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The Effectiveness of Virtual Worlds for Education: An Empirical Study

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ABSTRACT

Despite the widespread popularity of using virtual worlds for education, only a few studies have compared learning outcomes in virtual worlds versus other, less resource-intensive media. A within-subjects study examined cognitive and affective learning outcomes when using a virtual world and voice-over slide presentations to learn about the Forbidden City in China. Results show that learners consistently reported higher perceived learning and satisfaction with learning in the virtual world than when using voice-over presentations, even when scores on tests of declarative knowledge were lower when learning in the virtual world if the virtual world was used first. An interaction effect between learning method and learning method order indicates that simply using a virtual world is not sufficient to improve cognitive learning outcomes.

Keywords:

virtual worlds, education, situated learning, telepresence, immersion

INTRODUCTION

The use of virtual worlds for delivering education and training is gathering a lot of attention. Universities, educational organizations, museums, and libraries from around the world have created a presence within Second Life, a public virtual world with free access, as well as in private virtual worlds. The popularity of virtual worlds for delivering education may in part be attributed to the many benefits touted for online learning in general. These include: the elimination of travel or commuting costs; flexibility in meeting times; ability to have a gathering of people from all over the world; a decrease in performance anxiety that some students might have in a regular classroom; a record of classroom interaction; and synchronous and asynchronous interaction with the teacher and other classmates. With the number of virtual worlds estimated to double almost every two years (Schultze and Renneker, 2007), the use of virtual worlds for educational use is likely to gain in prominence in the future.

Virtual worlds are a form of non immersive virtual reality (Mils and Noyes, 1999) because the view of the user is limited to what is on the computer monitor as opposed to fully immersive virtual reality in which users wear head mounted displays and are surrounded 360 degrees by the simulated environment. Virtual worlds are characterized by the attributes of physicality, interactivity and persistence (Castranova, 2001). They have physicality in that users can interact with and move around in a 3-D virtual environment. The interactivity of virtual worlds stems from the ability of users to interact not only with objects but also with other users within the world. Virtual worlds are persistent in that changes in the world are saved and remain regardless of the entrance or exit of users, until another change in the world affects it.

Many virtual world environments are replicas of real world places that either exist now or existed in the past. For example, the Dresden Art Gallery has set up a replica of its building within Second Life; users can walk through this replica and take an audio tour of the art works as if s/he were in the real gallery in Dresden. Other examples of replications include a re-creation of ancient Rome, the Cologne Cathedral, and Mont Saint Michel, which all exist within Second Life. Similar to visiting such places in the real world, users are free to roam around on their own and seek out what is of personal interest. In this study, we are focusing on the educational use of virtual worlds that replicate real world environments.

Although interest in virtual worlds in education is increasing, there have not been many studies conducted on their effectiveness to date. The studies that do exist support some benefits of virtual environments and virtual worlds for education. Esteves, Fonseca, Morgado, and Martins (2009) found that learning computer programming in Second Life was possible for students when the project relied on the visual capabilities of the virtual world. Virtual world simulations have also been found

to lead to higher student evaluations, higher satisfaction, and less time spent memorizing work information for border crossing guards in Canada (Hudson and deGast-Kennedy, 2009). However, these studies do not show whether the same effects could be reached with another, less resource-intensive technology, and they focus on behavior-based learning rather than whether or not students can effectively gain declarative, or factual, knowledge. This study addresses both of these issues by comparing student learning about the Forbidden City using two different learning media. Changes in declarative knowledge and affective outcomes are examined.

Virtual worlds have been used to offer classes, educational events, virtual tours, replications of real life places or artifacts, and to offer experiences that may not be possible in the real world. Using virtual worlds for such purposes may be effective for several reasons. One reason is that virtual world users are able to have embodied interaction (Jarmon, 2009), which has been shown to have positive, real-world benefits. Known benefits include speedier recoveries for stroke victims who used Second Life and saw their avatars walking compared to those not using Second Life (Stein, 2007). Use of an avatar has also helped amputees eliminate phantom limb pain (Avasthi, 2007). Virtual worlds also offer important key capabilities such as telepresence and immersion in a realistic physical space (Dede, 1995), and allow people from all over to meet and learn together regardless of geography (Ondrejka, 2007).

