USING SECOND LIFE AS A DESIGN ENVIRONMENT IN INTERIOR ARCHITECTURAL DESIGN EDUCATION

A THESIS
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FOR THE DEGREE OF
MASTER OF FINE ARTS

By
Inci Cantimur
June, 2009

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Fine Arts.

Assist. Prof. Dr. Burcu Şenyapılı (Principal Advisor)

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Fine Arts.

Assist. Prof. Dr. Murat Karamüftüoğlu

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Fine Arts.

Prof. Dr. Bülent Özgüç

Approved by the Institute of Fine Arts

Prof. Dr. Bülent Özgüç, Director of the Institute of Fine Arts

ABSTRACT

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İnci Cantimur
MFA in Interior Architecture and Environmental Design
Supervisor : Assist. Prof. Dr. Burcu Şenyapılı
June, 2009

Virtual worlds are being increasingly used in architectural education. This thesis aims at investigating the potentials of one of such virtual world, Second Life (SL), as a design platform by focusing on its specific features, which provide a space for experiencing design process with avatars and sounds in the 3D environment. A pilot study was conducted to assess the validity of Second Life as a tool for designing and learning in architectural design education. Based on the feedback of the pilot study, main study was designed involving 21 students from Bilkent University, who attended the course IAED 316 Computer Applications. The assessment of SL as a design platform was conducted through pre-task, post-task questionnaires, electronic observations and interview with the tutor. The results depicted that students found SL a highly-motivating and enjoyable platform for designing. Based on the finding, this thesis put forth a framework for improving the use of SL as a design platform in architectural education.

KEYWORDS: Architectural Design Education, 3D Shared Virtual Worlds, Second Life, Avatars.

ÖZET

BİR TASARIM ÇEVRESİ OLARAK SECOND LIFE' IN İÇ MİMARLIK EĞİTİMİNDE KULLANIMI

İnci Cantimur
İç Mimarlık ve Çevre Tasarımı Yüksek Lisans Programı
Danışman : Y. Prof. Dr. Burcu Şenyapılı
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Sanal ortamlar mimarlık eğitiminde her geçen gün daha fazla kullanılmaktadır. Bu tez, böyle sanal ortamlardan birinin, Second Life'ın (SL), bir tasarım ortamı olarak sahip olduğu potansiyelin, tasarım sürecinin üç boyutlu çevrede avatar ve seslerle deneyimlenebilmesini sağlayan özelliklerine odaklanarak incelenmesini hedeflemektedir. Second Life'ın, mimarlık eğitiminde tasarım ve öğrenim aracı olarak geçerliliğinin değerlendirilmesi için bir pilot çalışma yapılmıştır. Pilot çalışmanın geri bildirimlerine dayanarak IAED 316 Bilgisayar Uygulamaları dersine katılan 21 Bilkent Üniversitesi öğrencisini içeren ana çalışma tasarlanmıştır. SL'nin bir tasarım ortamı olarak değerlendirilmesi çalışma öncesi ve sonrası anketler, elektronik gözlemler ve dersin yürütücüsü ile yapılan bir mülakat üzerinden gerçekleştirilmiştir. Sonuçlar öğrencilerin SL'yi, bir tasarım ortamı olarak yüksek derecede motive edici ve keyifli bulduklarını göstermektedir. Bu tez, elde edilen bulgulara dayanarak SL'nin mimarlık eğitiminde bir tasarım ortamı olarak kullanımının geliştirilmesi için bir çerçeve önermektedir.

Anahtar kelimeler: Mimari tasarım eğitimi, 3B Paylaşımlı Sanal Dünyalar, Second Life, Avatarlar.

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1. INTRODUCTION

Until recently, Computer-Aided Design (CAD) software packages were used for drafting rather than being a platform for designing. However, today computer is no longer a mere tool for representation and visualization but it is the primary environment of design (Erdem and Pak, 2004; Johnson 2005). The way we represent and visualize designs is changing by the impact of CAD and communication technologies (Gabriel and Maher, 1999).

In education, Computer Aided Architectural Design (CAAD) is becoming increasingly popular. In the recent years, advances in computer networking and multimedia representation made educators explore the potentials of computer-based educational environments. Academic and industrial researches are looking for novel and unexpected ways to use CAAD. “Schools have become experimental laboratories for creating design machines, promoting a new architectural imagination and treatment of materials, and finally extending the realm of architecture to cyberspace” (Andia, 2002, p. 7). CAD technologies still continue to develop, but there is not much consideration about practicing architectural design in the shared, simulated, synchronous, 3D space and time with multiple users (Ondrejka, 2008). Some of the current researches focus on virtual design studios using 3D virtual worlds to enhance students designing and practicing skills as an extension of physical ones in an immersive platform (e.g. Maher and Simoff 1999; Abdellatif and Calderon, 2007; Reffat 2007b).

Second Life is one of such platforms. It is a rich environment that allows students, instructors and professionals actively involve in learning experiences that could enhance discovery, investigation and creation in a dynamic and collaborative way (Coffman and Klinger, 2007).

This study investigates the value of using Second Life in architectural design. It is believed that before employing such platforms, its challenges and potentials should be examined in order to deploy these technologies in the best possible manner. As such, educators may elaborate these worlds to be suitable for the computer-based architectural design studio of the future.

1.1 Problem Statement

Researches on the potentials of designing in 3D virtual worlds are new (e.g. Reffat, 2005, Rosenman, et al., 2006 and Abdellatif and Calderon, 2007). However to date, few studies have been conducted which survey the potential of using Second Life in architectural design studio.

Many researches focus on comparing the virtual and traditional design studio or virtual design studios among themselves in order to understand the contribution of various media in design activity (e.g. Maher, Gül and Bilda, 2006; Gül, Gu and Williams, 2008, etc.). However, this study discusses the potentials of a specific 3D virtual world (SL) by focusing on its distinct features that add new dimensions to design experience.

Unlike many other online traditional systems, 3D shared virtual environments have three-dimensional characters. Consequently, a place is required to exhibit bodies and objects which has distinct influences on its users' experiences (Holmström and Jakobsson, 2001). Second Life enables users to experience objects/buildings in 3D, through rich view points. As architectural design is highly depended on visual and tacit demonstration, it needs a space for sharing designs of objects and buildings in a visible platform. Web sites are generally devoid of sense of space, and they are descriptive rather than experiential (Ondrejka, 2008). Second Life allows for uniting observers and observed buildings in a shared space, thus introducing a new opportunity for design development and design education.

1.2. Aim and Scope

This thesis discusses the usability and potentials of Second Life in architectural design education. It aims to find out whether and how students will adopt using Second Life for their designing activities. The research does not intend to compare Second Life with other CAD tools or traditional methods. In addition, the purpose is not to claim that Second Life should be used instead of any existing medium. Rather, the study aims at examining to what extent Second Life would improve and can be a useful tool as a design environment for interior architecture students.

In this study, the effects of Second Life environment are analyzed through synchronous and asynchronous applications, focusing on collaborative architectural design activities. The study is carried out in an interior architectural curriculum, with projects involving rich design decisions ranging from furniture to space. The

individual tasks were given only for exercising necessary designing skills. Collaborative projects were the main focus for the students' assessments.

1.3. Context and Structure of the Thesis

This thesis comprises an investigation of using a specific 3D virtual world, Second Life, as a design environment in an architectural design course. The study involves several architectural design tasks. Before and after the completion of the tasks, questionnaires and interviews are conducted to figure out students and tutor's perceptions of employing Second Life as a design environment.

This study consist of six chapters. The successive chapters of the thesis are structured as follows:

First chapter introduces the aim, problem and structure of the thesis.

Second chapter initiates by definitions and classification of various virtual worlds in order to display how the virtual worlds have emerged and developed. The transformation of 3D virtual worlds into platforms of design by combining the concept of space is discussed. Then, the meaning of architecture in 3D virtual worlds and the purpose of designing architecture in virtual worlds are explained. Lastly, the educational values of 3D virtual worlds in architectural design, including its benefits and challenges are discussed. In addition, the processes of learning and designing in a collaborative environment are reviewed.

The third chapter focuses on Second Life, the medium where all the design implementations for the study took place. The definition of Second Life is given including its general features and potentials. Moreover, designing and modeling in Second Life are explained in order to assess its capabilities and restrictions while generating architectural artifacts.

The fourth chapter of the thesis involves the case study, which is consisted of a pilot and the main study. This chapter initiates with the pilot study, which attempts to validate the possibility of using Second Life in a design course and indicate the possible problems beforehand to compose a basis for the main study. After the pilot study, the main study pursues. The main study is developed and organized by considering the weaknesses confronted in the pilot study.

In the fifth chapter, results and discussion, outcomes of the study are presented in tables and graphics.

The conclusion chapter of the thesis reviews the significant points of the findings. In addition, this chapter proposes suggestions for further studies, which are inferred by the gathered data and analysis. This chapter is followed by a list of references and appendices. The appendices comprise the questionnaires and interview.

2. 3D VIRTUAL WORLDS

2.1. Emergence of Virtual Worlds

With the aid of high-speed Internet connections, powerful graphical and microprocessor performances shared virtual environments have modulated from text-based to two-dimensional Web environments and eventually to a space perceived as a 3D environment by its' users. In other words, 3D virtual worlds (e.g. Second Life, Active Worlds and There, etc.) are the most recent generation of the 3D virtual worlds. In order to figure out how virtual worlds have been generated, it would be necessary to look back to the precedents.

2.1.1. Text-based Virtual Worlds

One of the first shared virtual environments is known as *MUDs* (Multi-User Dungeons), which are also referred to as "Multi-User Domains" or "Dimensions". MUDs are systems for networked communication and give access to the shared online environment to support synchronous actions. These environments comprise "rooms", "exits" and "objects" in the form of textual interfaces. Users describe actions by typing to trigger commands for manipulating the objects and places (Curtis and Nichols, 1993). The environment offers a place to its virtual communities for social interactions, communication, entertainment and education (Bartle, 2003).

The history of MUDs reaches to the early 1970's and has its origins in the fantasy game called "Dungeon and Dragons". Unlike the combative content of early MUDs, in the late 1980's with the development of TinyMUD, the content of MUDs began to focus on virtual problem solving, user cooperation and social interaction (Bartle, 1990).

In time, *MOOs* (Multi-user object oriented environment) are developed in the early 1990, as text-based shared virtual environments, where both synchronous and asynchronous communication is possible. The environment was promoted to a realm, where objects and verbs could be created. These environments provided its users with the ability to operate "their bodies and objects around them in a virtual space as if they had substance" (Kolko, 1995, p. 109).

In the text-based virtual worlds, words are the exclusive means to create a space. Cicognani (1998) debates on the linguistic characterization of design in the text-based virtual worlds, and points out to the essential effects of languages. In the text-based virtual worlds, spaces and objects created for virtual worlds depend solely on the employment of language, (i.e. words, sentences and letters), that have impact on the occurring of events.

As Curtis and Nichols (1993) emphasize even if some virtual worlds are in the form of graphical interfaces and 3D dynamic images, they are still influenced by linguistic aspects and their basis are still linguistic. Users of text-based virtual worlds would need to rely inevitably on imagination for visualizing, creating and constructing the space.

2.1.2. Graphic-based Virtual Worlds

Further development of MOOs extended as graphical images of objects and places that assist the user to realize and navigate the virtual world as a visualized space. By adding graphical visualization to the virtual worlds, spaces become familiar and intuitive environments that support online activities (Cicognani and Maher, 1998).

In 1985 “Habitat” emerged as the first graphical multi-user environment in which 2D visuals were used to construct the content of the world. It was the first time users were represented by animated avatars (Donath, Karahalios and Vigas, 1999). Another popular virtual world was “The Palace” in which the users could chat over an interface, where the 2D visual avatars pasted on (Dickey, 1999).

In a graphical virtual world, users are displayed in a space where the textual representation of spaces and functions are replaced by pictorial spaces. Graphical interfaces facilitate seeing or understanding the information that is hidden or unavailable in a textual representation (Donath, Karahalios and Vigas, 1999). Although the static image of graphical virtual worlds does not fully convey the spatial concepts of the space, these spaces served as a guide in the development of 3D virtual worlds.

2.1.3. 3D Immersive Virtual Worlds

With the advances in technology, virtual worlds have evolved from text-based, two-dimensional platforms into the three-dimensional interactive worlds. Nowadays,

users can easily adopt to these worlds for learning, designing, shopping, entertainment, and so on. Van Kokswijk (2003) perceives this state as a hybrid of two realms of real and virtual by explaining the phenomenon named as *interreality*. In this sense, virtual space becomes an extension of the real. In other worlds, users of virtual worlds experience both of the real and virtual worlds simultaneously (Thomas and Brown, 2009).

In the past few years, 3D virtual worlds have become more common. With the advent of VRML (Virtual Reality Markup Language) technology, shared spatial models can be created and modified to interact with the content. Immersive, shared virtual environments populated by thousands of users at the same time in the same place are available. Participants access these worlds by self-created highly personalized digital representations named as "avatars." These three-dimensional online digital worlds are elaborated by the interest and imagination of the users.

Jakobsson and Skog (2000) classified the four basic features to define a shared virtual environment as a virtual world: First, a virtual world supports the feeling of presence, which means the feeling of being at the same place although residing in physically distributed locations. As for human inhabitation, in order to create meaningful links between the human beings, their activities and the environment, the system must offer participants an environment to which they can attribute a sense of place. Second, virtual worlds provide platforms to interact with other people. Third, virtual worlds are persistent. Even if the user logs out, the world still exists and events keep going on. Finally, virtual worlds directly suggest some kind of spatial

metaphor. This usually intensifies the feeling of presence by evoking more familiar and intuitive places (Jakobsson and Skog, 2000).

