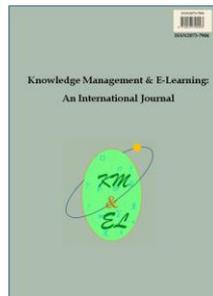

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Michael Chau

Wai-ki Sung

Songnia Lai

Minhong Wang

The University of Hong Kong, Hong Kong

Ada Wong

HKU School of Professional and Continuing Education, Hong Kong

Kristal W. Y. Chan

Tim M.H. Li

The University of Hong Kong, Hong Kong

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Evaluating students' perception of a three-dimensional virtual world learning environment

Michael Chau*

School of Business, Faculty of Business and Economics
The University of Hong Kong, Hong Kong
E-mail: mchau@business.hku.hk

Wai-ki Sung

Faculty of Architecture
The University of Hong Kong, Hong Kong
E-mail: h9508355@connect.hku.hk

Songnia Lai

School of Business, Faculty of Business and Economics
The University of Hong Kong, Hong Kong
E-mail: songnialai@gmail.com

Minhong Wang

Faculty of Education
The University of Hong Kong, Hong Kong
E-mail: magwang@hku.hk

Ada Wong

Institute for China Business
HKU School of Professional and Continuing Education, Hong Kong
E-mail: isada98@gmail.com

Kristal W. Y. Chan

School of Business, Faculty of Business and Economics
The University of Hong Kong, Hong Kong
E-mail: kristal@connect.hku.hk

Tim M.H. Li

Department of Social Work and Social Administration, Faculty of Social Sciences
The University of Hong Kong, Hong Kong
E-mail: h0716269@graduate.hku.hk

*Corresponding author

Abstract: Three-dimensional virtual environments have gained wide popularity due to improvement in graphic rendering technology and networking infrastructure. Many education institutions have been trying to leverage the potential of 3D virtual environments in their application in education. In this research, we aim to evaluate the students' perception of virtual environments in teaching and learning activities. We set up a virtual classroom, where a short presentation was delivered to students through virtual projectors in Second Life, the most widely adopted 3D virtual environment. The students filled in a questionnaire after the class. We found that the students gave a statistically higher evaluation to 3D virtual environments in terms of satisfaction and enjoyment, while comparable scores between 3D and traditional learning environment in terms of concentration, perceived usefulness, and learning and understanding were obtained. Our results show that virtual learning environment is of great potential in e-learning. Some recommendations in using the virtual environment for learning activities are given.

Keywords: Second life; Three-dimensional; Virtual learning environment; e-Learning; Perception

Biographical notes: Michael Chau is an associate professor in the School of Business, Faculty of Business and Economics at the University of Hong Kong. He received a Ph.D. degree in management information systems from the University of Arizona and a B.Sc. degree in computer science and information systems from the University of Hong Kong. His current research interests include information retrieval, web mining, data mining, social media, electronic commerce, and security informatics. He is the author of more than 100 articles and has been ranked as the #14 most productive researcher in the field of information science in the period 1998-2007 in a research productivity study. More information can be found at <http://www.business.hku.hk/~mchau/>.

Wai-ki Sung is a Ph.D. student in the Faculty of Architecture at the University of Hong Kong. She received a M.Sc. degree in management information systems from the University of Arizona and a B.Eng. degree in industrial and manufacturing systems engineering from the University of Hong Kong. Her research interests include safety knowledge management, Web 2.0 applications, e-learning, and human computer interaction.

Songnia Lai is an undergraduate student of the University College Birmingham in Marketing Management and a research assistant at the University of Hong Kong. Her research interests include virtual learning, social networking, and entertainment.

Dr. Maggie Minhong Wang is an Associate Professor in the Faculty of Education, the University of Hong Kong. She has been involved in multiple disciplinary research in the areas of technology-enhanced learning, complex problem solving and learning, knowledge management, adult learning and human performance, and artificial intelligence. She has published papers in *Computers & Education*, *Information & Management*, *IEEE Transactions on Education*, *Educational Technology & Society*, *Innovations in Education & Teaching International*, *Expert Systems with Applications*, *Knowledge-based Systems*, *Journal of Knowledge Management*, among others. She is the Editor-in-Chief of *Knowledge Management and E-Learning* and Associate Editor of *Information & Management*. She also serves on the editorial board of several international journals including *Educational Technology Research and Development*, and *Educational Technology & Society*. More details can be found at <http://web3.edu.hku.hk/magwang/>.

