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Xiaofeng Chen

University of Nebraska-Lincoln, xchen3@unl.edu

Keng Siau

University of Nebraska-Lincoln, siauk@mst.edu

Fiona Fui-Hoon Nah

University of Nebraska-Lincoln, fnah@unl.edu

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Recommended Citation

Chen, Xiaofeng; Siau, Keng; and Nah, Fiona Fui-Hoon, "3-D Virtual Worlds: Education and Learning" (2009). *SIGHCI 2009 Proceedings*. 13.

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3-D Virtual Worlds: Education and Learning

Xiaofeng Chen
xchen3@unl.edu

Keng Siau
ksiau@unl.edu

Fiona Fui-Hoon Nah
fnah@unl.edu

University of Nebraska-Lincoln

ABSTRACT

3-D virtual worlds are increasing in popularity as a medium for higher education. In this research, we assess the efficacy of two instruction strategies in a virtual world environment, Second Life, and their effects on interactivity, social presence, and perceived learning. The two instruction strategies are direct and interactive instruction strategies. Our findings suggest that the interactive instruction strategy is more effective than the direct instruction strategy in increasing perceived learning, social presence, and classroom interactivity in the virtual world environment. The study also captured data on perceived ease of use and usefulness of the virtual world environment for education. The results show that the virtual world environment is perceived by students to be easy to use for both direct and interactive sessions. Students perceived the virtual world environment to be more useful for the interactive session than for the direct instruction session.

Keywords

3-D virtual worlds, Second Life, instruction strategies, perceived learning, social presence, classroom interactivity, perceived ease of use, perceived usefulness

INTRODUCTION

The Education delivered over the Internet is increasing in popularity. With the advancement of technology and increased bandwidth, higher learning in 3-D virtual worlds is a growing phenomenon. A 3-D virtual world is a rich, immersive, and highly scalable environment that provides more features than a regular Web site. A class conducted in a 3-D virtual world differs from a traditional Web-based class due to the following interactive features: 3-D visualization, use of avatars to represent class participants, higher sense of presence for the learners, and creation of context-specific learning (Calongne, 2008).

Not only is the technology propelling the use of 3-D virtual world in education and learning, but the new generation of students is also demanding the use of advanced technology in education (Erickson and Siau, 2003). Proserpio (2007) argues that we are teaching a whole new generation of learners who are called a virtual generation of students. The Pew research center released a survey report in 2007 that highlights the characteristics of "Generation Next" as highly technology-oriented.

The objective of this research is to assess the effects of using two main teaching strategies in a 3-D virtual world

environment. The two main teaching strategies are the direct and interactive instruction strategies. Specifically, we empirically study the effects of the two main teaching strategies, on three key educational elements of the constructivist learning process -- classroom interactivity, social presence, and learning outcomes. This research also investigates the learners' perceptions of ease of use and usefulness of the 3-D virtual world environment.

LITERATURE REVIEW

Two areas of the literature are particularly relevant to this study: virtual education and technology acceptance.

Virtual education

Virtual worlds have to support core educational activities to be useful for education. Eschenbrenner, Nah, and Siau (2008) point out that the 3-D virtual world environment can enhance existing technological capabilities to achieve interactive learning, which can in turn enhance learning outcomes. Educational research on virtual worlds show that students are "likely to be more satisfied with their courses if they feel involved, and even more so if they develop relationships with other members of the learning community" (Hobbs, Brown, and Gordon, 2006). This view is also supported by studies from Rovai (2002), Kirschner and Bruggen (2004), and Dickey (2005). In virtual education research, the relationship between social presence and perceived learning was established in a Web-based learning environment by Richardson and Swan (2003). Hence, classroom interactivity and social presence are helpful in increasing students' learning.

To our knowledge, there is no empirical study that has examined how different instruction strategies are afforded and supported by 3-D virtual world educational environment and what are the effects of the strategies on key education and learning constructs, such as learning, classroom interactivity, and perceived social presence.

Technology acceptance and virtual worlds

The Technology Acceptance Model (TAM) (Davis, 1989) has been tested in MIS research on a wide variety of information technologies. Virtual world education involves the application of information and communication technology to core institutional functions (Farrell, 2001). Therefore, information technology is a key enabling technology in the use of virtual worlds for education. In studying the adoption of virtual worlds for education, it is important to examine user acceptance as the current virtual generation of students typically have

choices in selecting different modes of delivery of education.