Researchers of social sciences have explored that, as these worlds have matured, they formed new kind of virtual communities with specialized languages, political systems, social norms, ideologies, shared histories and particular values by mutual experiences (Steinkuehler, 2004; Krotoski, 2005). These are persistent worlds, such as multi-user virtual environments (MUVEs), and massively multiplayer on-line games (MMOs). MMOs are generally classified according to the purpose of employment. While most of them have a theme with a quest to interact with the content, others are based on contemporary realistic environments, which often stand for "social virtual worlds" (Book, 2004). Balkin (2004) believes that these environments will go beyond just gaming and will serve for diverse needs:

> As multiplayer game platforms become increasingly powerful and lifelike, they will inevitably be used for more than storytelling and entertainment. In the future, virtual world platforms will be adopted for commerce, for education, for professional, military, and vocational training, for medical consultation and psychotherapy, and even for economic experimentation to test how social norms develop. Although most virtual worlds today are currently an outgrowth of the gaming industry, they will become much more than that in time (p.2044).

This thesis focuses on the most widely publicized 3D virtual world, called Second Life, in respect to architectural studies. With the development of such virtual spaces, alternative platforms occurred to practice design and architecture. Although these virtual spaces have their unique principles in designing or creating a world, fundamentally 3D virtual worlds are still using the knowledge of physical architecture.

2.2. 3D Virtual Worlds in Architecture

With the contribution of the Internet and visualization technologies, many real life entities and spaces have been moved to shared virtual environments "which serve as an extension and a substitute for physical settings" (Kalay, 2004, p.195). These transformations have brought new meanings to the terms of '*space'* and '*architecture*' as well. Since people are immersed in these environments via avatars (visual representation of human), a new type of architecture has emerged that regards forms and functions of these networked environments (Maher and Gero, 2002). The exploration of these virtual spaces becomes an architectural issue (Campbell and Wells, 1995). The role of CAD systems has shifted from drafting to designing of the new 3D shared virtual environments (Reffat, 2005).

Gu and Maher (2005) define virtual worlds as "virtual architecture or cyberspace …, as networked environments designed using the metaphor of architecture" (p. 239). In Charitos and Rutherfords (1996) definitions, the user experiences a virtual environment as a three-dimensional space. With the developments of 3D interfaces, users of virtual worlds are increasingly dealing with higher degrees of spatial representations of bodies and objects in a space, rather than conceptual descriptions.

Architecture and environment become essential to cluster the avatars, their communication, activities and scenarios as physical spaces do. Now architecture embraces virtual spaces, particularly dealing with the *cyberspace* activities of virtual communities.

Recently, virtual foundations become available through computer networking such as libraries, museums, educational institutions, retail and recreational establishments and so on. As virtual communities need virtual spaces, new architectural demands rise to enhance and support virtual activities. Therefore, a new type of architecture emerged as a result of the shift of modern life to virtual realm (Jourabchi, 2006).

Building virtual places is an architectural process. Since “architecture is the art of making places” besides the spatial arrangements, it embraces social and cultural values (Kalay and Marx, 2001). Therefore, place making in cyberspace requires a meaningful connection between human and its environment as in real life. This may be done through “the adaptation and appropriation of the space with its inhabitants, their actions and conceptions” (Kalay and Marx, 2001, p. 770).

Debates on the concept of cyberspace architecture are not new. Novak (1991) explains this radical transformation in the conception of architecture underlining the terms of “liquid architectures of cyberspace”, “transarchitectures” and “transmitting architecture”. He explains the concept of liquid architecture as an imaginary terrain that only exists in the digital realm. In his words, he introduces this phenomenon as;

> ..., Liquid architecture is an architecture that breathes, pulses, leaps as one form and lands as another Liquid architecture is an architecture whose form is contingent on the interests of the beholder; it is an architecture that opens to welcome me and closes to defend me; it is an architecture without doors and hallways, where the next room is always where I need it to be and what I need it to be. Liquid architecture makes liquid cities, cities that change at the shift of a value, where visitors with different backgrounds see different landmarks, where neighborhoods vary with ideas held in common, and evolve as the ideas mature or dissolve.

Transarchitecture has put forward liquid architecture to create spaces that breathe, pulsate and respond to transformations. Thus, a trans-architect considers the virtual space as a landscape to perform and transform the architecture in an immersive, interactive and animated environment for constructing territories (Jourabchi, 2006). Therefore, transarchitecture can be considered as the creation of where the possible and the impossible are combined in multidimensional time and space (Tanaka, 1997). In fact, cyberspace architecture allows some kind of arbitrary creation of design and alters in the way of the users demands. However, the potential of this arbitrary freedom of cyberspace for architecture still remains to be explored (Tanaka and Tajima 1996; Tanaka, 1997).

As mentioned earlier, the phenomena of virtual worlds are not new but the inquiry of how it is going to be used, design and build successfully still remain as a question compared to traditional architecture (Jakobsson and Skog, 2001; Fors and Jakobsson, 2002). Virtual worlds may serve as an alternative platform for design exploration. In their studies Maher, Simoff, Gu and Lau (2000) pointed out the two purposes of designing virtual architecture: One is used for the simulation of the physical architecture, which directly demonstrates real world architecture through modeling a project to be created in the real world. The other one is functional virtual environments that serve for virtual activities in virtual worlds. As referring to the latter, “these media types are now used to design and create virtual worlds whose functions are available without a translation to physical structures” (Maher and Gero, 2002, p.1). In this sense, designing in virtual worlds is no longer limited to real world laws and constraints but exclusively depends on the imagination of its’ creators.

2.3. Educational Value of 3D Virtual Worlds in Architectural Design

As more technology is integrated with architectural education, the practices of architecture and design are being transformed accordingly (Bender, 2005). According to Norman (2001) and Reffat (2007b) there is a transition from hand drawing to the paperless design studio.

The teachings of architecture involve theories and media of representation (Kvan et al., 2004). Design, in architectural education, includes both theoretical knowledge and practical skills. The theories of design mainly accept Donald Schon's works on design pedagogy, involving reflection-in-action (a conversation with the situation) and knowing-in-action (tacit knowledge) (1987 cited in Kvan, 2001) as well as problem-based learning that is achieved by practicing the theory through solving complex and open-ended problems (Koschmann et al., 1994; Savery and Duff, 1995). Such theories of teaching and learning design are process focused and require collaboration of students and tutors. 3D virtual worlds, offer relevant platforms for design (Reffat, 2005).

Teymur (2001) indicates that in architectural education, skills for solving a problem cannot be directly gained from theoretical knowledge, and he approaches to architectural education as a practice of theory. 3D virtual worlds offer its users a space to share knowledge and design ideas through active involvement to the process.

According to Brusasco et al. (2000), computer-supported design studio has three important key elements: memory, process and collaboration. 3D virtual worlds with the advanced graphic and animation techniques are platforms for design teaching and learning, where new kinds of experiences that engage the students are offered. They enhance students and tutors in reflective dialogues while designing and evaluating in ways not possible in conventional design studios. Moloney et al. (2003) state that

> critics were invited to experience the architectural proposal in a participatory manner in the multi player project as opposed to passive viewing and listening which is the norm for analogue or digital reviews. This enlivened the whole process, relaxing the student and critic, and encouraging conversations about aspects of the work to evolve (pp. 255-256).

Some examples of 3D virtual worlds include prototype software, such as CALVIN (Collaborative Architectural Layout Via Immersive Navigation). It was put into use by University of Chicago in the late 1990s to experience multiple perspectives through immersion of avatars in architectural design process. Studies with CALVIN showed that active participation could be motivating and effective in the design of spaces (Leigh et al., 1996).

Another study used ‘Half Life and ‘Counter Strike’ as a design medium (Moloney, 2001) at the University of Aukland. In the course, students were encouraged to use the game software “to push the boundaries of architecture” (p. 123). Students received critics on the architectural tasks in an immersive manner through avatars (animated presentation of the users) rather than passive viewing and listening. Woo, Lee and Sasada’s (2001) investigation of multi-user workspace, which is experienced in Osaka University and Kyung Hee University, revealed that a 3D virtual space

supports collaboration of multidisciplinary groups for actively building and reviewing the designs.

Reffat (2005) examined a 3D real-time shared virtual environment (Active Worlds) for collaboration in architectural design learning based on IDCE (inhabit, design, construct and evaluate) model. In his study, the impacts of using metaphors in virtual world construction were addressed. In the study of Maher et al. (2006), a prototype system called DesignWorld was developed to investigate the early design phases of the design process by integrating a sketching tool with a 3D virtual world (Second Life). DesignWorld allow the designers to act between developing ideas and building models. The study revealed that designing in the 3D virtual world improved the ability of designers to create new built models.

As Kvan (2001) predicts, virtual design studios have promising opportunities to enhance architectural design education through prevailing potentials of technology compared to conventional methods of design education. On the other hand, with the rapid evolution of digital media, these innovative technologies bring new challenges for design education and require academicians to formulate new understanding on the existing design teaching theory (Achten, 2003; Gu, Gül and Maher, 2007; Oxman, 2008). The possible potentials and drawbacks of virtual worlds are still remaining questions to be resolved in architectural design education.

2.3.1. Learning in Virtual Worlds

3D virtual worlds have superior features in comparison to other text-based and two-dimensional online environments especially in architectural learning and design process. While these distinctions are encouraging, design tutors should be aware of the challenges before conducting 3D virtual worlds as a teaching, learning and designing tool in architectural design curriculum.

2.3.1.1. Benefits of Learning in Virtual Worlds

Sense of presence and 'being there'. Virtual worlds offer platforms give the users a sense of presence, sharing the same space to interact and experience activities with others (Albuquerque and Velho, 2002). Slater (1999) defines presence as the concept of 'being there'. According to Steuer (1992) presence means "the sense of being in an environment" (p.75). Presence has significant influences on the user's responses, behaviors and performances when interacting with the shared virtual environments. Social presence in collaborative systems enables knowledge transferring as well as possible enhancement of learning and performance (Witmer and Singer, 1998). 3D shared virtual environments especially with a higher degree of spatial character and richer visual cues play an important role in immersion and involvement in an activity to increase social presence (Jung, 2008).

Being in 3D graphical environment. As architecture is a three-dimensional representation, web-based tools offering less social presence may not support synchronous activities with concurrent users (Bouras, Giannaka and Tsiatsos, 2008).

They lack embodiment, which is one of the key feature to create a sense of presence to increase motivation and engagement in these environments. Gül, Gu and Williams (2008) state that 3D virtual worlds have space characteristic which use place metaphors in designing and constructing. Maher and Gu (2002) state that

> the use of real time rendering makes it possible to create 3D virtual worlds that can simulate the effect of walking through a physical environment and reacting spontaneously to the use of the place. This is in contrast to the 3D models that have prefixed animation or camera locations and do not support spontaneous collaboration within the 3D model.

Jabi (2004) states, "opinions about perceived successes and failures in the design can be clearly communicated because the game interface allows the articulation of the total spatial *experience*, rather than a perception of the cumulative effect of spatial elements" (pp. 116-117). In addition, trying to visualize two or three-dimensional projects through the drawings sometimes can be confusing. A three-dimensional experience by walking around the modeled building and then going back to its 2D drawings can be satisfying (Beaubois cited in Wong, 2007). Campbell and Wells (1995) indicate that the opportunity to walkthrough inside the design and observe it from within, enables designer to solve complex connections and details, which would otherwise be difficult to trace in other media.

Sense of realism. One of the aims of 3D shared virtual environments is to provide its' users' a sense of realism (Violante, Vezzetti and Tornincasa, 2005). Through realism social richness and immersion (Lombard and Ditton, 1997). Doughty and O'Coill (2005) indicate that the "photorealistic environments with increasingly sophisticated characterization can give the player the impression that they are actually taking part

in the on screen events" (p. 303). This allows the ability to engage the users as active participants instead of passive observers. Carter and Click (2006) state that the improved visual cues add enhanced dimensions to social interaction tools that increase the quality of communication among students compared to text-based or audio-based communication.

Integration of Avatars. The presentation of a user in the 3D world is an avatar. The avatars also provide a sense of awareness of other people in the virtual learning environments (Kalay, 2004). Thalmann (1999) classifies the important functions of using avatars as:

1) the visual embodiment of the user

2) means of interaction with the world

3) means of sensing various attributes of the world

In addition to the main functions above he compiles other crucial functions under 6 items:

1) perception (to see if anyone is around)

2) localization (to see where the other person is)

3) identification (to recognize the person)

4) visualizations of others' interest focus (to see where the person's attention is directed)

5) visualization of other's actions (to see what the other person is doing and what is meant through gestures)

6) social representation of self through decoration of the avatar (to know what the other participants' task or status is)

Carter and Click (2006) state

> Without facial expressions, heads nodding or tilting, and or eye contact, it is often difficult to get the true or complete message across. With the latest developments in 3D virtual environments,...,and a high-speed connection to Internet, technology is reaching a new level of immersive experience, incorporating rich visual elements and animations that provide full-featured social learning environment (p. 2).