However, it has also been noted that learning is affected more by what is delivered than by the delivery system itself, and that there is sometimes more variance in student learning within a medium than between media (Schramm, 1977). Technology and its features can potentially enable new forms of teaching and learning, but technology alone does not ensure a different or better educational experience (Kirkwood and Price, 2005). Therefore, a thorough understanding of the effectiveness of learning with virtual worlds is important to help guide their use in educational programs. Although many potential benefits have been proposed, these benefits have not been fully explored empirically. As organizations increasingly look to technology for aiding educational program effectiveness, it is crucial to understand how, or if, virtual worlds lead to differences in learning outcomes for students. This understanding will lead to better decisions about which technology to use for improving learning outcomes.

In this study we compare student learning using two different media. Students learned about the Forbidden City in Beijing, China using both a voice-over PowerPoint presentation and a virtual world that replicates the Forbidden City during the Qing dynasty. Voice-over presentations were used to reflect a tool common to online, asynchronous courses. We measured declarative knowledge with a quiz on what the students had learned. Affective outcomes are also important, as student experiences can affect future motivations and attitudes about learning. We therefore looked at the affective outcomes of perceived learning and satisfaction with the learning experience. These were measured with a post-learning survey after using each medium. The within-subjects design allows us to detect subtle differences in learning outcomes between the different learning methods while also minimizing error related to individual differences between learners.

THEORY AND RESEARCH MODEL

Our research model (Figure 1) proposes that using virtual worlds for learning will lead to different learning outcomes compared to using voice-over presentations. We propose that the ability to create experiences that allow situated learning and the features of virtual worlds will lead to positive cognitive and affective learning outcomes.

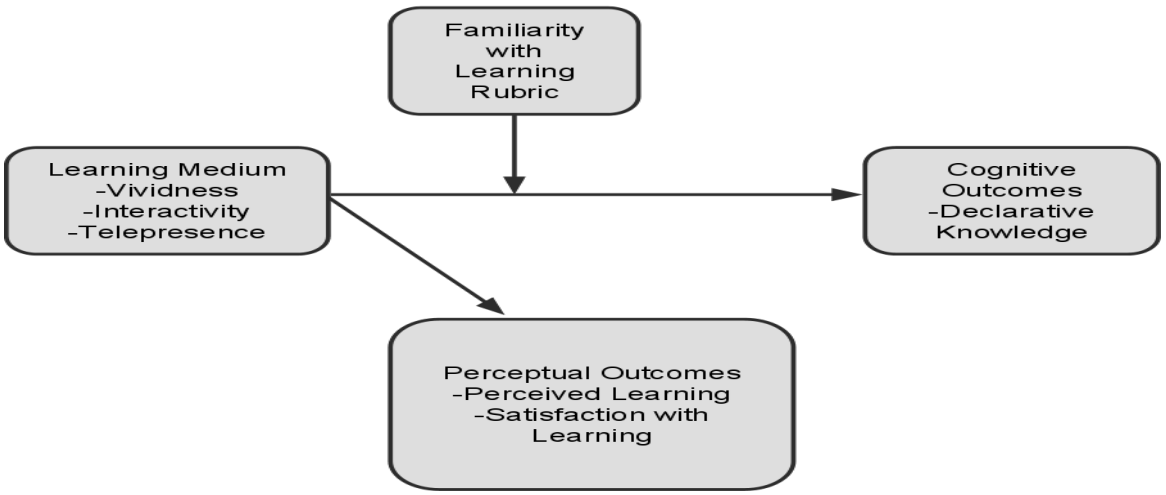

Figure 1: Effects of Learning Medium on Learning Outcomes

Situated Learning Theory

Technology can enable teaching and learning but does not ensure success. Technological features alone cannot coerce an unmotivated student to learn, for example. An understanding of the learning process is also critical to understanding the use of virtual worlds in education. Views on learning have changed over time, moving from a representational view of learning in which the teacher disseminates information to a more constructionist view in which learning is developed primarily through activity (Anderson, Reder, and Simon, 1997). Situated learning theory is one theory that falls under the constructionist paradigm. Situated learning theory proposes that learning happens within the context in which it is to be applied and within a social and physical environment (Lave and Wenger, 1991). Learning is active and acquired through relevant experiences rather than through passive means like memorization and lectures. In situated learning, learners do not gain knowledge from abstract concepts or theories that are provided without a meaningful context, but rather use their own experiences and perceptions to construct knowledge. Activities that promote meaningful experiences and knowledge acquisition within an authentic context can promote situated learning. Immersive language programs, simulations and role-plays, field trips, and immersion in virtual worlds are examples of this type of activity.

