Effects of 3D Immersive Learning Environments on Learning and Retention

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Abstract

Online, three-dimensional learning environments allow learners to actively construct meaningful knowledge from experiences in an immersive virtual world. In this study, students will experience a lesson through either a traditional combination of teacher-led discussion and textbooks or through a combination of teacher-led discussion and an immersive learning environment. At the end of the unit, students will be tested on their comprehension of the material. The two samples will be compared to measure initial performance. After a period of several months has passed, at the end of the semester, students will be tested again to gauge their retention of the material. The newest test scores will be compared to the older test scores to measure the amount of retention. The two samples will be compared again, this time comparing the differences between the past and present scores. Students will also be interviewed after each test to examine their experiences.

*Keywords*: immersive learning environment (ILE), Second Life (SL)
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Introduction

The rapid advancement of online and gaming technology has introduced a number of new and unique possibilities for teachers to engage their students. One technology, in particular, offers a unique advantage for educators trying help their students succeed. Immersive learning environments provide students with interactive, hands-on experiences that go beyond traditional textbooks and lectures and may help students achieve higher exam scores and retain knowledge for longer periods of time.

Literature Review

An immersive learning environment (ILE) is a three dimensional virtual environment that allows users to interact with their surroundings through virtual representations of themselves, called avatars. In these environments, students are able to move their avatars freely and interact with other virtual objects and avatars. ILE’s can be accessed through desktop computers or head mounted virtual reality headsets. If this definition makes the ILE sound more like a video game than a movie, that’s because multi-user virtual environments do indeed have their roots in the virtual gaming worlds of massively multiplayer online games such as NeverWinter Nights and World of Warcraft (Warburton, 2009).

Utilizing an immersive learning environment, a teacher can create a real or even imaginary world for the students to learn and explore in that would otherwise be too expensive, dangerous, or otherwise impossible to visit (Haycock & Kemp, 2008), such as a lesson set in space or at the battle of the Alamo, as this study will recreate. In one study, fifth grade students were able to work together in a virtual garden, altering conditions such as sunlight and water to
test the effects on the growth of their plants (Roussos, Johnson, Moher, Leigh, Vasilakis, & Barnes, 1999). Students were able to take the training further by doing things they would never be able to do in reality, such as shrinking down to travel underneath the soil to inspect the plant roots.

Many of the benefits of immersive learning environments become evident when looking at the technology through a constructivist paradigm. The constructivist theory states that students learn best when they are able to take an active role in their learning through authentic tasks. Immersive learning environments allow students to interact with a realistic environment, performing assigned tasks and encountering problems that require them to assimilate and apply new knowledge (Huang, Rauch, & Liaw, 2010).

Another important constructivist principal addressed by immersive learning environments is that of collaborative learning. Using the ILE as a shared space, large numbers of students are able to get together and assist each other with tasks, typing and speaking to each other to build shared understanding. Despite the fact that learners are interacting with each other through the use of virtual avatars, studies show that learners perceive of these avatars as real people, or rather as proxies of real people (Huang et al., 2010). Students can join in avatar or chat rooms to see and interact with each other in virtual settings, even though they may physically be miles apart.

One advantage of immersive learning environments concerns the concept of “presence”, which is the extent that a learner feels that they are actually “in” their environment (Xu & Ke, 2016). Mental and physical (sensory) immersion in an ILE is heightened as a user navigates their environment- when they move or interact with virtual objects, they use their visual, auditory, and haptic cues to gather information and react, furthering their sense of presence (Huang et al., 2010). Another advantage of presence is that it reduces cognitive load. Properly
designed, an ILE with intuitive controls enables the learner to concentrate on their tasks rather than focusing their attention on the logistics of navigating within their environment (Xu & Ke, 2016).

There are a variety of programs available at this time that support immersive learning environments, with many more (100+) under development (Salmon, 2009). Some examples of immersive learning environments include the CAVE, which is a room-sized system consisting of three walls and a floor, and includes a wand for interacting with the environment and a virtual reality headset (Roussos et al., 1999). Another popular program is OpenSimulator (OpenSim), which is an open-source virtual reality server. The most developed and popular program as of the time of this writing is Second Life (SL).

Some of Second Life’s greatest strengths include its flexibility and its object creation toolsets. Second Life’s flexibility can be observed by witnessing the sheer volume of worlds that have been created (Warburton, 2009). In addition to fantasy and adult-themed virtual worlds, several librarians have created islands in SL that host a number of learning resources. Second Life also allows faculty, students, and instructional designers the ability to create an unlimited amount and variety of virtual objects and structures within the environment (Haycock & Kemp, 2008). In fact, SL offers the most powerful object creation toolset of any ILE (Salmon, 2009), providing a simple and intuitive tool that allows both teachers and students to create learning artifacts.

Because of the advantages that SL provides, it was the program chosen to host the ILE for this study. The ILE environment will take place on a purchased “island” within Second Life created to model the Alamo before the famous final battle. The virtual environment will consist of the Alamo itself along with the surrounding natural environment and people within.
Significance of the Study

If the introduction of an ILE can be shown to cause students to achieve better test scores or improved knowledge retention, schools can begin considering the investment in the ILE technology, especially as the technology continues to evolve and become cheaper. In addition, many of the ILE studies have studied the immediate effect of the technology without regarding the potential long-term retention benefits such a tool might provide. This study will attempt to shine light on that aspect of ILE’s.

