Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 116 (2014) 1288 – 1292

Procedia
Social and Behavioral Sciences

5th World Conference on Educational Sciences - WCES 2013

Utilization of Second Life as a Tool for Spatial Learning in Interior Architecture

İpek Memikoğlu[a]*

[a]*Department of Interior Architecture, Faculty of Architecture, Çankaya University, Ankara, 06530, Turkey*

Abstract

With increase in computer usage, three-dimensional (3D) virtual environments (VEs) have become new areas for navigation and spatial learning. Second Life (SL) has become one of the most popular 3D VEs that is used as a learning environment. This study focuses on the issue of spatial learning during virtual navigation in a multi-level desktop VE designed in SL. The usability of SL as a tool for spatial learning in interior architectural design is investigated by analyzing virtual navigation paths, gender differences and sense of presence. The study is conducted with 90 interior architecture students studying at Bilkent University, Ankara, Turkey. Results indicated that SL can be an effective tool for individuals to learn an environment and for interior architects to improve their designs by learning from the navigation behaviors of the users.

Keywords: Virtual environments; second life; navigation; spatial learning

1. Introduction

Architectural design is the science and art of building that generally encompasses a broad diversity of tasks such as conceptualization, organization and construction of the built environment. It is a problem solving activity that requires experiencing the spatial layout of a building, discovering and learning spatial information, and maintaining spatial orientation during navigation. Lifelong learning is a must in our society with changing spatial environments and user needs. While developing the spatial organization of an environment during the initial phase of the design process, interior architects need to determine the nature of the way finding problems that future users will encounter during navigation (Passini, 1996). With the emergence of three-dimensional (3D) virtual environments (VEs), interior architects are able to obtain an immersed view of the proposed building, assess and improve their designs by learning from the navigation behaviors of the users. This study focuses on the issue of spatial learning during virtual

*İpek Memikoğlu. Tel.: +90-312-284-4500/4038
E-mail address: ipekmemikoglu@cankaya.edu.tr

doi:10.1016/j.sbspro.2014.01.384

navigation in a multi-level desktop VE designed in SL and investigates the usability of SL as a tool for spatial learning in interior architecture.

2. Virtual Environments (VEs)

In recent years, virtual environments (VEs) or computer-simulated environments have been applied to various fields. They have become a tool for spatial knowledge acquisition since they offer the opportunity of controlling and manipulating the characteristics of a real world environment. They allow simulated exploration of 3D environments from a view-centered perspective, allow the creation of environments with different levels of complexity, allow the researcher to have greater control over both visual features and complexities of the environment than the real world environments and allow interactive navigation with continuous measurements within it (Belingard & Peruch, 2000). Behavior of the individuals within the environment can be recorded and assessed separately. In the scope of lifelong learning, Kirschen, Kahana, Sekuler, and Burack (2000) indicated that VEs are used effectively in tests of spatial learning. Spatial knowledge acquired through learning the VEs can be effectively transferred to subsequent navigation in real world environments (Lessels & Ruddle, 2005). A VE for architectural use allows interior architects and clients to obtain an immersed view of a proposed building by allowing the user to move through it. It enables the individual to visualize and interact with the virtual 3D proposed spatial environment in real time (Çubukcu & Nasar, 2005).

2.1. Navigation

Navigation is a core functional requirement that individuals perform in VEs (Santos et al., 2009). It is a spatial activity that is guided by visual information of the environment (Zhang, 2008). Bell and Saucier (2004) stated that navigation is "a complex spatial problem that is routinely faced and solved by humans and other animals" (p. 252). Navigation can take place in familiar environments or in novel environments in which an individual has little or no prior experience; it can also occur in large environments that are difficult to perceive from a single point. In order to navigate successfully the individuals need to plan their movements using spatial knowledge gained about the environment and stored as a mental map (Santos et al., 2009). In the theory of interior architectural design, the idea of navigation is emphasized as a central theme. In order to understand a building's interior structure and spatial organization, one needs to make his/her way through the building. Hölscher, Meilinger, Vrachliotis, Brösamle, and Knuaff (2005) stated that we do not experience the spatial layout of the building as a static structure but perceive it as a result of navigation; we discover architectural information step by step.