Virtual worlds are a new tool that may aid situated learning through bringing previously unavailable contexts to users and allowing exploration and virtual embodiment for experimentation. For example, a replica of Mt. Saint Michel in Second Life, complete with surrounding streets, allows users to take a virtual field trip. Users can explore the area by walking through it, and experience it through their avatars. This would allow them to construct and interpret knowledge about the area in ways that are different from reading about it in a book or hearing someone talk about it.

Effects of Virtual Worlds on Learning Outcomes

Virtual worlds offer vivid, interactive environments which lead to a sense of telepresence, or being in a different location than where one is physically. Vividness is the medium's ability to produce a rich environment through the way information is presented to the senses. More vivid environments have greater interface breadth and sensory depth (Steuer, 1992). Breadth is the number of cues available for communicating or sensory stimulation. Sensory depth is the quality of the available channels, such as audio or video fidelity. For example, rather than a picture of a building or person as in a slide presentation, a virtual world can transmit information from several perspectives and in higher detail, thus adding to the quality of the image and the channels from which information can be obtained. Ambient sounds or atmospheric music also add to the depth of the audio channel. Therefore, virtual worlds would be placed higher on the vividness continuum than voice-over presentations because of their greater breadth and depth.

Virtual worlds also offer high interactivity, or the ability to manipulate the mediated environment in real time (Steuer, 1992). Interactivity is comprised of speed, range and mapping. Speed refers to how quickly information is communicated to the user; range is the extent of interactivity available; and mapping is how much human movements transfer into the virtual space

(i.e. pressing the left arrow key on your keyboard maps into your avatar turning and moving left in the virtual world). Virtual worlds have high interactivity in that users can manipulate the virtual environment around them in real time, and users can be active in their engagement with the information presented, the environment, and with other users of the environment (Pimentel and Teixeira, 1994). In contrast, voice-over presentations are lower on the interactivity continuum; they offer much less range and mapping of interactivity than virtual worlds.

Vividness and interactivity are pre-cursors to the sensation of telepresence (Steuer, 1992). Presence in computer mediated environments can be defined as the perceptual illusion of non-mediation (Lombard and Ditton, 1997). The vividness and interactivity in virtual worlds allows users to create this perception of non-mediation and become engaged in the mediated environment rather than in the environment in which they are physically located (Biocca, 1997). As compared to watching a voice-over presentation, a virtual world offers higher levels of vividness and interactivity and can therefore be expected to more easily enable a sense of non-mediation and telepresence in users.

Virtual worlds can thus offer unique experiences that are consistent with situated learning theory, including the ability for hands-on learning, learner controlled experiences, and concept perception (Bricken, 1991). Because of vividness and interactivity one is likely to feel one is present in the place one is learning about, which makes being in a virtual world more like a true experience. The contextually relevant context and ability to experience the subject should lead to a more personally relevant and meaningful learning experience. According to situated learning theory, this should enhance ability to learn declarative knowledge about the subject.

In contrast, voice-over presentations are less vivid and interactive, leading to less of a sense of telepresence. Therefore, using a voice-over presentation is less like an experience with the subject matter and more like listening to a lecture in a classroom. The disconnect between the subject and the learner's personal experience is likely to lead to a less personal and meaningful learning experience and overall less retention of declarative knowledge.

> H1: Declarative knowledge will be higher when students learn with the virtual world than when learning with the voice-over slide presentation.

Virtual worlds offer users more interactivity and control over their experiences than voice-over presentations. The sense of control and ability to interact with information in a way that is comfortable for the learner and at the learner's own pace should lead to an increase in perceived learning (Swan, 2001), because the learner is able to gather information in multiple ways rather than spending cognitive effort to adjust to how the information is being presented. This allows the learner to reflect on and incorporate his/her experience into existing cognitive models. It also should keep learners engaged in the learning activity. Thus the more interactive experience in the virtual world will make students perceive that they have learned more in addition to improved performance.