Ada Wong is a Senior Programme Director and College Principal Lecturer at the Institute for China Business, SPACE, the University of Hong Kong. She received a Ph.D. degree from the Warwick Business School at the University of Warwick in the UK. Her current research interests include ERP implementation, project management, mobile user interface, information systems strategic planning, business intelligence, information systems security and control.

Kristal W. Y. Chan was a research assistant and received a B.B.A. degree in information systems from the University of Hong Kong. Her research interests include virtual environment and e-learning.

Tim M. H. Li is a Ph.D. student at the Department of Social Work and Social Administration at the University of Hong Kong. He received an M.Sc. and a B.Eng. degree in computer science from the University of Hong Kong. His current research interests include Internet-based intervention, e-learning, social network, data mining, psycholinguistics and mental health. His research has appeared in journals such as *Journal of Medical Internet Research* and *Decision Support System*. He has been a teaching assistant in computer science and mental health course.

1. Introduction

The advancement of 3D graphic rendering technology and networking infrastructure has made 3D virtual environment one of the most popular trends in the technology world. The worldwide success of 3D virtual environment such as Second Life and World of Warcraft shows the ultimate potential for entertainment and leisure purpose. The number of users in 3D virtual environment kept increasing in recent years due to the popularity of 3D games (Kumar et al., 2008).

A computer-generated virtual world is an environment that makes use of 3D graphics and objects to create a virtual environment that resembles the real world (Mennecke et al., 2007). Users can create virtual characters known as “avatars” to represent themselves in a virtual world and engage in different kinds of activities. Virtual environments allow multi-channel communications. With the advancement of networking technology, interactions within virtual worlds are not restricted to text contents only. Users can communicate with others using voice or simple gesture presented by the avatars. It has been suggested that the multi-channel expressive communications in a virtual world could improve users’ communication and convey of emotional messages in a more realistic setting (Carey, 2007).

The use of virtual environments for educational purpose has recently gained more research attention (Tang, Lan, & Chang, 2012). Virtual environment has great potential to be a revolutionary educational platform given its various unique features (Chau et al., 2013). In fact, many educational institutions have put up their educational materials in the virtual world for teaching and learning activities. Many schools have built virtual campuses inside virtual worlds, such as New York University, Nottingham University, Ohio University, Princeton University, Stanford University, University of Florida, University of Southern California, University of Notre Dame, and Virginia Tech, among others (SimTeach, 2011).

Despite the fact that many educational institutions and universities have started research and trial on the use of virtual environment for educational purpose, there are few

evaluation studies in this area. Therefore it is important to evaluate students' experience in the use of 3D virtual world environment for learning activities.

2. Background

2.1. Virtual world learning

The technology advancement in network infrastructure and graphics technology in recent years has made virtual world learning more feasible. Nowadays, virtual world learning has been increasingly popular at the worldwide level. The unlimited possibility and the unique advantages of virtual world learning have attracted a lot of research attention. According to SimTeach (2011), many educational institutions have already set up learning platform in virtual worlds to explore the potential of this innovative educational medium.

Virtual world learning utilizes rich 3D graphics to create a game-like learning environments for users. Today's generation of university students grow up in a digital world with smartphones, the Internet, computers, and video games (Li, Chau, Wong, Lai, & Yip, 2013). These "Digital Natives" are very familiar with the latest information technologies. The rich use of multimedia and communication is believed to be beneficial to the learning process of students in virtual world environments. Various studies have reported that virtual environments can motivate students to engage in learning activities and achieve satisfactory results (Asgari & Kaufman, 2004; Reis, Escudeiro, Escudeiro, 2010; Yang, Zhang, & Bridges, 2012; Malik et al., 2011). As suggested by Tashiro and Dunlap (2007), 3D virtual worlds like Second Life can model the real world better than text-based or 2D environment, and thus enhance the realism, which could in return leads to better student engagement in learning activities. Moreover, the use of innovative education media could encourage learners to better collaborate and communicate, forming an effective and supportive learning environment (Bronack et al., 2008). The game-like environment of virtual world provides an immersive environment for users to customize and personalize the learning experience according to their needs (De Freitas & Yapp, 2005). The virtual environment also provides users an educational platform of higher learning autonomy (Field, 2007).