Avatars are useful means to increase the sense of realism and presence through reflecting emotional behaviors that can enhance communication by animated gestures and poses (Holmberg and Hulvia, 2008). The appearance of the avatars can be customized according to the user's demands. Such customization helps to identify the participants instantly in a virtual space. Moreover, avatars also serve as a camera and enrich viewpoints in the 3D environment by first-person and third- person view (Dickey, 2005). Campbell and Wells (1995) state that in a shared virtual environment the designer may easily control the viewpoints and determine the details. As Reffat (2007a) indicates, 3D graphical environment with avatars "encourage people to be more active in the way they interact with external representations, through having continuously choose their position and viewing perspective when moving through the virtual environment" (p. 662). Jabi (2004) indicates that "whether it is the movement of ourselves through space or the movement of other characters, the dynamic relationship of occupants to spatial boundaries helps us to understand the ergonomic characteristics of a space" (pp.117-118).

Integration of Sounds. Maher, Simoff, Gu and Lau (2000) explain 3-D immersive collaborative modeling world as "a gradual transition from textually described online environments through to virtual places that are described in 3D geometry, sounds and textures" (p.482). Charitos and Rutherford (1996) consider sounds as perceptual

enhancements that help the user to form a more complete picture of the space entered. “This is the sole purpose of the spatializer; it complements the visual elements by giving a *sense of place”* (p. 16). Provision of 3D sound in virtual worlds also increases the users’ sense of presence, so that people feel that they are as in the actual environment. According to Gunther, Kazman and Macgregor (2004) “auditory information is useful as navigational aids because they are complimentary to the visual stream of information and do not require conscious choices of attention, in contrast to additional purely visual aids” (p. 435).

Different modes of communication. Communication in the design studio is mostly depend upon graphical visualization. Especially, remote learning and designing of architectural projects requires a graphic-based context to communicate (Abdellatif and Calderon, 2007). Generally, avatars are communicating through text-based chat that requires the action of typing. This situation often becomes inconvenient for conveying complex ideas while manipulating objects in the design. For this reason, some of the advanced virtual worlds provide audio and video based-chat that facilitates communication during the design process (Rosenman et al., 2006).

Synchronous designing. Virtual worlds offer platforms for social networking and collaboration on design projects. Existing tools for generating and visualizing designs of buildings or other products usually focus on a single user (Rosenman et al., 2006). The main difference of 3D shared virtual environments from other media is that students’ designing activities and communications, which take place in a multi-user real-time 3D virtual environment, are visible to all designers from a single view (Reffat, 2007b). These environments offer a platform to work in an interactive

real-time environment for both synchronous and asynchronous communication and collaboration on design projects. The students participate in the 3D virtual from different locations, nations and even from different time zones (Zhu, Wang and Jia, 2007). As Ward and Sonneborn (in press) state, virtual worlds enable its users to access from anywhere in the world and allow individuals to gather from diverse geographical regions, bring along cultural perspectives that is unconstrained by financial, physical or geographic concerns. In the context of 3D virtual worlds, significant innovative ideas may emerge through collaboration. As such, synchronous experience is an essential aspect of virtual worlds in terms of creativity (Ward and Sonneborn, in press).

Task awareness. Feedback capabilities are crucial for the participants working collaboratively in 3D worlds. Awareness in a task often becomes important in collaborative activities to ensure working effectively and helps tracing what is going on as well as enhancing users' position in a collaborative task (Fjuk and Krange, 1999; Rasmussen, Krange and Ludvigsen, 2003; Leinonen, Jarvela, and Hakkinen, 2005). Advanced 3D virtual worlds provide characteristic movements of an action and feed-through behaviors (e.g. typing includes hand movements and transferring, moving or manipulations are visible to others) that enhances workspace awareness (Gül, Gu and Williams, 2008). This makes "students aware of each other's actions and can focus more on the development of the design model in a collaborative design task" (Gül, Gu and Williams, 2008, p. 586).

Enhancements for creativity and form-finding. Architecture designers may utilize virtual environments for form-finding, communication and presenting their ideas

(Bertol, 1996). Currently, digital media systems include new types of visualization possibilities that stimulate designers to focus on the exploration of form early in the design process (Brown, 2003). Dong and Gibson (1998) claim that, "digital media have elevated the visual senses to a new level" (p.10). Madrazo (1999) refers to digital visual representations as a support for visual thinking that can be used to enhance form understanding.

Furthermore, digital and communication media are changing the design thinking processes. They foster creativity and intuition through abstraction as well as capturing dimensional precision (Kvan, et al. 2004). Do and Gross (1997) claim that computational tools are not only functioning as an aid to analyze spaces, but they also help in spatial perception. Gül, Gu and Williams (2008) state that "3D virtual worlds offer many possibilities for understanding the spatial arrangement of the objects and developing student spatial abilities" (p. 584). In 3D shared virtual environments, the modeling of the building and the design decisions work out simultaneously (Gero, 2002). Ward and Sonneborn (in press) document that revealing the 'impossible possibilities' on problem solving through virtual worlds could have an influence on the creative idea.

Pleasure and play. Computer game-based learning has valuable outcomes due to pushing the user to act freely in shared virtual environment and including fancy context (e.g. graphics, sounds, scripting, etc.) (Yu et al., 2005). Dondlinger (2007) indicates that act of playing is a significant aspect which increases motivation. 3D virtual spaces enable users developing new values for learning new things with more engagement and pleasure (Brown and Bell, 2004).

2.3.1.2. Challenges of Learning in Virtual Worlds

Adequate training. Adequate training and instruction to get acquainted with the virtual worlds is essential to overcome frustrations at an early stage. Virtual worlds can be confusing for users who are unfamiliar with computers.

Hardware quality. Virtual collaboration requires high-capacity microprocessors and a broadband Internet connection to operate adequately. Accordingly, this situation affects the users' willingness to participate in synchronous activities (Jung, 2008).

Safety and Privacy. Because 3D virtual worlds are accessible to all users, others can distract the synchronous actions while designing. DeWinter and Vie (2008) state that " instructors must be aware that racism, sexism and other forms of harassment may be unavoidable; such as, instructors should approach these as teachable moments to help students understand the changes that online environment have wrought on our understandings of privacy and safety" (p. 319).

3. SECOND LIFE

3.1. Background

Shared virtual environments have emerged as 3D virtual worlds, which are developed from those of the gaming industry with the integration of networking, and advanced graphic performances (Maher and Gu, 2002). Second Life (SL) is the most popular and advanced one among these virtual worlds. These networked 3D graphical environments enable people to perform real-time interactions and provide support for various online activities such as; social communication, gaming, design collaboration, e-learning, e-business and so on (Gu, 2006).

Second Life is a computer-simulated 3D environment that is elaborated by the participation of its users. Users participate in the environment with an "avatar" to interact with the content. The avatar is manipulated with a keyboard and mouse action, and it is the visual representation of the user, through which the user's emotions and behaviors can be externalized.

Second Life enables real-time interactions and it offers its users the possibility to personify their avatars, build virtual spaces and objects through an user-friendly interface (Hendaoui, Limayem and Thompson, 2008) for "modding" the content (Kemp and Livingstone, 2006, p. 13). Users are able to navigate by walking, flying

and teleporting between spaces. In addition, other movement types are available like jumping, running, etc.

Second Life allows users to own the intellectual property of their own creations. As such they are able to make the "world of (their) very own" (Edwards, 2006).

The system also has connections to external web pages and other Internet resources (Kemp and Livingstone, 2006), which provides a flow between 2D web pages and 3D environment to enhance knowledge and information transfer.

The virtual worlds such as Second Life are incredibly playful spaces with its open-endedness aspect and diversity of residents (Book, 2004). Second Life provides autonomy for managing the environment and an economy to run virtual businesses (e.g. Dell, American Apparel, IBM, etc) (Hobbs et al., 2007). Although the places in Second Life are virtual, it has a rapidly growing community and economy that is real (Williams et al., 2007).

In the recent years, several theorists have highlighted the educational potential of virtual worlds. Among other virtual worlds, such as Active Worlds, There and other analogs, Second Life is largely used for educational, social and business purposes (De Lucia et al., 2008). Especially, educators have begun to explore the potentials of Second Life as a platform for education (e.g. Harvard University; MIT, Ohio University, ETH Zurih, University of Cincinnati, etc.) (Kemp and Livingstone, 2006; Collins and Jennings, 2007; Manson, 2007, etc.). In most of the studies, Second Life

is used as an experimental and innovative platform to figure out its possibilities for online learning, distance-learning, open learning, etc.

Second Life has an evolving nature and allows educators to take place in the progress and construction of this virtual world (Schmidt et al., 2007). More than 225 institutions including universities, museums and research centers currently participate in Second Life (Calongne and Hiles, 2007).

In contrast to the thematic and storyline settings of MMOGs (such as World of Warcraft), Second Life is mainly based on modern-day environments that rely on reality (Book, 2004; Kemp and Livingstone, 2006). Usually, the pre-defined and limited content of MMOGs is not suitable for customizing as learning spaces, since it restricts the design space (Ondrejka, 2008). For this reason, the flexible nature of Second Life makes it a preferred environment by educators, in which one can easy adapt the space to fit educational and experiential needs. Second Life environment enables users to reach a self-directed level of training (Fortney, 2007). Second Life is not only a gaming environment; it is a new category of online environment where both gaming and education is possible (Buckland and Godfrey, 2008).

In terms of design, SL provides free accounts for its users allowing them to design, integrate and texture structures, furnishings and clothing. Sandboxes and other SIMS offer open spaces for creativity. Moreover, Second Life allows its users to make simulations and collaborate (Coffman and Klinger, 2007). Video-conferencing, synchronous or asynchronous collaborations on design projects can be held and the

designed models can be stored in the inventory. One can take snapshots from every point of view and record the whole design process through the movie recording tool.

3.2. Designing in Second Life

Pfeiffer (2007) describes the virtual world Second Life as;

> Almost everything is 'perfect' in Second Life: not only the weather is always nice, but also the population mainly consists of good-looking young people in the prime of their life; sickness and death do not exist; everyone can fly; nobody needs a home to live in, etc. On the other hand, boredom is just around the corner, as are disappointments, broken hearts, and so on (as cited in Nederveen, 2007, p.4).

According to Mikulski (2007), Second Life and other similar virtual worlds seem as arouse a feeling of being in a 'natural' environment, but in fact, they are quite different in terms of needs and expectations. Architecture gains new meanings in terms of function and meaning. For instance, the purpose of architecture to provide enclosure or shelter becomes irrelevant because there are no physical constraints, no gravity or bad weather conditions (Mikulski, 2007). As such, the distinct natures of virtual worlds render the concept of architecture and architectural design prone to alterations.

Gordon and Koo (2008) explained designing in Second Life as follows:

> Second Life allows for group authorship, which better enables a sense of collective ownership in a space or object. And unlike professional design programs, it affords users a sense of playfulness and allows them to experiment with designs and concepts that have little connection to empirical reality (p. 220).

Some researches were done to investigate the appropriateness of using SL in architectural education. VIPA (Virtual campus for virtual space design Provided for European Architects) project aims to find out the most suitable 3D virtual world among Open Croquet, Bender and Second Life, to run with the learning management system (Moodle) for architectural education at the Vienna University of Technology (Hoog, Falkner and Seifried, 2007). Abdellatif and Calderon (2007) observed the usability and potentials of Second Life environment as a communication tool in distance learning for criticizing architectural drawings and ideas. The study showed that Second Life is appropriate for a distance virtual critic.

> Second Life virtual environment possess high perceptual qualities obtained from the spatial attributes that give the sense of being 'in a place' and provides rich context of the activities that take place in it, it presents an opportunity for exchanging design ideas and drawings via both text-based and graphic-based means of communication (Abdellatif and Calderon, 2007, p. 48).

O' Coill and Doughty (2004) state that Second Life platform encourages building through a simple but powerful building tool that does not require exclusive skills as in other sophisticated CAD software or animation programs. Moreover, the advanced features of Second Life, such as; immersion, ease to use and not complex but powerful building tools make it an excellent choice to generate both individual and collaborative design projects as well as to use in architectural education (Gordon and Koo, 2008).

3.2.1. Modeling in Second Life

Construction of architecture in Second Life is done by applying volumes (prims) to the landscape and changing their position on a grid (Mikulski, 2007). Second Life building tools use parametric modeling. Models can be created instantly by assigning parameters, and they stay on the site unless they are taken or deleted. A basic three-dimensional geometric object, a primitive or "prim" refers to a single unit that makes up all artifacts in Second Life with the flexibility to generate a limitless set of possibilities (Ondrejka, 2008). The maximum dimensions of a prim is 10 meters, the minimum is 0.010 meters. There are 13 basic shapes in Second Life. A primitive can be in the form of several 3D shapes: a box, a cylinder, a sphere, a torus, a tube or a ring, etc.

Second Life allows its users to create more complex design visualizations by modifying the prims through applying skew, twist, shear, cut, taper, revolution, dimple features and adding or changing hollow shapes and sizes. The grass, trees and avatars are not made up of prims however; they are treated like primitives, because they are created in Second Life (Rymaszewski et al., 2007). Second Life also offers tools and interface to create real-time realistic renderings through lighting and texturing effects (Weber, Rufer-Bach and Platel, 2007).

In Second Life, 3D objects depend on scripts to perform complex interactions and a large quantity of other actions by the application of Linden Scripting Language (LSL) (Kemp and Livingstone, 2006). Rymaszewski et al. (2007) state "Instead, anything created in-world was built via static creations and physics. Objects in

Second Life act more or less like real-world objects, colliding with each other, falling under the effect of gravity, etc" (p.164).