Voice-over presentations, on the other hand, offer a more passive way of learning and one that may be in a format that is difficult for some learners to use effectively. Additionally, the less interactive presentation may lead to periods when the learner is not fully concentrated on the learning experience.

> H2: Perceived learning will be higher when students learn with the virtual world than when learning with the voice-over presentation.

The theory of cognitive fit proposes that IT applications should fit user tasks in order to obtain positive outcomes from using IT (Vessey and Galletta, 1991). Suh and Lee (2005) found that virtual reality environments were able to increase consumer learning for products that could be easily examined through the senses of vision and sound. Other research has found that when users find that the technology fits their task, they believe that it has a more positive impact on their effectiveness (Goodhue and Thompson, 1995).

When using a virtual world to learn about a place, the feelings of task-technology fit should be high because the features of the virtual world stimulate users' senses of orientation, sight, and sound and allow them to feel immersed in the virtual world environment. Users may also be able to manipulate items in the virtual world in order to gain more perspective and visual details of items. Due to positive feelings of task-technology fit, users are likely to feel that the virtual world enabled them to complete their learning task effectively, thereby leading to higher satisfaction with learning.

> H3: Satisfaction with learning will be higher in the virtual world than with the voice-over slide presentation.

Although situated learning theory purports that learning experiences should be learner centered, interaction with the instructor is still an important component of learner achievement and satisfaction because of the guidance and structure that the in-

structor can provide (Hong, 2002; Swan, 2001). Learners may find too much information without facilitation and connection, such as one might experience by surfing the web, to be distracting and confusing. Access to information by itself does not constitute learning. Therefore, although learner control is important for learning, structured activities and facilitation are also important for successful learning outcomes (Swan, 2001).

In a learning situation such as a virtual world that is designed for free roaming and learning with minimal guidance, learners may be distracted or may not know what information is important. A voice-over presentation, on the other hand, guides learners through the most critical information through selected text and pictures. Experience with a voice-over presentation can show students what types of information they may encounter or wish to seek out in the future when in the virtual world. Familiarity with the assessment tool used may also help learners understand what information is critical for them to learn for future assessment. This idea of what information is critical, coupled with the higher levels of vividness, interactivity, and presence should lead to higher scores when a virtual world is used for learning after a student has learned a similar topic using a voice-over presentation. Those who use the virtual world first may find it too overwhelming and unguided to provide a meaningful learning experience despite the extra features available for learning. Meanwhile, those who use the presentation first and then learn with the virtual world will have the benefits of the medium, plus some familiarity with the topic and the evaluation methods so that their performance will increase. Those that use the presentations, after the virtual world, although gaining some familiarity with the topic and the evaluation method will lack the benefits of the virtual world learning method. Based on this, we propose the following interaction effect of learning method and the order in which one learns using a virtual world:

> H4: There will be an interaction effect of learning method and the order in which one learns using a virtual world on declarative knowledge. Specifically, when the learning experience in a virtual world happens after the learning experience with voice-over presentation, declarative knowledge gained in virtual world relative to that gained via voice-over presentation will be higher than when the virtual world learning happens first.

Note that declarative knowledge should increase in the second round of learning. However, declarative knowledge will increase the most for those who used a virtual world second, and will show less of an increase for those who used a virtual world first.

METHOD

Participants

Participants were students enrolled in the "Introduction to MIS" course of an MBA program at a Northeastern university (N=80). Participants volunteered for the study as part of their regular course credit. Those that did not wish to participate in the study were able to complete the course credit another way. Participants were 46.2% female. Average age of participants was 24.45 years. Participants were divided randomly into 4 groups. These groups signified which learning medium they would use first and which learning scenario they would complete first.

Study Design and Procedure

This study employed a within-subject design examining the outcomes of two different methods for online learning: voice-over presentations and a virtual world. The study focused on learning facts about the history and culture of China in the Forbidden City during the Qing dynasty (1644-1912). Students were free to complete learning modules on their own and at their convenience within given time frames. Assessment of learning outcomes was done through a quiz after the completion of the learning modules and a survey of the participants' experiences and perceptions.