Using 3D virtual worlds in teaching and learning has several advantages (Boulos, Hetherington, & Wheeler, 2007; Tashiro & Dunlap, 2007; Zhu, Wang, & Jia, 2007). First, students can participate in learning activities from anywhere. This can facilitate distance learning of students from their home or anywhere else. Virtual world learning has created a new way of distance learning. There are various ways of distance learning in the past, including textbooks, graphics, audio recording, and videos. However, the use of virtual world in distance learning could provide real-time interaction and collaboration among the users (Dickey, 2005). Virtual world as an educational learning platform provides a social space with interaction and communication, which is crucial to improving education (Berge & Collins, 1995). It has been reported that the use of virtual world as a distance learning platform gives satisfying and promising results to learning (Ritzema & Harris, 2008).

In addition, students can navigate the virtual learning space easily by "flying" and "teleporting" inside the virtual world without any physical constraints. This allows students to switch between different learning activities more quickly and hence engage in more such activities. Moreover, instructors and students can meet and interact more

easily. It is also possible for different groups of students around the globe to meet inside the virtual world to engage in educational activities (e.g., cultural exchange). Compared with other online media like emails or instant messaging, virtual worlds allow users to have better interaction like movements and gestures.

The virtual world environment can also simulate the real world and allows students to experiment with different concepts without doing real harm. For example, physics students can see a rocket from inside out and even create new designs; medical students can experiment with surgery operations (John, 2007). Besides, students can learn from simulation where the real task is inaccessible due to barriers of travel, time, or cost. The learning opportunity for students can be increased (Getchell, Miller, Nicoll, Sweetman, & Allison, 2010) and students can get better hands-on learning experience in these tasks (Chau, Huang, & Chen, 2003; Chau & Wong, 2010; Chau, Wong, Zhou, Qin, & Chen, 2010; Chen, Li, Chau, Ho, & Tseng, 2009). Furthermore, the virtual environment also improves students' fantasy and imagination. The "game" nature of virtual worlds may also have a positive impact on students' motivation and engagement in the learning activities (Marty & Carron, 2011).

2.2. User experience and learning

User experience in the virtual world platform is one of the important factors to determine the quality of learning. The adoption of virtual world platform for educational purposes brings several advantages to the learning experience. The rich environment of virtual world provides students with engaging experience (Bronack, Riedl, Tashner, & Greene, 2006). However, problems such as difficulties in navigation and using 3D interfaces are often present in the adoption of virtual reality technologies in educational environment (Chau et al., 2013; De Lucia, Francese, Passero, & Tortora, 2009). Some students who have high computer self-efficacy and capability may find it easy to manage in the virtual environment but some may need a longer time. These problems may therefore reduce the learning time of students. Furthermore, it has been suggested that some students may not enjoy online interaction so they may have anxiety about learning in Second Life (Baker, Wentz, & Woods, 2009). Thus, it is important to examine students' perception on virtual learning experience compared to traditional classroom learning.

Moreover, as shown in previous studies, technical issues such as slow connection may significantly impede the user experience in the virtual world educational platform (De Freitas, Rebolledo-Mendez, Liarokapis, Magoulas, & Poulouvasilis, 2010). Slow connection may lead to communication delay in the learning environment. For example, the delay incurred may lead multiple overlapping conversations in discussions as students may type out comments and responses simultaneously (Baker, Wentz, & Woods, 2009). This may make the discussions in the virtual learning environment complicated and confusing. In addition to high speed network, high-quality hardware such as high-end graphics card and high screen resolution are also crucial to providing high-quality 3D animations. Technology in the way may affect the perception of the learning experience.