Second Life offers flexible camera movements, and even some viewpoints has no real-world equivalents. It has viewpoints that are more flexible compared to other computer programs (Mansfield, 2008). The camera may be operated independently from the position and orientation of the avatar (Wadley, 2008).

One of the distinct features of Second Life is that, it permits users to collaborate with each other for working on large and complex projects, joining different skills of the designers (Rymaszewski et al., 2007).

4. CASE STUDY

4.1. Research Questions

The aim of the study is to understand the usability and potentials of Second Life in architectural design education. The thesis discusses to what extent Second Life would improve and can be a useful tool as a design environment, through a study held with interior architecture students. The effects of designing in a specific 3D virtual world, Second Life, are analyzed by focusing on its distinct features.

The research questions derived from this framework are:

1. What is the potential of Second Life as a learning environment in architectural education?
2. How do students perceive the usability of Second Life in architectural design education?
3. How do students perceive the effects of using avatars and 3D graphical environment of Second Life in their design implementation?
4. What would be the factors to be taken into consideration when using Second Life as a design platform in education?

4.2. Methodology

The research is composed of two parts including a pilot and a main study. A pilot group was administrated in order to evaluate Second Life (SL) as a design environment for users who have not experienced SL before.

The reason for conducting the pilot study is to assess the validity of SL as a tool for designing and learning in architectural design education. In addition, the pilot study was aimed at understanding the level of readiness of the design students in using SL as design environment in a design course. A positive assessment obtained from the pilot study would reveal that students would be willing to use SL as a design environment in a design course. Another reason for conducting the pilot study is to comprehend the system deficiencies beforehand and compose a basis for the main study. The context of the main study that was based on the lessons learned from the pilot study, which is explained in detail in the further chapters.

4.3. Pilot Study

The pilot study was handled in seven weeks within the calendar of an elective design course, IAED 316 Computer Applications. The course met once in a week, for 3 scheduled course hours. The course content was scheduled in order to acquaint students with necessary information and skills for designing in SL.

4.3.1. Tasks

Most of the studies revealed that usability can only be expressively measured during task process (Granić, Glavinić and Stankov, 2004). In order to understand the usability of SL as a design environment for a design course, an individual and a collaborative task was offered respectively, in seven weeks.

Students were guided with orientation tutorials of SL and pursued the tasks. The tasks involved creating 3D design projects by using the modeling tools of SL.

The individual project was to design a chair in SL. It was handled in class sessions (see Appendix C1, Figure C1.1). The collaborative task was done by groups of students. The project involved the design of an "avatar cafe". Students were expected to design the inside of the given shell for the avatars to inhabit and perform virtual activities in SL. The duration for completing the project was 3 weeks (see Appendix C1, Figure C1.2).

4.3.2. Participants

20 senior students who were enrolled to the IAED 316 course participated in the pilot study. 5 of the students were male and 15 female. For the collaborative tasks, students formed groups that consisted of 4-3 and 2 persons. All of them were experienced in various software tools for their design projects; however, none of them used SL before.

4.3.3. Site

All applications were held in the [K-5] land, Public Sandbox, which allows to build temporary settings in SL. The land allows residents 24 hours to clear the constructed objects and animated scripts.

4.3.4. Data Collection

In the pilot study, the evaluation was based on observations, as well as students' and tutor's subjective assessments. The study involved implementation of an interior architectural design problem in SL. Interactions such as meeting, analyzing, designing and evaluating the projects through the 3D virtual interface of SL were analyzed. The method used for documenting the data was gathered through *electronic observations and a set of questionnaires* based on the study of Abdellatif and Calderon (2007), which focused on the assessment of SL in design collaboration. The students were given a pre-task questionnaire to obtain background information (see Appendix A1). After the completion of the course, students were asked to complete post-task questionnaires concerning surveys about the usability of SL, the design processes, their learning outcomes and perceived usefulness. The questionnaires inquired the effects of SL environment on designing process by concentrating mainly on its specific properties such as using avatars, sounds and designing in a shared real-time 3D graphical environment (see Appendix A2).

4.3.4. Feedbacks for the Main Study

A set of 5-point Likert scale was used to obtain assessments of using SL as a design environment. By conducting a pre-task questionnaire, the demographic information and previous computer experience of the students were obtained (see Appendix A3).

The pilot study showed that students seemed to be satisfied and perceived using SL in the design course as an enjoyable experience (m= 3.80, σ = 1.05). Students' overall satisfaction with the SL interface has moderate means (see Appendix A4, Table A4.1).

The students were mostly in positive in the assessment of the operational tools of SL. The results show that they had little difficulty in using SL tools. The most difficult operation was "*controlling the camera*" (m=2.95,. σ = 1.09) and "*navigation*" (m=2.95, σ = 0,94) (see Appendix A4, Table A4.2).

Concerning the internal validities of the questions, the questionnaire was controlled by Alpha Cronbach tests, and only the ones over 0.7 alpha values were taken into consideration. The third session of the post-task questionnaire was omitted from the main study due to the reliability reasons (see Appendix A4, Table A4.3).

Designing with avatars was the critical understand. It was important to see whether the students would adopt these agents in their designing process. The results related to the contribution of avatars to the design process showed that avatars have significant roles in students' designing experience (see Appendix A4, Table A4.4).

The results of current study showed that overall, students found designing in 3D graphical environment as positive (see Appendix A4, Table A4.6).

The assessment of contribution of SL to the students' learning experience (see Appendix A4, Table A4.7) was removed due to unreliable outcomes.

The findings attested at moderate means about perceived usefulness and students did not pointed out a major dissatisfaction towards SL (see Appendix A4, Table A4.8). Sounds were another novel and critical contribution of the SL environment. However, the limitations caused by the technical problems hindered the sounds to be used most effectively (see Appendix A4, Table A4.5). In the main study, sound factor was omitted due to the low Internet connection speed or individual hardware problems.

In the pilot study, students were asked to use voice-chat while designing and capture video clips of the process. The captured video clips were of poor quality due to technical problems. The low resolution of recorded videos made it difficult to follow and analyze the activities and design behaviors. Therefore, main study was conducted based on text-based communications in design collaboration.

The findings of the pilot study helped to formulate new understanding to teach architectural design through SL with considering the reasons about students' difficulties or discouragements of SL for technical reasons or biases. As the students mostly expressed in open-ended questions, they have to cope with adaptation problems, communication problems, technical problems and time-based problems

while experiencing with a new design medium. By regarding this, the main difference of the instruction method from the pilot study was the amendments that were made in terms of *training procedure, duration and sets of the projects and context of the design projects.*

4.3.4.1. Training Procedure

The feedback gained from the pilot study showed that students mostly complained about adaptation, technical and time-based problems. In order to compensate these issues, the schedule was expanded from seven weeks to thirteen weeks. In this way, students were instructed more and they had freer time slots to create their designs. Students had the opportunity to get more critics and develop their designs in an immersive and interactive way by integrating simultaneous evaluation process at the end of the projects.

4.3.4.2. Sets of the Projects

In the pilot study, two design tasks were assigned to the students comprising one individual and one collaborative design projects. For the first project, students were led to design individually. The final project was designed in groups. For the main study, four sets of projects were scheduled. The first two projects involved individual tasks and the other two were done in groups as major submissions for the course (Table 5.1).

4.3.4.3. Duration of the Projects

Throughout the pilot study, the duration of the projects were limited. Students had a week to complete the individual project and the time was offered to complete the group project was three weeks. For the main study, as more training time was available, students had a week to complete the first project. The following individual project was completed in two weeks. Then, the collaborative projects pursued which were completed in two and three weeks respectively (Table 5.1). .

Table 5.1. Offered Schedule for the Projects

	Sets of the Projects	**Duration of the Projects**
Pilot Study	1. Individual 2. Collaborative	1 week 3 weeks
Main Study	1. Individual 2. Individual 3. Collaborative 4. Collaborative	1 week 2 weeks 2 weeks 3 weeks

4.3.4.4. Context of the Design Projects

Throughout the pilot study, students dealt with projects that had requirements close to the physical counterparts as possible. This sets of projects included walls, doors, windows, floors, etc. Thus, students sought solutions that were imitating the world. However, as discussed earlier, designing in virtual worlds, as a new design discipline, can go beyond its traditional uses. By regarding this, throughout the main study, students were encouraged to expand the boundaries of architecture in SL. The aim was to see to what extend SL would enhance students' skills in designing, by feeling more flexible and creative with the new possibilities.

4.4. Main Study

The main study was conducted within the calendar of the elective design course, IAED 316 Computer Applications. The course met once in a week, for 3 scheduled course hours. The course content was scheduled in order to acquaint students with necessary information and skills for designing in SL. The calendar for the main study was as follows:

Week 1- Introduction to Second Life: Students were introduced with SL and were informed about its features and potentials. The accounts to access SL were taken and students explored the environment for the first time.

Week 2- A lecture was given including issues such as navigation, communication, interaction and camera controls in SL. A short demonstration about designing in SL was introduced.

Week 3- A detailed lecture explaining how to design in SL was given. A warm-up assignment was carried out.

Week 4- Students got their first critics by testing and evaluating each other's designs inside the world of SL. Another individual project was assigned to the students.

Week 5- Each student got critics interactively by testing each other projects and developed their designs according to the reviews which they got from the tutors and classmates.

Week 6- Interactive critics were given during the course session for the final version of the project. They developed their designs during the course session

and were asked complete and submit the final form of the project for the following week.

Week 7- The new and collaborative project was introduced. The duration of the project was three weeks. A lecture was given about designing collaboratively in SL. Students were taught about the tools of SL to create models with more avatars. For data collection, students were informed about recording chat history and capturing snapshots.

Week 8- Critics were given during the course session for the project.

Week 9- Second round of critics were given for the project.

Week 10- Students submitted the final projects and the assessment was done in SL. The last assignment was introduced.

Week 11- Each group were asked to complete the final project with recorded materials (chat logs and snapshots of their applications). They had three weeks to complete the project.

4.4.1. Tasks

The main study involved four sets of successive design projects. The first two projects were undertaken individually by students. Projects were given to solve design problems by using 3D modeling tools of SL. The first individual project was to design a chair in SL. It was handled in class sessions (see Appendix C2, Figure C2.1). After a week, students were asked to design a kiosk within a week (see Appendix C2, Figure C2.2). The primary objective of these short projects was to gain software frequency. Another objective was to gain designing skills in SL.

The next projects were designed by groups, working collaboratively. Students were encouraged to design spaces to express their design ideas and skills in SL environment. As such, the students were led to push the boundaries of architecture and to question real vs. virtual architecture. It was expected that they could be more flexible and creative in their designs. The first collaborative project involved the design of a stage for an entertainment group(see Appendix C2, Figure C2.3). In the final project, transparent adjacent spheres were given as a shell, so that students could design the inside according to a theme derived from a movie (see Appendix C2, Figure C2.4).

4.4.2. Participants

21 students who were enrolled to the IAED 316 course participated in the main study. 7 of the students were male and 14 female. The students of the course comprised 3rd and 4th grade students. For the collaborative study groups that consisted of 3 persons were formed.

4.4.3. Site

The same site used in the pilot study was used for the main study. All applications were held in the [K-5] land, Public Sandbox, in SL. For following the assessments of the projects by the observer and students in computer labs, the tutors met for reviewing the projects to guide the student's judgments by discussing and criticizing. This was done by monitoring the representations projected on the wall that each student and tutors have the possibility to follow the projects by participating in an immersive environment actively (Figure 4.1).

Figure 4.1. The Computer Labs

4.4.4. Data Collection

In the main study, both qualitative and quantitative approaches were employed in conjunction with each other using three methods *1) Electronic Observations 2) Sets of Questionnaires* and *3) Interview with the tutor*. The study set up as an experiment, thus to supplement the findings qualitative approaches was used. As such, beside the numerical data gathered by questionnaires, experiences, opinions and feelings would be put forth through the observations of the researchers. The method used for documenting the online activities is as follows:

4.4.4.1. Electronic Observations

To enhance the assessment of designing in SL through formal data analyzing (questionnaires and interviews), text-based communications were analyzed in order to scrutinize the interactions and behaviors that were exposed in SL. The text-based logs, which are recorded by the group members, helped in the explanation of the students' behaviors and their approaches on the design problem. They also displayed the solutions emerged during the collaborative study, which was executed through real-time 3D shared space of SL. Moreover, the logs informed the observer about the usability of some tools, how some interactions occurred in real-time and how both synchronous and asynchronous project development were carried out during the collaborative design process (see Section 5.4).

As Kvan et al. (1999) indicated that limited chat-line condition has possible benefits in helping researcher to seek an interpretation for collaborative design communication. Therefore, in order to capture the history of Instant Message conversations, chat logging system was used for recording dialogues of the given design task in which students worked collaboratively.

4.4.4.2. Questionnaires

The questionnaires used in the pilot study were iterated with changes for the main study. This time sound factor was omitted due to the low internet connection speed or individual hardware problems. Concerning the internal validities of the questions, the questionnaire was controlled by Alpha Cronbach tests, and only the ones over 0.7

alpha values were taken into consideration. As a result of these tests, the opinions pertaining to the process and learning outcomes were discordant and omitted from the questionnaires of the main study.

Questionnaires are commonly used for quantitative approaches and they can be used to assess user's perceptions. In this study, two sets of questionnaires are used for documenting the assessments of students about their designing experience in SL (see Appendix B).

4.4.4.2.1. Pre-task Questionnaire

This questionnaire is used for documenting the demographics and previous computer experience of the students. Responses comprise data about age, gender, experience and skills in using Internet and computers, and students' familiarity with SL (see Appendix B1).