2.2. Second Life

Second Life (SL) is one of the most popular 3D VEs that is used for educational, social and business purposes (De Lucia, Francese, Passero, & Tortora, 2009). Especially, educators have begun to explore the potentials of SL as a learning environment. It is a rich environment that allows students, instructors and professionals to actively create learning experiences through the creation of specific environments (Coffman & Klinger, 2007). SL enables its users to experience objects/buildings in 3D through rich viewpoints and introduces a new opportunity for interior design development and education. SL encourages building through a simple but powerful building tool that does not require exclusive skills and that offers real-time realistic renderings through lighting and texturing effects (O'Coill & Doughty, 2004; Weber, Rufer-Bach, & Platel, 2007).

SL is elaborated by the participation of its users in which they are able to interact in the environment with an avatar. The avatar, which is the visual representation of the user, is manipulated with a keyboard and a mouse. SL enables real-time interactions and that offers its users the possibility to build virtual spaces and objects, and to personify their avatars through a user-friendly interface (Hendaoui, Limayem, & Thompson, 2008). Users are able to navigate by walking, flying and teleporting between spaces; other movement types such as jumping and running are also available. Users are able to view the 3D environment through the avatar, i.e. first-person viewpoint, or over the avatar, i.e. third-person viewpoint in which they see the avatar. Navigation in SL is controlled by the keyboard and the direction of view is changed by the mouse.

2.3. Sense of Presence

VEs enable people to experience, navigate and interact with virtual cues intuitively in real time. During this interaction, they often experience a sense of being in the VE that is referred to as presence. In order to be fully spatially present in the VE, the individual has to forget about the physical environment and accept the VE as the only reference frame (Riecke, 2003). In addition, the VE should be immersive and easy to use so that the participant does not pay attention to the equipment and experiences a sense of being there in the VE. Presence and learning are strongly related; increasing presence increases learning and performance (De Lucia et al., 2009).

Schubert, Friedmann, and Regenbrecht (2001) used a rating scale to assess presence in a 3D computer game. The 'Igroup Presence Questionnaire' (IPQ) comprises 14 items rated on a 7 point scale that ranges from -3 to 3 (Schubert et al., 2001). The IPQ consists of three subscales that measure different dimensions of presence and one additional general item that assesses the "sense of being here" (in the computer generated world I have a sense of "being there"). The subscale 'Spatial Presence' assesses the sense of being there in the VE (e.g. I had a sense of acting in the virtual space, rather than operating something from outside). The subscale 'Involvement' measures the attention devoted to the real environment and the VE (e.g. I was not aware of my real environment), and the subscale 'Realness' measures the reality judgment of the VE (e.g. how much did your experience in the virtual environment seem consistent with your real world experience?).

3. Method

3.1. Participants

The participants consisted of undergraduate students from the department of Interior Architecture and Environmental Design at Bilkent University, Ankara, Turkey. Ninety senior students (45 females and 45 males) were chosen randomly according to gender from the 4^{th} year 'Interior Design' studio with cluster sampling. As 4^{th} year students they were familiar with computer-based environments due to the computer-based courses that they took during the second and third years of their education and had a sufficient design education background.

3.2. Procedure

The participants were seated at the computer and tested individually. They navigated the desktop VE from an egocentric reference frame by utilizing the keyboard for walking and the mouse for changing their points of view. Each participant was given 3 minutes to acquaint themselves with the keyboard and mouse within the SL environment. They navigated in an open environment to become familiar with the virtual world. The VE, which was designed in SL, consisted of 2 floors with 6 rooms; 3 on the ground floor, 3 on the first floor and 2 staircases (Figure 1). The staircases were located on both sides of the building's entrance.