Research Questions

By comparing the results of an immersive learning environment to a traditional classroom environment, this study will seek to answer the following three questions: One, does interaction in an immersive learning environment improve student performance on exams? Two, does participation in an immersive learning environment increase the amount of knowledge students retain after a significant amount of time has passed? And three, what are student attitudes toward immersive learning environments?

Methods

This study will compare a lesson taught using a combination of lecture and immersive learning technology to a lesson taught using a traditional combination of textbook and lecture. The study will utilize a mixed method approach, consisting of quantitative analysis of exam scores given at two different periods of time, along with qualitative interviews to record student feelings toward immersive learning technology.
Learning Scenario

This study will utilize a virtual immersive learning environment consisting of an island created on Second Life designed to mimic the Alamo. The majority of the lesson will take place within the walls of the Alamo, specifically covering the 13-day siege and eventual final battle of the Alamo. Activities within the ILE will focus on allowing students to explore and participate in events leading to the downfall of the Alamo. Students will be able to create their own avatars and will be provided with clothing options appropriate for the time period. They will also be able to choose weapons (also appropriate for that time period), or if they wish, choose no weapons at all. The purpose of the avatar selection process is to further student immersion into the virtual world.

The lesson will consist of three loosely structured activities. The first activity will function as both a tutorial for using Second Life as well as an exploration of their surroundings. Students will participate in a small skirmish introduced to begin the 13-day siege. Students will explore the interior and exterior of the Alamo, and will be able to interact with objects, clicking on them for more information as needed. Interactive objects will include food stores, artillery, ammunition, non-player characters (NPCs) going about their work, and of course, key historical figures, such as James Bowie, William Travis, and Davy Crockett.

The second activity will consist of game-based tasks that will allow students to further explore the setting. Tasks such as gathering supplies and running messages to key historical figures will help to enrich their understanding of the time period. They will also witness the legendary speech by Travis where he supposedly drew a line on the ground.
The third activity will be the most game-like, where they’ll actively take part in the final battle. They’ll be tasked with visiting different areas of the defense and speaking to key figures again, and play a role in the losing battle.

**Participants**

The population will consist of 4 different periods of a junior high Texas History class. The classes will be randomly assigned to either the control group (consisting of the traditional lecture and textbook methodology) or the experimental group (consisting of the lecture and immersive learning environment).

The teacher will also participate within the ILE as a facilitator and tour guide. Additionally, a researcher will be onsite with the students to provide technical support as needed and to record observations. The experimental groups will attend their class in a computer lab while the control groups will attend class in their normal classroom.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Experimental Group (Lecture + ILE)</th>
<th>Control Group (Lecture + Textbook)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam # 1 (Testing initial ILE effectiveness)</td>
<td>2 Texas History class periods</td>
<td>2 Texas History class periods</td>
</tr>
<tr>
<td>Exam # 2 (Testing knowledge retention)</td>
<td>2 Texas History class periods</td>
<td>2 Texas History class periods</td>
</tr>
<tr>
<td>Qualitative Interview (Testing student attitudes)</td>
<td>2 Texas History class periods</td>
<td>Not Interviewed</td>
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</tbody>
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**Data Collection and Analysis**

After completing the lesson, all four groups will take the first exam, consisting of multiple choice and short answer questions. The independent variable will be the application of the immersive learning environment to the two sample groups. The dependent variable will be the students’ test scores, which will be averaged in each sample group and compared for the
purpose of determining which group got the better scores. These results will answer the first research question, which was “Does interaction in an immersive learning environment improve student performance on exams?”.

At the end of the semester, a second test will be administered to the students. Once again, the exam scores will be separated by those that participated in the ILE (the experimental group) and those that did not (the control group). This time, the students’ test scores will be compared to their previous test scores. The differences between the two scores will be recorded. Those score differences will then be averaged in each sample group and then compared to the other group for the purpose of determining which students retained the most knowledge. The results will answer the second research question, “Does participation in an immersive learning environment increase the amount of knowledge students retain after a significant amount of time has passed?”.

Following the first exam, the students in the experimental group will also be interviewed. Questions will focus on several themes: motivation, ease of technology use, feeling of overall learning, and enjoyment of the technology. Additionally, observations from the onsite researcher will also be used in the qualitative analysis. The results of these interviews will answer the research question, “What are student attitudes toward immersive learning environments?”.

**Anticipated Results**

It is anticipated that the students that participated in the immersive learning environment will achieve higher scores in both the initial and second exams than those in the control group. Further, it is likely that the differences between the two sample groups will be even more pronounced in the second exam, as students should be able to better retain the knowledge after
having participated in an immersive learning environment. It is also anticipated that student attitudes in the experimental group will be positive, but it is expected that a small percentage of the students may have negative feelings due difficulties with the technology or lack of direction during the exercise.

Conclusion

Immersive learning environments provide a unique and compelling alternative to traditional teaching methodologies. However, the time and effort that goes into creating them, along with the cost of the equipment needed to facilitate this teaching alternative, necessitate preliminary testing to justify the expense. If the introduction of immersive learning environments can be shown to consistently improve student grades and retention, other schools and software developers will recognize the unique opportunities they provide and begin to purchase and develop products to take advantage of the emerging technology.
References