Participants used the Virtual Forbidden City: Beyond Space and Time (http://www.beyondspaceandtime.org). The Virtual Forbidden City (VFC) is s result of collaboration between the Palace Museum in China and IBM. It is a replication of the Forbidden City during the Qing dynasty. Registering to use the VFC is free. In the VFC, users can view maps, move around and through buildings, read information about artifacts, view and manipulate 3-D models of buildings and artifacts, see some photos of the real buildings and artifacts in Beijing, and interact with scripted characters that provide text-based information about what the user sees. Avatars in the VFC are dressed in historically accurate Chinese clothing and represent characters that may have been present during this period of history. Participants are able to choose freely among these avatars for their representation within the virtual world. The VFC also has some active scenes that users can watch. The scenes use pro-

grammed avatars to act out parts of daily life in the Emperor's court. Visitors to the VFC can observe and move around within these scenes and receive text-based information about what they are seeing.

A voice-over PowerPoint presentation was also used to convey information about the Forbidden City. Voice-over presentations are multi-media presentations that can incorporate text, images, audio, and embedded video. The voice-over presentations used in the study were PowerPoint slide presentations, rendered as an online video. The presentations featured the same artifacts and information that could be found in the VFC. The slides included important points about the topic, images of artifacts or activities, and an audio track describing the artifacts and their historical significance within the Forbidden City. The slide text was formatted as bullet points, while the audio track featured a female voice that provided more information about the bullet points. Information on the slides was taken directly from the VFC so that students received the same information and had a chance to view the same images regardless of learning condition, although the images in slide presentations were 2-dimensional rather than 3-dimensional as in the VFC.

The study consisted of three phases, a training phase and two learning phases. In the training phase participants completed an exercise designed to familiarize them with the virtual world. This exercise, which consisted of several steps, was implemented in Blackboard, a popular web-based course management system. After the participants started their exercise, subsequent steps were released adaptively only upon completion of the prior steps. Participants downloaded the VFC software onto their own computers and completed the training phase at a location convenient to them, in order to more accurately mimic online learning situations. Participants were given a training document and access to a training video that showed them how to set up their VFC accounts and begin navigating around the virtual world. During the training exercise, participants explored the VFC, were instructed to visit specific areas of the VFC, and completed a survey with some basic demographic information. Participants provided proof of successful completion by submitting a document in which they gave their user name and screen shots of their activities within the VFC. The screen shots also contained dates and timestamps from their computer screen and VFC account so that the experimenters could verify that the exercise was completed on time and before the other phases of the experiment. At the end of the training phase, participants responded to a survey designed to gather demographic data as well as their reactions to learning in a virtual world.

In each of the two learning phases, participants completed one of two learning scenarios (A and B) in which they learned about some specific artifacts and events in the Forbidden City. Each scenario consisted of 4 items (3 artifacts and 1 event) to learn about. Two versions of each learning scenario were created, one for each learning medium. During the first learning phase, 20 participants learned about items in scenario A in the VFC, 20 learned about items in scenario B in the VFC, 19 learned about items in scenario A by viewing a voice-over presentation online, and 21 learned about items in scenario B by viewing a voice-over presentation online. For the second learning phase the learning method and scenario were switched for each participant. Thus the order in which participants used a learning medium was counter-balanced perfectly while the order in which participants saw the learning scenarios was approximately counter-balanced. Perfect balance could not be achieved for learning scenarios due to participant attrition.

Participants completed the learning phases at a time and place of their choosing during two 4-day windows made available to them. There was a gap of 2 days between the two windows. Each learning phase consisted of several steps and was implemented in Blackboard. After the participants started any learning phase, subsequent steps were released adaptively only upon completion of the prior steps. For instance, students could not see or complete the final survey before completing the prior steps necessary to complete the phase. Students were instructed to complete all the activities in the learning phase at once to avoid "forgetting" what they have learned due to a time gap. Timestamps from screen shots of participants' computers and from Blackboard helped determine that the phases were completed within the correct time frame and all at once. After each learning phase, participants took a quiz to test their knowledge on what they had learned. The quiz was given a fifteen-minute time limit so participants would not have time to look up answers on the Internet or go back to the learning materials. Blackboard logs suggest that participants stayed focused on the quiz and did not stray elsewhere. Finally, participants filled out a survey after each learning phase which measured perceptions of their experiences.

