
“Based on your learning methods about the Battles of Galveston that you have just been given, how much more or less interested are you in learning about history?”	$p = 0.075$

compared to those that read the packet, though this experiment only tested the short-term recall of the students. However, for one particular question, the one that most closely aligned the the gameplay, the students that played the game showed an improvement. The students that played the game also showed a greater interest in learning about history and the Civil War, and were statistically significantly more likely to recommend the learning tool to a friend, compared to those that read the text packet. This validates that games that are closely designed with the gameplay matching the desired learning outcomes can be an effective tool at teaching students and also building interest in the subject matter.

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