RESEARCH QUESTION

The virtual or new generation (Proserpio 2007) has different characteristics from the earlier generations, such as the T.V. generation identified by Gioia and Bras (1986). Education research should focus on the new generation in higher education since the instruction strategies that are suitable for the T.V. generation may not be suitable for the newer virtual generation. In this study, we empirically assess whether 3-D virtual worlds can support different instruction strategies and whether different instruction strategies used in 3-D virtual worlds produce similar or different learning outcomes. Hence, our research question is to examine whether different instruction strategies can moderate learning outcomes in 3-D virtual worlds.

THEORETICAL FOUNDATION AND HYPOTHESIS DEVELOPMENT

The educational literature shows that traditional education utilizes 5 categories of instruction strategies: 1) direct instruction; 2) indirect instruction; 3) interactive instruction; 4) independent study; and 5) experiential learning (Gallen and Bold 1989; McNeill and Wiles 1990; Seaman and Fellenz 1989). Two of the most important and common instruction strategies in traditional classrooms are the direct instruction and interactive instruction. Direct instruction strategy is a teacher-centered instructional approach (Kroesbergen and Van Luit 2003) that emphasizes rich structure, drilling, and content. Interactive instruction strategy relies heavily on discussion and sharing among participants (Seaman and Fellenz 1989). In this research, we study how these two instruction strategies affect interactivity, social presence, and learning outcomes.

Transactional Distance Theory (Moore, 1991) has been used to explain the effect of geography on pedagogy. Transactional distance is defined as psychological and communicational space between the participants (Moore 1997). There are three variables that affect transactional distance: structure, dialogue, and learner autonomy. When there are higher amounts of dialogue and less structure, a distance learner is likely to perceive a smaller degree of transactional distance. Transactional distance is one of the key factors that affect students' satisfaction and learning in distance education (Rovai 2002).

Interactivity is tied to all three key theories of learning. Classroom interactivity is defined as the active involvement and participation of students in a classroom (Bannan-Ritland 2002; Sims 2003). Interactivity in the classroom will influence students' learning outcomes, such as attitude and achievement (Siau et al. 2006). An interactive learning process is expected to continue to be a key element in virtual education. Different instruction strategies can create different environments that promote or hinder classroom interactivity because instruction

strategies use different structures and require different levels of dialogue in activities. Since the interactive instruction strategy relies more on interactions by nature, such as more questions, discussions, and idea exchanges, to facilitate learning, we hypothesize that:

H₁: Interactive instruction session will create a higher degree of classroom interactivity than direct instruction session in the 3-D virtual world education environment.

Different instruction strategies can take advantage of available features in a virtual world educational environment and create different levels of classroom interactivity. Proserpio (2007) claims that optimal teaching and learning occur when teaching strategies align with learning styles; therefore, interactive instruction strategy is expected to be more effective for teaching the virtual generation who favor interactions with others using technologies. More classroom interactivity will lead to smaller transactional distance according to transactional distance theory, which in turn will lead to better learners' satisfaction and learning (Rovai 2002). Hence, we postulate that interactive instruction strategy will generate better learning outcomes.

H₂: Interactive instruction session will generate higher perceived learning than direct instruction session.

Gunawardena and Zittle (1997) find that different types of communication media are capable of affecting an individual's perception of social presence. Researchers have found that a person's perception of social presence is highly related to others' intimacy behaviors such as physical proximity (Short et al. 1976; Chang 2002). In distance education, transactional distance implies more than physical proximity (Ketterer and Marsh II 2006) and perception of social presence will be affected by transactional distance. Based on past research and transactional distance theory, we hypothesize that when conducting education in 3-D virtual worlds, a small degree of transactional distance, which can be shortened by more dialogs (interaction) between teachers and learners, will increase perceived social presence.

H₃: Interactive instruction session will generate higher perceived social presence than direct instruction session.

Studying the role of perceived ease of use (PEOU) in TAM, Gefen and Straub (2000) conclude that the role of PEOU depends on the primary task in the specific context studied. Since we study the efficacy of two instruction strategies for the same primary learning task using the same 3-D virtual world environment, we do not expect learners' perceptions of PEOU to differ across both sessions. Therefore, we posit that:

H₄: There is no difference in perceived ease of use of 3-D virtual world environment between the two instruction strategies.