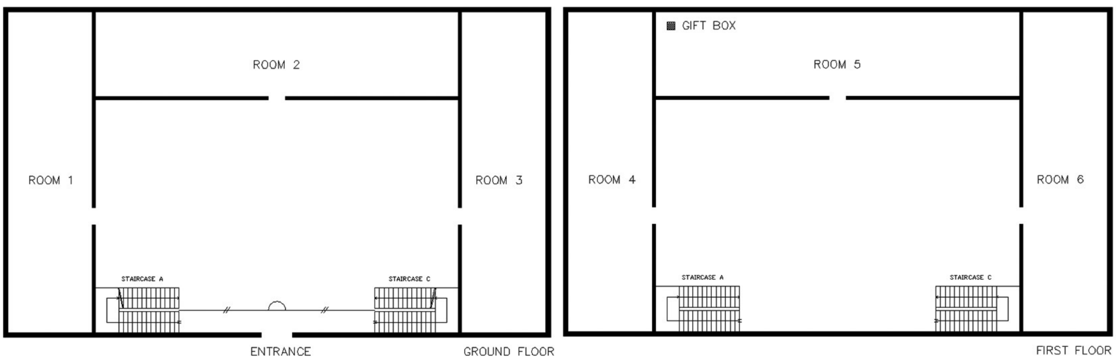

Figure 1. The plans of the VE

The participants were told to explore the ground floor and then the first floor, get the gift box and return to the entrance. While navigating in the VE, each participant's navigation path, staircase preference and their reasons were recorded. After navigating in the VE, the IPQ was administered in order to assess the participants' sense of presence within the VE. By answering the items, the spatial presence of the participants was verified.

4. Results

According to the results, 6 alternative routes for the ground floor and 5 alternative routes for the first floor were identified as navigation paths. Participants navigated the rooms of the ground and first floors in any order. For the staircase preferences, 4 alternative routes were determined in the VE. Participants either utilized the same staircase for ascending and descending or the reverse (i.e. one for ascending and the other for descending). In order to understand the reasons behind staircase preferences, 28 items were identified from the participants' responses from the open-ended questions. These items were classified under 5 attributes as: 'distance', 'angular position', 'view direction', 'personal feeling' and 'personal preference'.

More than half of the participants (46 participants) preferred to start at Room 3 on the ground floor and Room 4 on the first floor. In both cases, the majority of the male and female participants preferred these rooms (Table 1). In addition, more than half of the participants utilized the same staircase for ascending and descending; with 30 participants utilizing the staircase on the right of the entrance and 25 utilized the staircase on the left. The participants indicated that the attributes 'distance', which is being close to the last visited room on the ground floor and 'personal preference', which is familiarity with the same staircase, determined their staircase preference.

Table 1. First visited room preferences on the ground and first floors

	First Visited Room on Ground Floor			First Visited Room on First Floor		
Gender	**Room 1**	**Room 2**	**Room 3**	**Room 4**	**Room 5**	**Room 6**
Female	10	16	19	22	5	18
Male	7	11	27	24	10	11
Total	17	27	46	46	15	29

According to the first visited room in the VE, Staircase A was preferred more than Staircase C since the participants started their virtual navigation from Room 1 and finished at Room 3. This indicated that the participants utilized the staircase that they saw first while entering Room 1 in the VE; in other words, the 'view direction' attribute was influential in the staircase preference. With respect to the last visited room, Staircase C was utilized more than Staircase A for descending since the participants preferred the closest staircase to the last visited room. As a result, 'distance' was a determining attribute for staircase preference. Participants utilized the staircases that were situated on the left side of their view directions. In addition, the majority of the female participants preferred the staircase that was located on the right side of the last visited room on the first floor.

In the IPQ, the participants rated the general item and the 3 subscales of 'spatial presence', 'involvement' and 'realness' as 5.37 (SD=1.13), 4.69 (SD=0.85), 3.74 (SD=1.10) and 3.53 (SD=0.76), respectively. Male participants evaluated the subscales 'general item' and 'realness' higher than the female participants. Seventy-one participants rated the general item as having themselves a good sense of 'being there' in the VE. For the subscales 'spatial presence' and 'realness', 54 of the participants felt present in the VE and indicated the VE to be consistent with the real world, in addition, 49 participants indicated that they were aware of the VE.