Measures

Declarative Knowledge

Knowledge about what was learned during the learning phases was measured using a quiz. Quiz performance was measured by taking the individual scores from the quiz after each learning phase. The quizzes were comprised of twelve multiple choice questions, three questions each about four different items covered in the learning scenario. Two of three questions per-

taining to each item were designed to test knowledge about the role the artifact played in the Forbidden City or Chinese culture. The third question was used to test physical knowledge of the artifacts, such as size or placement. To control for variations in scores due to the learning scenarios, quiz scores were standardized within each learning scenario before they were employed in data analysis.

Perceived Learning

A survey was administered at the end of learning phases to measure perceived learning, satisfaction, and other variables. The perceived learning scale comprised of six items based on Alavi's (1994) study of computer-mediated learning (α= .88). Items relevant to this study's learning exercise were used to construct the scale. The items used a 7-point Lickert scale from strongly agree to strongly disagree. (Sample item: Today's learning exercise increased my understanding about the Forbidden City.)

Learning Satisfaction

Five survey items comprised a 7 point semantic differentiation scale for measuring satisfaction with learning (α= .84). The items were adapted from Alavi, Yoo, and Vogel (1997). (Sample item: Learning about the Forbidden City using a virtual world is Understandable/Confusing.)

RESULTS

Two MANOVAs were performed, one to test the effect of learning method on declarative knowledge and another to test the effect of learning method on perceptual variables. The MANOVA test was chosen to test repeated measures to avoid problems with assumptions of sphericity and inflation of Type I errors that can occur with ANOVAs and repeated measure tests (O'Brien and Kaiser, 1985). A variable representing the order in which the learning methods were used and another representing which scenario they completed first were added as controls.

The MANOVA for declarative knowledge yielded no significant main effect of learning medium on quiz scores ($F(1, 77) = .33$, $p = .57$). Quiz scores were standardized within learning scenarios so variations due to learning scenario were controlled for. Quiz performance after using the virtual world were lower than after using the voice-over presentation ($M = -0.03$ vs. 0.03). There was no main effect of learning medium on quiz scores, so H1 was not supported. However, there was a significant interaction effect of learning method and order ($F(1, 77) = 3.98$, $p < .05$), supporting H4. In the first learning phase, those who learned with the virtual world performed significantly worse than those who learned using slides with voice-over ($M = -0.32$ vs. 0.02, $p < .04$). In the second learning phase, there was an improvement in the performance of those who learned with the virtual world relative to those who learned using slides with voice-over. Specifically, in the second learning phase, those using the virtual world performed as well as those who learned using slides with voice-over. In fact, virtual world users displayed higher performance than the users of slides with voice-over; however this difference in performance was not significant ($M = 0.25$ vs. 0.05, $p < .36$).

The MANOVA for perceptual variables yielded a significant effect of the learning method ($F(2,76) = 9.95$, $p = .00$). Since the MANOVA yielded significant results at the composite level, univariate analysis was conducted for each variable. Participants reported higher perceptions of learning in virtual worlds versus perceptions of learning using the voice-over presentation ($M = 5.39$ vs. 4.94). This was also significant ($F(1, 77) = 16.38$, $p = .00$). Participants reported a higher level of satisfaction with learning after learning with the virtual world versus satisfaction with learning after learning with the voice-over presentation ($M = 5.30$ vs. 4.88). The test for satisfaction with learning was significant ($F(1, 77) = 13.83$, $p = .00$). No interaction effects were observed. Therefore, H2 and H3 were both supported.

DISCUSSION

This study empirically tested cognitive and affective outcomes of using a virtual world to learn declarative knowledge as compared to using an online voice-over presentation. Results support the finding from previous online learning literature (e.g. Piccoli, Ahmad, and Ives, 2001) that affective outcomes are not correlated with cognitive outcomes. Participants using the virtual world consistently reported higher perceived learning and satisfaction with learning, even when overall performance for declarative knowledge acquisition after using the virtual world was much lower. This also lends support to champions of using virtual worlds who have argued that the experiential and immersive nature of virtual worlds will positively affect student perceptions of their learning.