Perceived usefulness (PU) is defined as the degree to which a person believes that using a particular system would enhance his or her performance (Davis 1989), which is learning in this case. We argued earlier that the interactive instruction strategy will create a higher degree of classroom interactivity and generate higher perceived learning than the direct instruction strategy. Therefore, in the same vein, we expect the PU of learning in the interactive instruction session to be higher than that in the direct instruction session. Hence, we hypothesize that:

H₅: Interactive instruction session will generate a higher degree of perceived usefulness of the 3-D virtual world environment for students' learning than direct instruction session.

RESEARCH METHODOLOGY

A within-subject experimental design was used where subjects participated in two equivalent (i.e., different content but similar in nature of domain) learning sessions – one using the direct instruction strategy and the other using the interactive instruction strategy.

Subjects

We recruited college students to participate in virtual classes conducted in a 3-D virtual world, Second Life. Students are the most appropriate subjects for this research that is related to education and learning. Students in a System Analysis and Design class from a large Midwestern U.S. university participated in this study. Attendance was mandatory since the study was part of a regular class. A total of 22 students participated in this study.

Operationalization of 3-D virtual world education environment

Although there are numerous 3-D virtual worlds, the most popular 3-D virtual world is probably Second Life. Second Life is a 3-D virtual world created by its residents (Linden 2006) and supported by the software from Linden Research. Linden Research has created a Second Life Grid that provides a platform for education and non-profit organizations who are interested in 3-D virtual learning. Numerous universities (e.g., Harvard, Princeton, and MIT) have set up education environments in Second Life for virtual classes. Attendees in a virtual classroom can see, hear, and interact with the setting, instructor, and other students.

Research procedures

Prior to the subjects' participation in the virtual class sessions, we conducted a short tutorial session to familiarize the subjects with the basics of using Second Life, which include walking, talking, interacting with fellow students, use of the headphone, and the use of instant messaging.

After the tutorial, a direct instruction session was conducted in Second Life. The guest lecturer used the audio function in Second Life to lecture. Students

listened to the lecture and could ask clarifying questions using instant messaging. The instructor conducted the lecture using Microsoft PowerPoint in Second Life and the students could see the PowerPoint display. The topic of the direct instruction session was "Designing effective input for an information system." The students filled up a survey form after the direct instruction session. The survey consists of questions related to interactivity, social presence, perceived learning, perceived ease of use, and perceived usefulness.

After the survey and a short break, an interactive instruction session was conducted in Second Life by the same guest lecturer. The topic of the interactive instruction session was "Designing effective output for an information system." The topics for the direct and interactive sessions were similar in structure and difficulty. Also, the two sessions had the same number of PowerPoint slides. Therefore, the content variation of the sessions is controlled in this study. This interactive instruction session was discussion focused and provided a chance for students to discuss issues and to present their ideas and solutions using the instant messaging feature in Second Life. Students were encouraged to ask and respond to questions during the session. Students could use the instant messaging tool in Second Life to send comments, questions, and answers to the entire class. After the interactive instruction session, the same survey instrument was administered to the students.

The experiment used the within-subjects repeated measures design to reduce the error variance associated with individual differences. Furthermore, the within-subject design requires less number of subjects than a between-group design to have the same results.

Measurement

The measures for perceived ease of use and perceived usefulness were adapted from Davis (1989). The items for measuring perceived learning were derived from Richardson and Swan (2003), and Wu and Hiltz (2004). The scale for measuring classroom interactivity was adopted from Siau et al. (2006). The scale for measuring perceived social presence was adopted from Hassanein and Head (2007).

Data analyses

Although the survey instruments were adopted from published and tested instruments, we first tested the reliability of the instruments because they were being applied in a new context. The reliability of the instruments was assessed using Cronbach's alpha coefficient. The reliability test for all related variables shows that they all have Cronbach's alpha (ranging from .88 to .98) that is well above the Nunnally's threshold of .70, which indicates that the instruments used in this study are highly reliable.

The descriptive statistics indicate that the mean difference of perceived ease of use from the two class sessions is

minimal, $M=6.08$ and 6.17 for direct and interactive instruction respectively. Both means of perceived ease of use are relatively high (over 6 out of 7). The mean differences of other studied variables - perceived usefulness, perceived learning, and perceived classroom interactivity - are significant.

Data analysis results are presented below.