4.4.4.2.2. Post-task Questionnaire

This session is comprised of four parts. All of the four parts aim to assess the usability and potential of the SL environment while implementing a design task. In order to assess SL environment as a design environment in an architectural design course, questionnaires were conducted to find out:

- whether students found using SL as an enjoyable experience as a design environment in the design course (see Appendix B2, Question 1)

- the level of user-interface satisfaction, (see Appendix B2, Question 2a, 2b)
- the effects of contribution of avatars and 3D graphical environment to the design process (see Appendix B2, Question 3a and 3b)
- the evaluation of perceived usefulness of SL (see Appendix B2, 4).

Questions about the user-interface satisfaction were compiled from the surveys that have been tested and standardized by previous researches. The questionnaire related to user-interface satisfaction derived from Chin et al.'s (1988) user-interface satisfaction survey. Amendments were made according to the spatial characteristics of SL interface. The questionnaire aims to find out the users' subjective rating of SL interface as a design environment in architectural design course. As Çepni and Çağdaş (2004) state that "the most important feature of an effective interface design is the satisfaction the user feels while using the interface, which answers his/her needs, appropriate for the users skills and increases the efficiency of the process" (p. 189). Students were inquired whether they were able to adopt to and were satisfied with the 3D interface in terms of communication tools, designing menu, controlling the avatar, controlling the camera, navigation and movement as well as their overall impressions of SL in general.

The effects of avatars and 3D graphical environment were questioned to understand the contributions of these specific features to students' designing and learning experience.

In the last session, there is a test of Perceived Usefulness. The measurement of Perceived Usefulness (Davis, 1989) explores the extent to which students believe

that the particular system would enhance their job performance. After the experiment, students were asked to rate their experience while using SL environment for their designing activities, which is based on 5-point Likert scale ranging from strongly agree=1 to strongly disagree=5).

The last part of the questionnaire consists of students' preferences on using SL as a design environment. Students were asked if they would prefer to design the project in another medium and would prefer using SL in their future works. They also asked if they would prefer to take SL course solely in SL or both meet in SL and real classroom. In addition, students' opinions about simultaneous evaluation were asked. As open-ended questions, students' suggestions to improve the use of SL in architectural design education were inquired. Finally, students were asked to list the most positive and negative aspects of SL as a design environment.

4.4.4.3. Interview with the tutor

For the last document of data collection, an interview with the tutor was conducted. The interview comprises inquires about how the tutor found using as SL a design environment in a design course, especially for criticizing the students' built models in an immersive environment through avatars. The interview inquired about the opinions about using SL tools, design communication, the design process, learning environment and perceived usefulness of the system (see Appendix B3).

5. RESULTS and DISCUSSION

5.1. Pre-task Questionnaire:

By conducting a pre-task questionnaire, the demographic information and information about the previous computer experiences of the students were obtained. All of the students taking the course participated in the main study (n=21), 14 female and 7 male. The mean age was 22 years (m=22.3, ranging from 20-25). The average for using computers is 11.04 years, the average for Internet use is 8.42 years. Students are using computers and Internet for at least 5 years (Table 5.2).

TABLE 5.2. Means for the Age, Years of Using Computers and the Internet

	Mean	Standard deviation	Min	Max
Age	22.30	1.17	20	25
Years of using computers	11.04	3.10	6	18
Years of using the Internet	8.42	2.22	5	12

All of the students stated that they use computers for accessing the Internet. 19 of them are using computers for executing CAD software and 12 for computer gaming. The other areas of use are office software and Photoshop[1]. Students are using the Internet generally for research and e-mailing. Other reasons for using the Internet respectively are for fun, chat, social networking, forms and blogs, and

[1] Photoshop is a registered trademark of Adobe Systems Inc.

online gaming. Students also indicated that they use internet for downloading, watching movies and shopping (Figure 5.1).

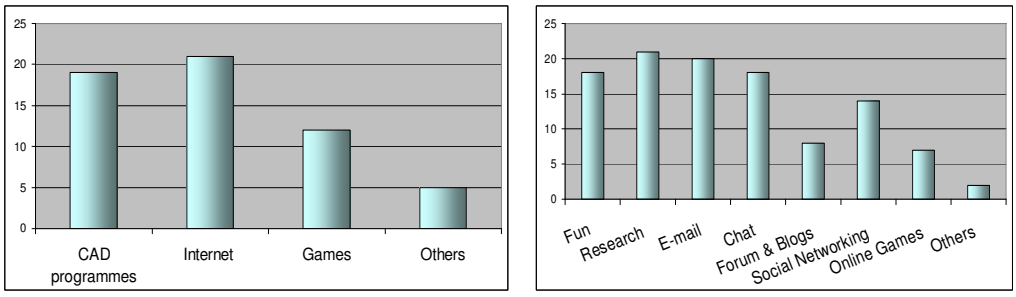


Figure 5.1. Reason(s) for Using Computers and for Using the Internet

Students' perception of their skills in using computers is given below (Figure 5.2).

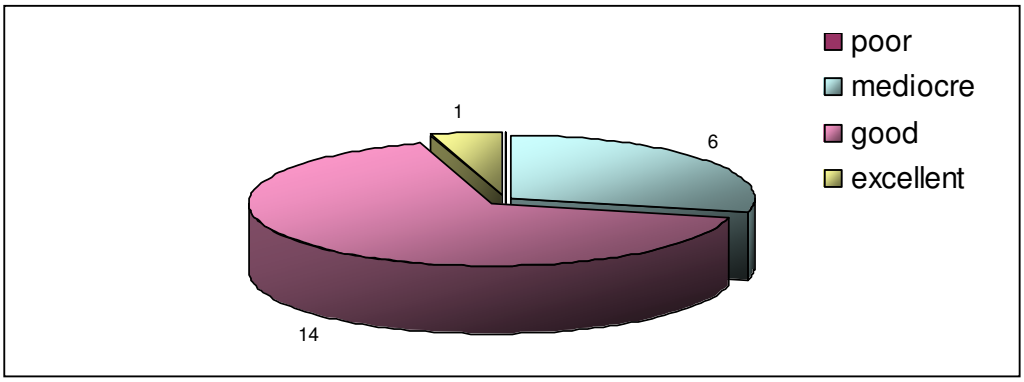


Figure 5.2. Computer Skills

The findings showed that all of the students are using AutoCAD[2]. Out of 21 students, 8 of them are using 3DsMax[3], 9 using SketchUp[4] and the remaining are using other CAD software.12 of the students heard about Second Life before and out of 21 students, 16 did not access Second Life before.

---

[2] AutoCad is a registered trademark of AutoDesk.
[3] 3DsMax is a registered trademark of AutoDesk.
[4] SketchUp is a registered trademark of Google.

5.2. Post-task Questionnaires:

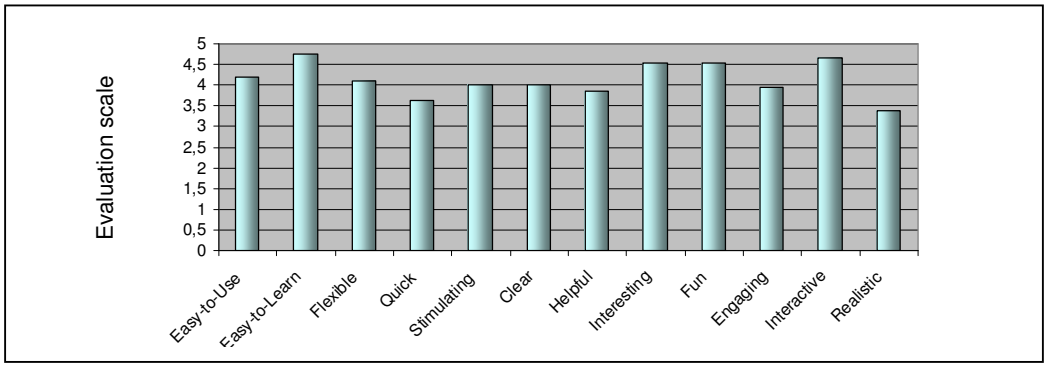
5.2.1. Overall Satisfaction with SL

The students assessed the Second Life environment on Likert Scale ranging from 1 to 5. As for SL being an enjoyable experience students found designing in SL enjoyable (m= 4.52, σ= 0.60).

Pearson correlations (Morgan and Griego, 1998) between students' previous computer experience and post-task questionnaire statements were analyzed and no significant relationship was obtained. This finding and the observations indicate that designing with SL does not require a prerequisite for use in a design course.

5.2.2. User-Interface Satisfaction with SL

The students' overall satisfaction with the interface is consisted of 12 items including characteristics such as "*ease of use*", "*ease of learn*", "*flexible*", "*quick*", "*stimulating*", "*clear*", "*helpful*", "*interesting*", "*fun*", "*engaging*", "*interactive*" and "*realistic*" (Figure 5.3).



Note: (1=difficult to 5= easy; 1= rigid to 5= flexible; 1= time-consuming to 5= quick; 1= dull to 5= stimulating; 1=confusing to 5= clear; 1=not helpful to 5= helpful; 1=uninteresting to 5= interesting;

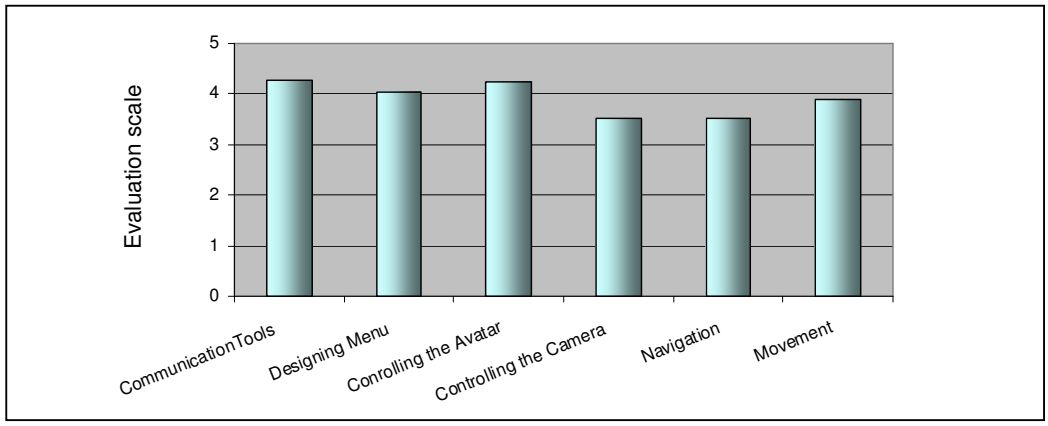
1=boring to 5= fun; 1=not engaging to 5= engaging; 1=not interactive to 5= interactive; 1= unrealistic to 5= realistic).

Figure 5.3. Overall Impressions of Using SL as a Design Environment

The students assessed SL interface strongly positive and believed that SL offers a low learning curve as well as provides a space that is entertaining, interesting and interactive.

5.2.3. Difficulty of Operational Tools While Designing in SL

The operational tools were assessed involving operational tools under the headings: "*communication tools*", "*designing menu*", "*controlling the avatar*", "*controlling the camera*", "*navigation*" and "*movement*" (Figure 5.4).



Note: For all items 5-point scale (1= difficult to 5= easy) were used.

Figure 5.4. Difficulty of Using SL Operational Tools

The Cronbach α index conveys that the opinions about the difficulty of operational tools are incongruous. For this reason the distribution of each factor are shown in (See Appendix B4, Figure B4.1-B4.6).

Findings indicated that students were mostly in positive interaction with the operational tools of Second Life during the design process. The use of operational tools was evaluated as being easy. However, the most difficult operation the students found was "*controlling the camera*" (*m*= 3.52, σ = 0.81) and "*navigation*" (*m*= 3.52, σ = 1.03). The current results concur with the previous studies that users sometimes confronted with a type of disorientation in 3D environments and have difficulty in navigation within the environment (Darken and Siebert, 1996; Dickey, 2004).

A Pearson Correlation was conducted to measure the strength of the linear relationship between variables of the post-task questionnaire and overall satisfaction (enjoyable experience). There is no evidence that the post-task questionnaire variables are related to overall satisfaction. Only the correlations related to operational tools attested as meaningful. The correlation matrix for the 6 items is shown in Table 5.3.

Table 5.3. Correlations for the Operational Tools of SL (n=21)

	CT	DM	CA	CC	N	M
CT	1					
DM	0,32	1				
CA	0,29	-0,10	1			
CC	-0,12	-0,21	0,27	1		
N	-0,27	-0,23	0,08	0,61** (p=0.003)	1	
M	0,06	-0,23	0,27	0,59** (p=0.004)	0,64** (p=0.002)	1

** Correlation is significant at the 0.01 (2-tailed)

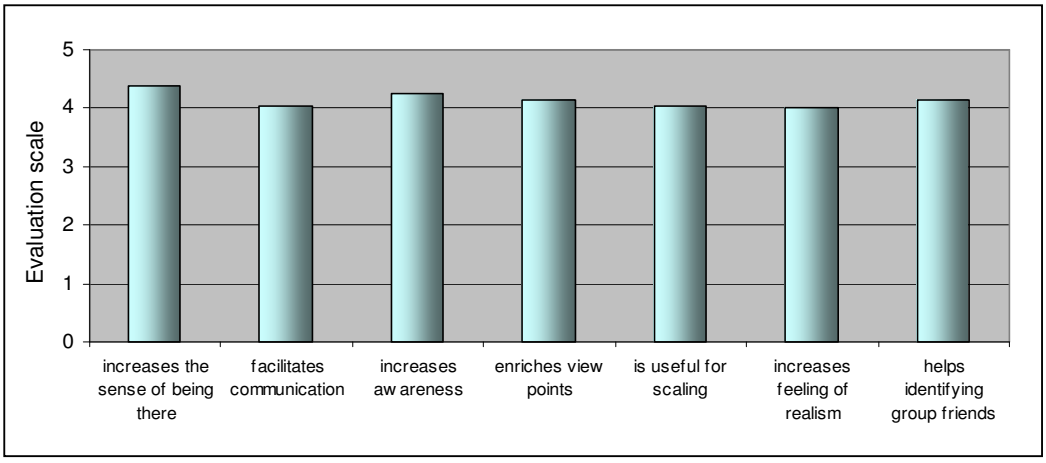
Communication Tools (CT), Designing Menu (DM), Controlling the Avatar (CA), Controlling the Camera (CC), Navigation (N), Movement (M).