5. Conclusion

The study revealed that SL as a learning environment can be utilized as a tool for spatial learning in interior architecture and can aid interior architects in the design process. In SL, participants were able to navigate from an egocentric viewpoint and learn the spatial environment. They indicated that they had a sense of presence in the VE and their virtual navigation behaviors were similar to the real world environment. It can be stated that spatial knowledge acquired from the VEs can be effectively transferred to real world environments. During the design process, interior architects need to consider the navigation problems of the individuals; SL can be utilized as a tool for understanding the spatial environment and allowing interior architects to obtain an immersed view of the proposed building, as well as assess and improve their designs. In addition, SL enables interior architects to learn from the navigation behaviors of male and female users in order to overcome potential navigation problems that individuals will encounter in a spatial environment. Further research can be conducted with design students to understand the effectiveness of SL as a design environment in interior architecture design education.

References

Belingard, L., & Peruch, P. (2000). Mental representation and the spatial structure of virtual environments. *Environment and Behavior*, 32, 427-442.

Bell, S., & Saucier, D. (2004). Relationship among environmental pointing accuracy, mental rotation, sex, and hormones. *Environment and Behavior*, 36, 251-265.

Coffman, T., & Klinger, M. B. (2007). Utilizing virtual worlds in education: The implications for practice. *International Journal of Social Sciences*, 2(1), 29-33.

Çubukcu, E., & Nasar, J. L. (2005). Relation of physical form to spatial knowledge in large-scale virtual environments. *Environment and Behavior*, 37, 397-417.

De Lucia, A., Francese, R., Passero, I., & Tortora, G. (2009). Development of a virtual campus on second life: The case of SecondDMI. *Computers and Education*, 52(1), 220-233.

Hendaoui, A., Limayem, M., & Thompson, C. W. (2008). 3D social virtual worlds: Research issues and challenges. *IEEE Internet Computing,* 88-92.

Hölscher, C., Meilinger, T., Vrachliotis, G., Brösamle M., & Knuaff, M. (2005). Finding the way inside: Linking architectural design analysis and cognitive processes. In C. Freksa, M. Knauff, B. Krieg-Brüchner, B. Nebel and T. Barkowsky (Eds.). *Spatial Cognition IV – Reasoning, Action, Interaction*. (pp. 1-23). Berlin: Springer-Verlag.

Kirschen, P. M., Kahana, M. J., Sekuler, R., & Burack, B. (2000). Optic flow helps humans learn to navigate through synthetic environments. *Perception*, 29, 801-818.

Lessels, S., & Ruddle, R. A. (2005). Movement around real and virtual cluttered environments. *Presence*, 14, 580-596.

O'Coill C., & Doughty, M. (2004). Computer game technology as a tool for participatory design. In *eCAADe2004: Architecture in the Network Society*, 15-18 September 2004, Copenhagen, Denmark. Retrieved November 10, 2012, from http://eprints.lincoln.ac.uk/97/1/COCoill_-_Game_Technology_eCAADe.pdf.

Passini, A. (1996). Wayfinding design: Logic, application and some thoughts on universality. *Design Studies*, 17, 319-331.

Riecke, B. E. (2003). *How far can we get with just visual information? Path integration and spatial updating studies in virtual reality*. (Unpublished doctoral dissertation). Tübingen: Eberhard-Karls-Üniversitat. Retrieved November 29, 2008 from http://tobias-lib.uni-tuebingen.de/volltexte/2003/999/pdf/thesis_final.pdf.

Santos, B. S., Dias, P., Pimentel, A., Baggerman, J.-W., Ferreira, C., Silva, S., & Madeira, J. (2009). Head-mounted display versus desktop for 3D navigation in virtual reality: A user study. *Multimedia Tools and Application*, 41, 161-181.

Schubert, T., Friedmann, F., & Regenbrecht, H. (2001). The experience of presence: Factor analytic insights. *Presence*, 10(3), 266-281.

Weber, A., Rufer-Bach, K., & Richard, P. (2008). *Creating your world: The official guide to advanced content for Second Life*. Indianapolis, IN: Wiley Publishing, Inc.

Zhang, X. (2008). A multiscale progressive model on virtual navigation. *International Journal of Human-Computer Studies*, 66(4), 243-256.