With the use of Wilks' criterion for the omnibus MANOVA test, the combined DVs (classroom interactivity, social presence, and perceived learning) were significantly affected by instruction strategies, $F(3, 14) = 7.06, p = .004$. The results show that the instruction strategies make significant difference for the combined dependent variable that is a combination of classroom interactivity, social presence, and perceived learning.

To investigate the impact of each dependent variable on the combined dependent variable, univariate tests were performed. Since there were only two levels of within-subjects factor, the four adjustments show the same results, $F(1, 17) = 23.43, p < .001$ for classroom interactivity; $F(1, 17) = 7.61, p = .014$ for perceived learning; and $F(1, 17) = 6.45, p = .022$ for perceived social presence. These results show that the three tested dependent variables contributed significantly to the difference of the combined scores between the two class sessions differentiated by the instruction strategy.

These findings demonstrate that the interactive instruction supported by the 3-D virtual world environment does produce significantly different classroom interactivity: $M = 5.92$ and $M = 4.92$ in the interactive and direct lecturing session respectively; generate significantly different perceived learning: $M = 5.44$ and $M = 4.96$ in the interactive and direct lecturing session respectively; and create higher perceived social presence in the interactive session ($M = 5.67$) than in the direct instruction session ($M = 4.96$). Therefore, our hypotheses 1, 2, and 3 are supported by the empirical tests from this study.

A paired sample t-test was run to test statistical mean significances of perceived ease of use and perceived usefulness between the direct and interactive instruction sessions. The results of the t-tests suggest that students felt no difference with the perceived ease of use of the 3-D virtual world for direct ($M=6.08, SD=.82$) and interactive ($M=6.17, SD=.84$) instructions; $t(17) = -1.74; p=.10$. This supports our hypothesis 4. The relatively high means of perceived ease of use (over 6 out of 7) suggest that the 3-D virtual environment is suitable for the two most popular instruction strategies in education. The statistics also show that there is significant difference in the scores of perceived usefulness for the direct ($M=4.59, SD=1.34$) and interactive ($M=5.54, SD=1.56$) instruction sessions; $t(17) = -3.81, p=.001$. The results of the t-tests suggest the students felt that Second Life was significantly more useful in the interactive session than the direct instruction session was for their learning. This finding supports our hypothesis 5.

DISCUSSION AND CONCLUSION

Virtual worlds are gaining popularity and importance in education. An experimental research was conducted to investigate two different instruction strategies, direct and interactive instructions, in a virtual world. The empirical data from this study show that interactive instruction strategy in 3-D virtual world, compared to direct instruction strategy, is perceived to contribute to better learning, promote higher social presence, and contribute to a higher degree of classroom interactivity. Our results are in line with prior studies that show a strong correlation among perceived learning, perceived social presence, and perceived classroom interactivity.

Our secondary analysis studied perceived ease of use and perceived usefulness of the virtual world environments for education. The data collected from this study show that the 3-D virtual environment, Second Life, is perceived by the students to be easy to use (over 5 out of 6) for class activities. We hypothesized that perceived ease of use is not significantly different between the direct and interactive sessions and the results show no difference. Second Life is also perceived by the students to be significantly more useful in an interactive instruction session than in a direct instruction session.

Like any research, there are limitations in this study. This is an ongoing experimental research and more data are being collected in order to statistically and confidently eliminate the order effect of instruction sessions. It should be noted that we obtained statistically significant results for hypotheses 1, 2, and 3 when the order of the study is direct instruction strategy followed by interactive instruction strategy. It can be argued that the effect will be even more pronounced when the order is interactive instruction strategy follows by direct instruction strategy because the subjects will experience a more drastic change moving from interactive instruction strategy to direct instruction strategy. Thus, hypotheses 1, 2, and 3 should also be supported when the order of instruction strategies is reversed. Second, the sample size may be small in this study. However, despite the limited sample size, all five hypotheses proposed in this research are statistically supported. In spite of these positive outcomes, it would be good to collect more data to boost the sample size and to counter-balance the order of the instruction sessions. We are currently collecting data to do that.

This study presents a pioneering effort in investigating the effects of different instruction strategies on education in virtual world environments. In this study, we examined two of the most important and relevant instruction strategies, direct and interactive instruction strategies, in a 3-D virtual world environment, Second Life. Future studies can study other instruction strategies such as independent study and experiential learning in the 3-D virtual world environments. Other variables that are important to education such as enjoyment can also be studied

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