The results indicate that the strength of association between the variables "*controlling the camera"* and *"navigation"* (r=0.61, p<0.001), "*controlling the camera"* and *"movement"* (r=0.59, p<0.001) and "*navigation"* and "*movement"*

(r=0.64, p<0.001) that the correlation coefficients (r) are very highly significantly different from zero (p< 0.001).

5.2.4. Contribution of Avatars to Design Process

The assessment of being in the design environment, represented by avatars was done through 7 items. This part consists of the statements including if avatars "*increase the sense of being there*", "*facilitate communication*", "*increase awareness*", "*enrich view points*", "*are useful for scaling*", "*increase feeling of realism*" and "*help identifying group friends*" (Figure 5.5).



Note: For all items 5-point Likert-type scale (1= strongly disagree to 5= strongly agree) were used.

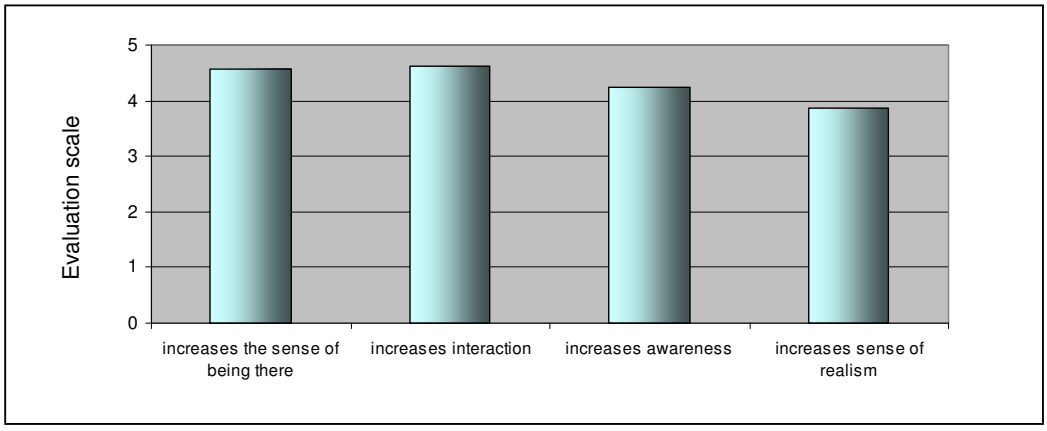
Figure 5.5. Contribution of Avatars to Design Process

The responses showed that avatars have significant roles in students' designing experience. Especially, avatars are essential mediators to increase the sense of being there. As they have certain dimensions, they can be used for proportioning as well. For instance, one can build the staircase and test if the avatars' head will bump or not. In addition, avatars facilitate identifying the other avatars, and the students

intuitively recognized them by their personally elaborated appearance. The means were high for the contribution of avatars to design process. This result indicates that when students start to get more sense of control on the manipulation of avatars they may feel more involved in the process and be satisfied with the items classified above.

5.2.5. Contribution of 3D Graphical Environment to Design Process

The 3D environment offered by SL was assessed under the category including statements such as, "*increases the sense of being there*", "*increases interaction*", "*increases awareness*" and "*increases feeling of realism*".



Note: For all items 5-point Likert-type scale (1= strongly disagree to 5= strongly agree) were used.

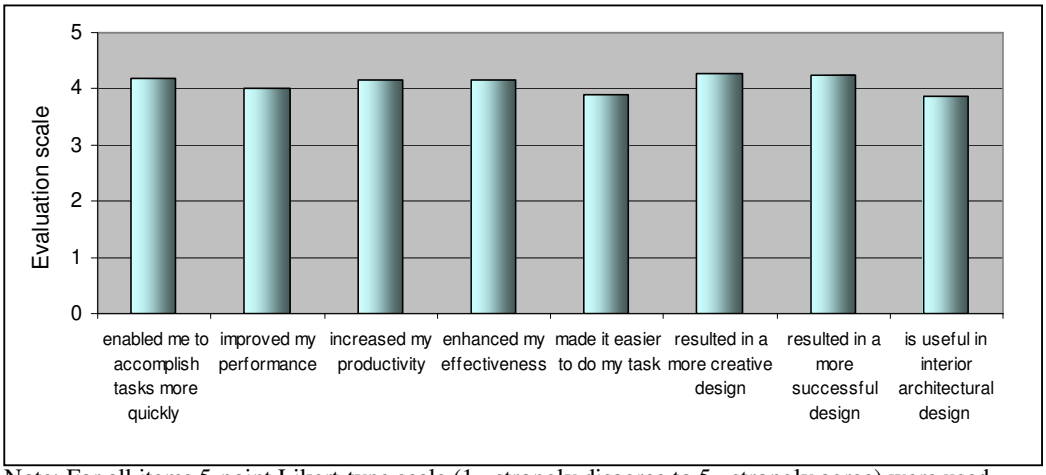
Figure 5.6. Contribution of 3D Graphical Environment to Design Process

3D shared virtual environments provide a space which is dynamic and interactive. In these environments, avatars and their activities are illustrated explicitly, which gives a more natural way of interaction and experience that enhances engagement and involvement (Casanueva and Blake, 2000). The results of current study showed that

overall, students found designing in 3D graphical environment as positive and mostly agreed with the statements above (Figure 5.6).

5.2.6. Perceived Usefulness of Using SL as a Design Environment

Finally, the students assessed how the process contributed to their design progress (Figure 5.7)



Note: For all items 5-point Likert-type scale (1= strongly disagree to 5= strongly agree) were used.

Figure 5.7. Perceived Usefulness of Using SL as a Design Environment

Students mostly agreed with the statements of perceived usefulness of SL. The findings explicitly show that students perceived that working with SL in the design course led to more creative and successful designs (Figure 5.7).

5.2.7. Students' Preferences on Using SL as a Design Environment

A set of yes-no questions along with a set of open-ended extensions were asked to determine the students' ideas about using SL instead of other media, using SL in

their future works, and the preference for meeting in SL or in a hybrid setting.

Majority of the students preferred to design in SL and they believed that designing in such an environment makes them more flexible and creative. Only 2 of them stated that it is better to design with other media instead (Figure. 5.8).

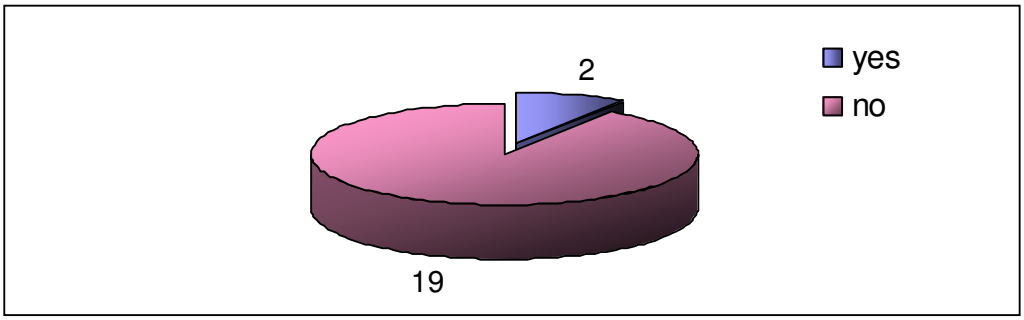


Figure 5.8. Students' Preferences on Designing in another Medium.

Most of the students were satisfied with designing in the environment of SL. Out of 21 students, 14 of them preferred and 7 of them did not prefer to use SL for their future works (Figure 5.9). Some of the negative comments were:

> *"You can't draw actually what you are thinking".*
>
> *"I found it interesting and enjoyable, however it should have more powerful features for designing".*
> *"It is not totally realistic. Dimensions of the projects do not reflect the reality, so it will be a problem although it gives the 3D representation opportunity".*
>
> *"3ds Max and Auto CAD are more realistic and architecturally professional".*

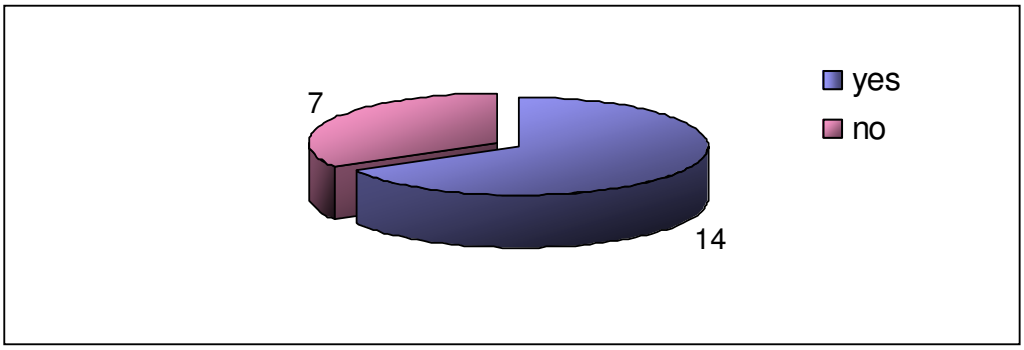


Figure 5.9. Students' Preferences of Using SL for Future Works.

Findings indicated that out of 21 students, 17 of them preferred the hybrid state which comprises both meeting in SL and in the real-classroom, and other 4 students preferred to meet solely in SL (Figure 5.10).

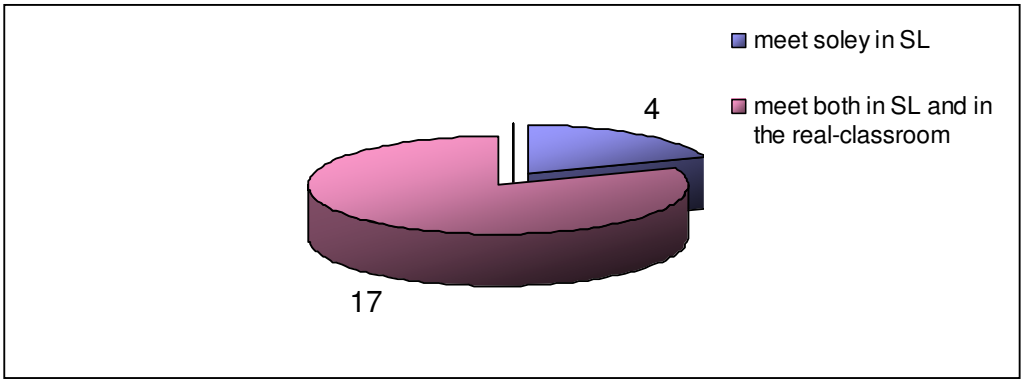


Figure 5.10. Students' Preferences of Taking the Course of SL.

As for the simultaneous evaluation of the projects, which was done by projecting SL on the wall of the classroom, students were satisfied and stated that they enjoyed the experience. All of the students found the simultaneous evaluation in which they could actively participate in the assessment of the designs, quite useful, interesting, engaging, and enjoyable. Some of statements on simultaneous evaluation were as given below:

"It can be more realistic, but seeing others' projects, make judgments and find out the projects' failures or deficiencies were very useful".

"It was good and like an exhibition. The jury members are the students, I liked it".

"It was the most exiting part of the course. That was great".

"It was the most beautiful asset of SL because we had the opportunity to see and evaluate others' designs".

"It was beneficial; we saw others' projects and improved ourselves".

"It is better than the traditional evaluation. Instant reactions to the design give a better understanding to the project's owner. And it gives the opportunity to see and experience others' designs".

"In my opinion it was the most attracting experience because it was not like the traditional evaluating system. It was interesting and enjoyable".

"Not only the course mates evaluate your projects, also other people in the world of Second Life may see and give critics or share their opinions. This is good for design phases".

"I think it is a useful way of evaluating our projects. It draws our attention to explore each other's designs. It also enables sharing information between each other".

"Experiencing others' designs provides the opportunity to improve our creativity and free thinking about designs".

"It was the best way of learning by taking part actively in the design projects by a walk-through experience".

5.3. Interview with the Tutor:

The interview comprised inquires about how the tutor assessed using SL as a design environment in a design course. Firstly, the overall impression about the students' performances in using SL as a design environment was asked. Secondly, the difficulty of operational tools was inquired. Then, the effects of designing with avatars and in a 3D graphical environment were found out. Finally, the comments about to what extend SL enhanced students' designing activities were gathered.