There are some studies that evaluate the user experience in the virtual world environment. In the work of De Lucia, Francese, Passero, and Tortora (2009), user experience was evaluated in four aspects: presence, communication, awareness and comfort. A four dimensional framework is developed by De Freitas and colleagues (2010) to evaluate the efficacy of virtual world educational platform and representation, which includes fidelity, interactivity and immersion. However, these studies mainly focus on the evaluation of virtual world educational platform. There are few studies that compare the

user experience in virtual world educational platform with the traditional classroom learning.

3. Research questions

In this research we aim to answer the following research questions:

1. Do students perceive better usefulness, satisfaction, and enjoyment when using virtual worlds for learning activities compared with traditional classroom learning?
2. Do students have a lower level of control and concentration when using virtual worlds for learning activities compared with traditional classroom learning?
3. Do students achieve better learning and understanding when using virtual worlds for learning activities compared with traditional classroom learning?

4. Methodology

We conducted the study with three different courses taught in two semesters at a university in Asia. These courses included both freshmen courses and senior-level courses in business and education. A one-hour regular class time was used for the study. Instead of learning in a traditional classroom, students were asked to enter a virtual classroom in Second Life (www.secondlife.com). As mentioned, Second Life is one of the most popular virtual world platforms for educational purpose. Users could freely download the client software and register an avatar inside Second Life. Educational institutions could rent a piece of "land" in Second Life and set up virtual world classrooms or even a campus inside. Second Life and other educational institutions have provided resources for educators to develop their own educational platforms. Code-free development tools are provided for users to develop objects for educational purpose. Many universities and educational institutions have developed their own educational platform on the Second Life and there are more than 150 universities or educational institutions in Second Life in 2011 (SimTeach, 2011).

We provided students a brief introduction to Second Life, and showed them the registration of user account, creation of avatars, and navigation within the virtual environment. Students then spent about 45 minutes for learning in Second Life. This kind of e-learning study in classroom settings can significantly reduce the dropout rate (Hoic-Bozic, Mornar, & Boticki, 2009).

Instructors have an important role on facilitating students' learning experience in virtual world learning (Gaudio, Hernandez-del-Olmo, & Montero, 2009). In the study, the instructor gave a presentation in Second Life by going through a set of slides through the virtual projector there (see Fig. 1). We designed and developed the virtual classroom on our virtual campus in the Second Life environment (see Fig. 2).

After this virtual teaching session, the students were asked to fill in a questionnaire to compare their experience in Second Life with the traditional classroom environment. The questionnaire included items related to our measures, namely satisfaction, enjoyment, concentration, control, perceived usefulness, and learning and understanding, in both the virtual learning environment and the traditional learning environment. Participants were asked to give their responses to the following items on a 7-point Likert scale (1 = strongly disagree; 7 = strongly agree) on both 3D virtual learning environment and traditional classroom learning environment.

Eighty-two complete responses were received and the data were analyzed. Two-tailed t-tests were conducted to see whether there was significant difference in the measures between the virtual world learning environment and the traditional learning environment.



Fig. 1. Virtual classroom set up in Second Life



Fig. 2. Virtual campus set up in Second Life

5. Data analysis and discussions

The data are summarized in Table 1. In general, our results show that students gave higher scores to satisfaction, enjoyment, and concentration to the 3D virtual world learning environment and higher scores to control, perceived usefulness, and learning and understanding to the traditional learning environment. Out of these six comparisons, three of them (i.e., satisfaction, enjoyment, and control) are statistically significant. In the following, we discuss each measure in more detail.