The lack of support for a main effect of learning medium suggests that the immersive experience of virtual worlds may not lead to higher learning on its own. Our results showed that students learning in a virtual world did worse than those learning with a voice-over presentation in the first learning phase, and scores improved only if the virtual world was used last, in the second learning phase. In the second learning phase, though the scores of the virtual world participants were higher, they did not significantly exceed scores of participants in the voice-over presentation condition. This interaction of learning method and method order lends support to the idea that a virtual world by itself will not increase learning. Simply sending learners into a virtual world and asking them to explore certain items without guiding them about what they should learn about those items may hinder acquisition of declarative knowledge. Even with the benefit of familiarity with the evaluation method and the structure offered by previous experience with the voice-over presentation, quiz performance after the virtual world did not significantly exceed that of the voice-over presentation. This suggests that the major benefit of using virtual worlds for education may lie in the affective outcomes, which are important for student motivation and perceptions of their own capabilities.

Qualitative data gathered from participants in an open-ended question about their experiences using the two media seems to support the findings of the quantitative data. A majority of the participants believed that they learned better with the virtual world, and enjoyed the learning more with the virtual world, because it was engaging, interesting, enjoyable, and made the learners feel as if they were in the Forbidden City. Following are some comments from participants about their preference for learning with a virtual world:

> *There is no doubt that using a virtual world is more helpful and enjoyable, which makes it EASIER AND FASTER (emphasis is participant's) to learn. ….The virtual city provides large amount of information and visualization at the same time. During my studies in the past, I observed that learning about a new topic requires to imagine and that is what virtual world exactly does [sic].*
>
> *It was definitely easier to learn in the virtual world. It made it much more interesting and exciting. I found it easier to remember what I had learned in the virtual world as opposed to what I learned from the presentation. The virtual world definitely makes you feel like you are in the Forbidden City, the presentation does not. I would rather learn about the Forbidden City via the virtual world.*

On the other hand, the benefits of using the voice-over presentation also supported our results and previous literature about the need for facilitation and interaction with an instructor. Those that did claim benefits of the voice-over presentations over virtual worlds cited that it felt like there was guidance given about what to learn and that the wealth of information in the virtual world could seem distracting.

> *I personally found learning via voice-over more effective because I was given exact and the most important information about different objects in the Forbidden City. ... This way of learning takes less time and provides specific, the most important information...*
>
> *Although both ways of learning are good, I prefer using the voice over slides. To me I feel like I have a teacher teaching me the material one on one and there are very few distractions. With the voice over I can block everything out and just focus on what my person is saying on the slides.*

LIMITATIONS AND FUTURE RESEARCH

We used a multiple-choice quiz to measure cognitive learning about the Forbidden City after short interactions. Some online courses may have multiple measures of learning progress, such as testing ability to integrate and use information, and a longer period of time to learn material. The results from our study are best suited to situations when the desired outcome is scoring well on a test of facts about the subject matter. Future studies using real world classes spanning a longer time period and with multiple cognitive learning outcomes could extend these results.

Another avenue for future research is the use of the capability to interact with others that is often available in virtual worlds. When visiting a virtual world that replicates a real environment, such as the Virtual Forbidden City, although it is common to spend one's time focusing on the items available in the virtual world and not talk with other visitors, interacting with others could have large effects on learning experiences. Discussing material and sharing experience with others could help students' memories and engagement with the material being learned. Future studies could incorporate the more social capabilities of the virtual world.

Lastly, we used a fairly straightforward topic and quiz of simple factual knowledge to test the results of learning declarative

knowledge in the two media. Future studies can also look at whether learning of more complex topics can be achieved better with one medium or the other. An example is whether or not management courses can be successfully delivered using virtual worlds and whether or not skills and behaviors, not just knowledge, can be affected.

Despite its limitations, the current study's design enabled rigorous examination of the effects of learning by immersing oneself in a 3-D virtual world and observing items like one would in a real-world environment relative to learning with an online voice-over presentation. We believe that this and future studies are relevant and timely as more and more educational institutions look to cut costs and resources in delivering online courses. However, before accepting and implementing new technologies right away because of their new graphics and features, or relying on old technology because it seems easier and familiar to face-to-face classrooms, a thorough understanding of the impacts of the use of the technology is necessary. When the potential learning outcomes are understood, then educators can make informed technology decisions based on the desired outcomes of select courses or learning modules.

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