The tutor found using SL quite satisfying and an enjoyable experience in the design course. The tutor stated that in general, students had little difficulties in using and learning SL as a design environment. She added that SL was fairly easy to use and had a low learning curve. It took few courses to figure out how to design in SL. She believed the tools of SL are quite flexible to create and develop designs. The possibility to work on the same project by connecting from different location is a flexible way of designing collaboratively for students. The tutor found SL to be fun, interesting, engaging, interactive and stimulating. However, she was not sure whether the environment was realistic enough. She said that the rendering quality was not robust enough like other professional CAD programmes. Also, the voice-chat opportunity seemed to be a quicker and effective way of communication than chatting by typing. She indicated that she wished the hardware were powerful enough to make voice-chat work interruptedly.

She stated that the students easily communicated their design ideas through SL. She observed that the students used the communication tools, the avatars, navigation and movement quite easily. However, she pointed out that most of the students struggled with the tools in the beginning since they were used to design with the software packages.

The tutor especially pointed out to the positive effects of the avatars. She stated that the avatars increase awareness by seeing others' actions and existence. She added that most of the students gave importance to the appearance of their avatars and elaborated the avatars in diverse appearances to facilitate identifying each other. She stated that the possibility of having diverse and flexible angles of sight through the

avatars enrich viewpoints. She said that unlike many other virtual design platforms, the user might extend the viewing angle by zooming out to include the avatar in the line of sight or zooming in where the user can see as if through an avatar's eyes. As such, the students used avatars as a scaling factor in the designs, rather than just seeing the representations of themselves. She stated that designing in a same 3D graphical environment in which students were able to see and test each other's designs dynamically increased peer interaction.

The tutor recommended that a free design land in SL reserved for teaching and learning would be more convenient. In addition, she suggested that as SL does not support detailed modeling and has insufficient tools to elaborate the designs compared to design software packages, the opportunity of integration of popular CAD software files would be beneficial.

5.4. Electronic Observations:

The descriptive results help in the assessing the usability and difficulty of some tools while designing, how some interactions occurred in real-time and understanding how the project developed through the collaborative design process.

As mentioned earlier, students were experiencing peer interaction intensively in SL while designing. Due to the synchronous property of SL, students asked and got immediate feedback from their peers. By observing the chat dialogs, students had the opportunity to share information about the features and tools that they used while elaborating their designs:

arda Portal: How did you do this?
never Monday: hmmm flexible path, transparency and played with its material
arda Portal: Excellent
arda Portal: it looks like kripton ☺

The original language of the dialogs were in Turkish. They were translated.

Review of the chat-logs showed that students started individually to the proposed design project. Then they came together for sharing their ideas and developed their designs with mutual understanding. Generally, there was not a leader in the group. The decisions were made in turns, according to the particular skills of the students in the group. The saved dialogs below are the examples:

Sonia Juanos: Timuçin if you wish we can continue by developing yours
Tmcn Warden: Could you bring it out of your inventory?
Sonia Juanos: Merve will also show hers
mng Arriaga: Well I did something like this
Tmcn Warden: It looks nice. Could you click on the option "you can edit this friends' object" in communicate menu?
mng Arriaga: OK.

The original language of the dialogs were in Turkish. They were translated.

Kutay Renfort: I've deleted the stages and added more boxes to make it more experimental
Ozge Blackheart: Well the tutor suggested to draw "S" by boxes in her critics.
Kutay Renfort: OK we can try "S" then
Kutay Renfort: She also recommended continuing in vertical, now I'm doing that.
Ozge Blackheart: OK
Kutay Renfort: Could you go on with designing the materials?
Ozge Blackheart: Now I'm dealing with textures
Kutay Renfort: OK.

The original language of the dialogs were in Turkish. They were translated.

Some technical problems occurred related to the hardware and Internet connection:

> *arda Portal: Again there is a delay in sending messages.*
> *never Monday: Yes*
> *never Monday: I will reach you from private chat, trace me from there, sometimes problems occur while chatting with more people.*

The original language of the dialogs were in Turkish. They were translated.

Most of the students had no problems in conveying and following each other's statements on the project. However, they were frequently confused if the avatars got far from eachother:

> *blabla Jupiter: No, this is not (our design)*
> *boonie Miggins: How come it isn't*
> *boonie Miggins: Users can sit and watch the performance (in ours)*
> *blabla Jupiter: I didn't tell you*
> *boonie Miggins: Oh! Ok.*

The original language of the dialogs were in Turkish. They were translated.

To enable sharing design ideas students brought their avatars together. This supports the view that avatars play an important role in synchronous activities especially, in terms of providing essential cues for recognizing and enhancing the design conversations. Moreover, the characteristic movements of an action performed by avatars enhance workspace and cognitive awareness. SL provides various gestures and animations to enrich actions and communications. For example, avatar holds his arm and an instrument like a magic wand appears during the transformations (Figure 5.11). Therefore, students were aware of each other's actions and did not have much difficulty in following what is going on in real-time.

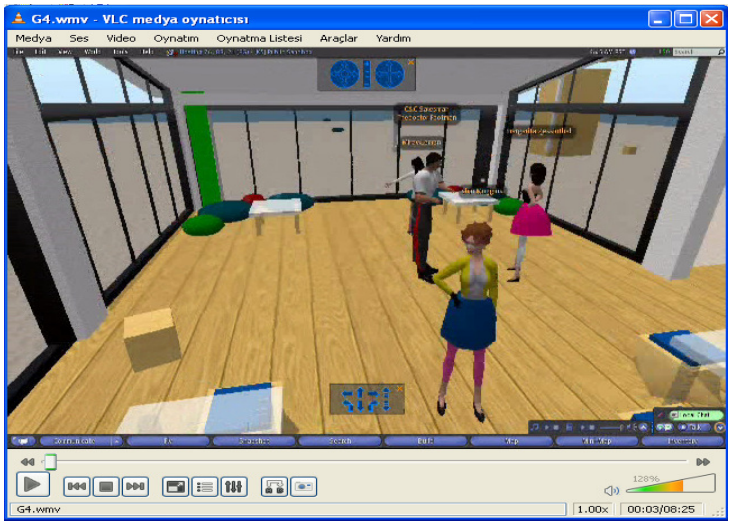


Figure 5.11. An Example of Interactive Relationship of the Avatars with Eachother.

In the SL environment, students were able to see and follow not only their group friends, but what other groups were doing as well. Most of the students were curious about testing each other's designs by walk-through experience. This experience also increased peer interaction.

In addition, the opinions for the proposed projects were not only restricted to the students of the course. Some of the students got ideas from other users in SL. The saved dialog below is an example:

blabla Jupiter: Did you like it?
mirea Soulstar: What is it??
blabla Jupiter: It is a stage for Cirque du Soleil
blabla Jupiter: Did you hear about it?
mirea Soulstar: No, but why do you build a stage for it?
blabla Jupiter: It is an assignment
mirea Soulstar: I see
mirea Soulstar: well, have fun blabla!
mirea Soulstar: Good job so far ☺
blabla Jupiter: Thank you
mirea Soulstar: It looks good actually☺

The original language of the dialogs were in Turkish. They were translated.

Another important supportive evidence obtained through observations was the testing of designs with avatars. The dynamic relationship of the avatars with the proposed designs made it easy to understand the spatial relationship and ergonomic characteristic of a space while designing. Experiencing the designs interactively gives a better understanding of the problems during the design process. Students related the usefulness of scaling and communication with avatars highly. A snapshot from one group's video-clip is an example for this situation (Figure 5.12).

Eray Miliandrovic: Cihan could you make, what you did, more bigger? I can't pass through.
Cihan Millet: OK. I'll do it.
Eray Miliandrovic: We can build a tunnel to make a connection to the stages.
Eray Miliandrovic: May be you can make a little bit longer
Cihan Millet: Well I have done it, try it! its very enjoyable ☺ hahah

asli Silvercloud: Ayşe could you try to get inside the space which I've built just now, the place with angles
aisa Abeyante: Well OK.
aisa Abeyante: I can go inside but I can't move and fly, the scale is too small.

Eray Miliandrovic: If this place is not for the audience, so for whom?
Cihan Millet: Well, the show begins from there
Cihan Millet: Watch me and see the show ☺
Eray Miliandrovic: hmmm it's for stage exit then
Cihan Millet: Yes, you got ☺

The original language of the dialogs were in Turkish. They were translated.

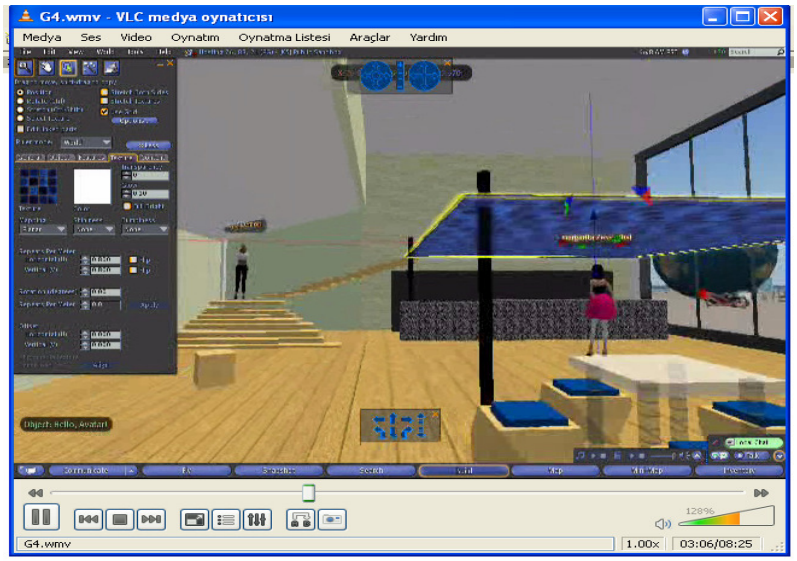


Figure 5.12. An Example of the Dynamic Relationship of the Avatars with the Proposed Projects.

5.5. Framework for Future Use of Second Life in Design Studio:

The results highlight the potentials of using SL by the design students, experiencing and practicing architecture, in a design course by regarding the following issues:

5.5.1. Technical Issues:

The findings pointed out that the usability of SL as a design environment has some technical limitations. These limitations may be traced in the suggestions of the students to improve the use of SL in architectural design education. They are:

i) the importing and exporting files in SL,

ii) dependency on hardware and Internet quality of the system

SL has restricted geometrical aids for designing and does not support detailed modeling. Basic shapes and their relations may be easily modeled in SL through selecting geometric forms and manipulating their parametric features. However, some students had difficulties in performing more complex geometries by using the modeling tool of SL. The habits acquired by using other CAD tools made it difficult for some students to operate the forms in SL. This hinders the students to generate more detailed and complex geometries, which they visualize in their minds. Therefore, the file transfer between CAD software and SL is crucial. The possibility of importing and exporting files in SL would be useful.

Secondly, SL requires adequate system hardware to run properly. Problems that occurred in Internet connection and system crashes caused discouragement in some students. They stated that slow streaming and system instability were frustrating. The digital design studio which should embed SL as a design platform requires technically powerful settings.

5.5.2. Biases

As discussed earlier, SL is not developed as a platform from designing. However, it offers tools for designing both individually and collaboratively. In the beginning, students may have biases for using a game-based space for designing projects. However, the results of the study showed that, students found SL environment highly-motivating, exciting and enjoyable platform for designing. Moreover, the fact that there turned out to be no significant relationship between the students'

background in computers and their satisfaction with SL, proves that even the students with little or no computer experience may got adopted to SL.

5.5.3. Training Procedure

The findings showed that SL requires sufficient training time and courses for adaptation and improving students' learning in SL. Students indicated that they need sufficient time to get used to the environment and tools of SL. Some of them suggested that it would be better to get interactive courses from their tutors in SL. They also indicated that on-line tutorials can be useful to understand how to use the tools of SL more effectively. In addition, students believed that opening forums and blogs would be beneficial to help each other in problems related with designing in SL.

5.5.4. Duration and Sets of Projects

As SL requires technically powerful settings in a design course, in order to overcome the technical problems such as, Internet connection and system instability, the duration of the course and projects become crucial. The majority of the complaints obtained from the pilot study were related to the Internet connection disruptions and system crashes as well as limited time issues. The main study observations and results showed that students were more satisfied with using SL for their designs when the duration was elongated and number of projects was increased. The results indicate that when students start to get more sense of control on the manipulation of

the avatars, objects, and related tools for designing, they may feel more involved in the process.

5.5.5. Context of the Projects

As mentioned earlier, although SL can be used for CAD modeling despite of its limited geometry, it should be considered as a new platform, which promotes architectural design by involving interactive, immersive and virtual experiences other than only imitating the physical world. Most of the students reported that their experience with SL were quite interesting and exciting that the distinct features, apart from the real world, encouraged them in finding novel and creative solutions for the projects. Within this frame, SL should be regarded as a new design platform where students experience architectural design projects in a new dimension.

6. CONCLUSION

A large amount of architecture and design schools are using 3D worlds for architectural education and practice. As an innovational platform, Second Life provides designers with novel and fascinating ways to experience architectural design and education. Most of the current computational tools employed by the students, support single user interactions in an asynchronous mode. The investigation of this thesis highlights the potentials of using SL by the design students, experiencing and practicing architecture within a multi-user, immersive and synchronous 3D environment.

This thesis introduces a case study with the purpose of analyzing the possibility of using SL as a design environment in a design course. In fact, SL is not developed as a design platform. It serves as a platform for users from all kind of disciplines to implement diverse activities. However, it provides some tools for both individual and collaborative designing with its specific features (i.e. the contribution of avatars, sounds and 3D environment, etc.), which promote architectural designing and learning. This thesis investigates the ways to promote and improve the use of SL as a design platform in architectural design.