Table 1
Analysis of questionnaire data

Measures	3D Virtual World Learning Environment	Traditional Learning Environment	<i>t</i> -test <i>p</i> -value (n = 82)
Satisfaction	5.119	4.951	*0.0657
Enjoyment	5.393	4.704	***0.0000
Concentration	4.817	4.689	0.1647
Control	4.047	4.304	**0.0015
Perceived Usefulness	4.686	4.724	0.6880
Learning and Understanding	4.829	4.993	0.1624

Note: * $p < 0.1$; ** $p < 0.005$; *** $p < 0.0001$

Students had statistically better satisfaction and enjoyment when using the virtual world learning environment. A possible explanation is that students enjoyed playing with the avatar in the 3D virtual world which is similar to a video game environment, resulting in a higher satisfaction with this novel technology when compared to traditional classroom learning. Maslow's hierarchy of needs theory has been studied to construct usage motivations of online learning environments (Milheim, 2012). It has been found that self-actualization needs, the highest level of needs, are associated with satisfaction and enjoyment (Cao et al., 2013). The findings in this study may reflect that learning motivation of students and continuance intention on using the virtual world learning environment is high.

Students also felt that they could concentrate better in the virtual world environment, though the difference is not significant. One possible explanation is that they concentrated better on the computer screen when using the virtual world environment. They can be more selective on the virtual world. For instance, they can turn off the sound easily if concentration on visual learning materials is needed. However, it is difficult to concentrate in the traditional classroom due to real world distractions that they cannot easily filter.

Students also found that they did not have good control in the virtual environment. One major reason is that it is not easy for a student to learn the basic skills for navigating and controlling inside Second Life or other similar virtual world environments. Therefore, some students found that it was hard for them to control what the avatar should do or how the avatar should carry out tasks.

In terms of perceived usefulness and learning and understanding, students gave slightly higher score to the traditional learning environment than the virtual world learning environment. We think a possible reason is that students are still more used to the traditional environment and they may not be very familiar with how to learn effectively in the 3D virtual learning environment. However, as the differences between

the two environments are not significant, it shows that students could achieve the same level of perceived usefulness and learning and understanding in the two environments.

The qualitative comments from students about the virtual world learning environment are also satisfactory and encouraging. Many students found the virtual world learning experience enjoyable and interesting. A number of students considered the interactivity of virtual world learning as an advantage. Some students also considered the flexibility of the virtual world learning as an advantageous feature as it may allow students to study anywhere. Generally, students' comments on virtual world learning are positive. Meanwhile, there are some complaints about the technical issues of the virtual world. Students complained about the time lag due to unstable network connections. Moreover, some students found it difficult to control the avatar and navigate in the virtual world. It took some times for students to get used to the control and navigation.

6. Conclusion

In summary, based on self-reported data, students enjoyed and were satisfied with the virtual world learning experience. Virtual world learning platforms provide students with interactive and flexible learning environment in which they can personalize their learning experience. Virtual world learning platforms created a game-like immersive environment for enhancing the learning activities with the use of various 3D objects and avatars. Through comparison between the evaluation of 3D virtual world learning environment and traditional learning environment, we found that the game-like characteristics of 3D virtual world learning environment brings better satisfaction and enjoyment to learning when compared with the traditional learning environment. On the other hand, some students found it hard to control the avatar, as they are not familiar with the navigation control in *Second Life*. We also found that the virtual environment and traditional environment attained comparable score in perceived usefulness and learning and understanding.

We believe that 3D virtual world is of great potential for education. For example, mutual teaching and learning and visualization of learning progresses of students can be facilitated in virtual classes. Students who are afraid of asking questions in front of class can use the private channel in virtual world to communicate with their teachers. This may motivate students to ask more questions in the virtual classes. With this interactive learning experience which may not be achieved in tradition classroom environment, teachers can understand more thoroughly about their students' learning progresses. Teachers can also check out the chat history with students after class to review students' progress or needs carefully. Besides, the flexibility of virtual world learning environment implies that education is no longer bounded by geographical locations. Interactive learning is feasible with use of various communication tools. With the use of virtual world learning platform, students from different parts of the globe can work together and learn interactively from each other anytime, anywhere. The collaboration and communication within the virtual world environment would be beneficial to the achievement of learning outcomes. Students could personalize their learning experience within the virtual world, which allows them to have better learning autonomy. The game-like immersive environment of virtual world can bring better satisfaction and enjoyment during the learning activities. Although this study only demonstrated a better perception on virtual learning environment, we will further examine self-paced learning in the environment in the future.

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