In terms of the research questions, as stated in this thesis (4.1 Research Questions), the potential of SL as a learning environment in architectural education turned out to be high. The research revealed that employing new technologies can be motivating. Students got adopted SL and experienced designing in an engaging and enjoyable platform.

Students' perception of the usability of SL was positive. The students' overall satisfaction with the interface was strongly positive. Students believed that SL was easy to use and offers a low learning curve as well as provides a space flexible, entertaining, interesting and interactive. Overall, the operational tools are evaluated as being easy. The most difficult operation the students found was controlling the camera and navigation. Students mostly perceived SL as useful. The findings showed that students perceived that working with SL in the design course led to more creative and successful designs.

The sense of presence via avatars and the opportunity of designing in the same 'place' with the peers are positive assets. The findings showed that using an avatar while designing increases the sense of being there, facilitates communication, increases awareness, enriches viewpoints, is useful for scaling, increases feeling of realism and helps identifying group friends. Students found designing in the 3D environment offered by SL as positive. They mostly agreed that 3D graphical environment increases the sense of being there, increases interaction, increases awareness and increases sense of realism.

Most of the students satisfied with designing in SL and they preferred to use for future works. Especially, simultaneous evaluation, which makes the critics and judgments more dynamic and interactive was the most appreciated characteristic of SL. Another important thing obtained from the results is that as more time spent in SL for training and designing, students began to get more control over the tools of SL, felt themselves more confident and overcome the problems easily. To sum up, the findings of this study showed that SL can be used for individual and collaborative designing activities for design students beside all the limitations and drawbacks related to restricted geometry and hardware issues.

These assets may be used to develop the platform of SL for designing and learning by considering the requirements of the architectural design course using SL. The method traced and the framework developed in the study also put forth suggestions for those who will make researches on the related subject.

For further studies, the cognitive process of the students while designing in SL can be investigated in detail by using coding schemes and protocol analyses. In addition, a comparative study demonstrating the effect of using SL or other medium can be studied. Furthermore, the collaborative design process in the immersive environment can be explored by focusing on team management and organization. The participants of the study can be extended to other disciplines to observe the cross-disciplinary and cross-cultural issues.

REFERENCES

Abdellatif, R., and Calderon, C. (2007) SecondLife: A computer-mediated tool for distance-learning in architecture education? In A. Okeil , A. Al-Attili, and Z. Mallasi (Eds.), *Em'body'ing Virtual Architecture: The Third International Conference of ASCAAD'07* (pp. 17-34). Egypt, Alexandria: ASCAAD.

Achten, H. (2003). New design methods for computer aided architectural design methodology teaching. *International Journal of Architectural Computing*, *1*(1), 72-91.

Albuquerque, A. L. P., and Velho L. (2002). Togetherness through virtual worlds: How real can be that Presence? Paper presented at the *In Presence 2002, Fifth Annual International Workshop on Presence, Porto, Portugal*. Retrieved September, 20, 2008, from http://www.visgraf.impa.br/Data/RefBib/PS_PDF/nelma08/togetherness2002.pdf.

Andia, A. (2002). Reconstructing the impacts of computers on practice and education during the past three decades. *Journal of Architectural Education, 56*(2), 7-13.

Balkin, J.M. (2004). Virtual liberty: Freedom to design and freedom to play in virtual worlds, *Virginia Law Review, 90*(8), 2043-2098.

Bartle, R. (1990). *Summary MUD history.* Retrieved March 20, 2008, from http://www.livinginternet.com/d/di_major.htm.

Bartle, R. (2003). *What are virtual worlds?* Retrieved March 20, 2008, from http://www.peachpit.com/articles/arcticle.aspx?p=99703andseqNum=3.

Bender, (2005). Developing a collaborative multidisciplinary online design course. *The Journal of Educators Online, 2*(2), 2-12.

Bertol, D. (1996). *Designing digital space: An architect's guide to virtual reality*. New York: John Wiley.

Book, B. (2004, October). *Moving beyond the game: Social virtual worlds*. Paper presented at State of Play 2 Conference, USA: New York. Retrieved November 15, 2009 from http://www.virtualworldsreview.com/papers/Bbook_SoP2.pdf.

Bouras, C., Giannaka, E., and Tsiatsos, T. (2008). Exploiting virtual environments to support collaboraive e-learning communities. *International Journal of Web-Based Learning and Teaching Technologies, 3*(2), 1-22.

Brown, A. G. P. (2003). Visualization as a common design language: Connecting art and science, *Automation in Construction*, *12*(6), 703-713.

Brusasco, P. L., Caneparo, L., Carrara, G., Fioravanti, A., Novembri, G., and Zorgno, A. M., (2000). Computer supported design studio. *Automation in Construction, 9*, 393–408.

Buckland, A., and Godfrey, K. (2008). Gimmick or Groundbreaking? Canadian Academic Libraries in Second Life. *Refer*, *24*(3), 5-10.

Brown, B., and Bell, M. (2004). CSCW at play: 'There' as a collaborative virtual environment. *Proceedings of the 2004 ACM Conference on Computer Supported Collaborative W*ork, *Chicago, Illinois, USA* (pp. 350-359) Chicago: ACM Press.

Calongne, C., and Hiles, J. (2007). Blended Realities: A Virtual Tour of Education in Second Life, *12th ANNUAL TCC Worldwide Online Conference***,** *2007*(1), 70-90. Retrieved from February 10, 2009, from http://edumuve.com/blended/ BlendedRealitiesCalongneHiles.pdf.

Campbell, D., and Wells, M. (1995). *A critique of virtual reality in the architectural design process.* HITL Technical Report No. R-94-3. Seattle, WA: HIT Lab, University of Washington. Retrieved January, 25, 2009 from http://www. hitl.washington.edu/publications/r-94-3/.

Carter, B., and Click, A. (2006). Imagine *the real in virtual: Experience your second life*. 22nd Annual Conference on Distance Teaching and Learning, Madison, WI. Retrieved February 25, 2009, from http://www.uwex.edu/disted/ conference/Resource_ library/proceedings/06_4202.pdf.

Casanueva, J. S., and Blake, E. H. (200). *The Effects of Group Collaboration on Presence in a Collaborative Virtual Environment.* Paper presented at EGVE'00 - 6th Eurographics Workshop on Virtual Environments.Retrieved March 6, 2008, from http://citeseerx.ist.psu.edu/viewdoc/summary? doi=10.1.1.12.4824.

Chin, J. P., Diehl, V.A., and Norman, K. L. (1988).Development of an instrument measuring user satisfaction of the human-computer interface. Proceedings of the SIGCHI conference on Human factors in computing systems, Washington, D.C., USA (pp. 213-218). USA, New York: ACM.

Cicognani, A. (1998). A linguistic characterization of design in text-based virtual worlds (Doctoral Dissertation, University of Sydney, 1998).

Cicognani, A., and Maher, M. L. (1998). Two approaches to designing virtual worlds.*International Journal of Design Computing, 1*. Retrieved March 15, 2009, from Proceedings of Design Computing on the Net 98: http://www.arch.usyd.edu.au/kcdc/journal.

Charitos, D. and Rutherford, P. (1996). Guidelines for the design and exploration of virtual environments. In C. Hand, and R. Hollands (Eds.), *Proc 3rd UK Virtual Reality Special Interest Group Conference* (pp. 93-111). UK: Virtual Reality Special Interest Group and Contributors.

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

Collins, C., and Jennings, N. (2007). Emerging "best practices" for campus builds in second life. In J. Kemp and D. Livingstone (Eds.), *Proceedings of the 3rd AnnualMeeting of the Second Life Community Conference*, *SLCC, Chicago, IL* (pp.78-81).

Curtis, P., and Nichols, D. (1993). *MUDs grow up: Social virtual reality in the real world.* Paper presented at the Third International Conference on Cyberspace, Texas: Austin. Retrieved March 6, 2008, from ftp://ftp.ccs.neu.edu/pub/mud/ docs/ papers/MUDsGrow.

Çepni, T.S., and Çağdaş, G. (2004). Team Face: A Collaborative Environment for the Virtual Design Studios, In A. Dikbaş (Ed.), *itc@edu: Third International Workshop on Construction Information Technology in Education* (pp.187-205). Istanbul:İTÜ Yayınevi.

De Lucia, A., Francese, R., Passero, I., and Tortora, G. (2008). Development of a virtual campus on second life: The case of SecondDMI. *Computers and Education, 52*(1),220–233.

DeWinter, J., and Vie, S. (2008). Press enter to "say": Using second life to teach critical media literacy, *Computers and Composition, 25*, 313-322.

Darken, R. P., and Siebert, J.L. (1996). Navigating in large virtual worlds, *The International Journal of Human–Computer Interaction, 8*(1), pp. 49-72.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319-340.

Dickey, M. D. (1999). 3D Virtual worlds and learning: An analysis of the impact of design affordances and limitations in active worlds, blaxxun interactive, and onlive! traveller; and a study of the implementation of active worlds for formal and informal education (Doctoral Dissertation, School of The Ohio State University, 1999).

Dickey, M. D. (2004). An architectural perspective for the design of educational virtual environments. *Journal of Visual Literacy*, *24*(1), pp.49-66.

Dickey, M. D. (2005). Three-dimensional virtual worlds and distance learning: two case studies of active worlds as a medium for distance education. *British Journal of Educational Technology,* 36(3), pp. 439-461.

Do, E., and Gross M. D. (1997). Tools for visual and spatial analysis of CAD models: Implementing computer tools as a means to thinking about architecture. In R. Junge (Ed.), *CAAD Futures Proceedings of CAAD Futures 1997 Conference, Munich, Germany* (pp.189-202). Dordrecht: Kluwer Academic Publishers,.

Donath, J., Karahalios, K., and Vigas, F. (1999). Visualizing conversation. *JCMC, 4*(4). Retrieved from http://jcmc.idiana.edu/vol4/issue4/donath.html# Morningstar.

Dondlinger, M. J. (2007). Educational video game design. *Journal of Applied Education Technology*, *4*(1), 21-31.

Dong, W., and Gibson, K. (1998). *Computer visualization: an integrated approach for interior design and architecture.* New York: McGraw-Hill.

Doughty, M. and O'Coill, C. (2005). Computer game technology, collaborative software environments and participatory design. In P. Kommers and P. Isaías (Eds.), *Proceedings of IADIS International Conference on Web Based Communities, Algarve, Portugal* (pp. 303-306). Portugal: IADIS.

Edwards, C. (2006). Another World. *Engineering and Technology, 1*(9), 28-32.

Erdem, A., and Pak, B. (2004). Potentials of integrating 3d modeling environments to design education : PG.W workshop, *Proceedings of ECPPM '04 Conference, ITC@EDU WORKSHOP.* Retrieved March 16, 2007, from http://atlas.cc.itu.edu.tr/~pakbu/blog/poi.pdf>

Fjuk, A. and Krange, I. (1999). The situated effects of awareness in distributed collaborative learning: Interactive 3D an example. In C. Hoadley, and J. Roschelle (Eds.), *Proceedings of the 1999 conference on Computer support for collaborative learning, Standford University, Palo Alto, California* (pp. 159 – 166). USA: International Society of the Learning Sciences.

Fors, A.C., and Jakobsson, M. (2002). Beyond use and design: The dialectics of being in virtual worlds. *Digital Creativity*, *13*(1), 39-52.

Fortney, K. (2007). Using Second Life to provide corporate blended learning solutions. *Proceedings of the 3rd Annual Meeting of the Second Life Community Conference, SLCC: Chicago, IL* (pp. 83-85).

Gabriel, G., and Maher, M. L. (1999). *Does computer mediation affect design representation?* Retrieved October 5, 2008, from Proceedings of Design Thinking Symposium, Cambridge: MIT: http://web.arch.usyd.edu.au/~mary/ Pubs/ pubs99.html.

Gero, J.S. (2002) Advances in IT for building design. In M Anson, J. Ko and E.Lam (Eds.), *Advances in Building Technology* (pp. 47-54). Amsterdam: Elsevier.

Gordon, E., and Koo, G. (2008). Using Virtual Worlds to Foster Civic Engagement. *Space and Culture*, *11*(3), 204-221.

Granic, A., Glavinic, V., and Stankov, S. (2004). Usability evaluation methodology for web-based educational systems. *8th ERCIM Workshop "User Interfaces for All".* Vienna, Austria.

Gu, N. (2006). *Capter2 Background.* Retrieved from February 5, 2008, from ses.library.usyd.edu.au/bitstream/2123/984/3/03chapter2.pdf.

Gu, N., and Maher, M.L. (2005). Dynamic design of 3D virtual worlds using generative design agents. In B. Martens and A. Brown (Eds.), *Proceedings of the 11th International CAAD Futures Conference* (pp. 239-248). Netherlands, Dordrecht: Springer.

Gu, N., Gül L.F., and Maher M.L. (2007). Designing and learning within the design: A case study of principles for designing and teaching 3d virtual worlds. In G.Yu, Q. Zhou, and W. Dong (Eds.), *CAADRIA 2007: Proceedings of the 12th International Conference on Computer-Aided Architectural Design Research in Asia, Nanjing*, *China* (pp. 127-132). China, Hong Kong: CAADRIA.

Gunther, R., Kazman, R., and Macgregor, C. (2004).Using 3D sound as a navigational aid in virtual environments. *Behavior and information technology*, *23*(6), 435-446.

Gül, L.F. Gu, N., and Williams, A. P. (2008). Virtual worlds as a constructivist learning platform: Evaluations of 3D virtual worlds on design teaching and learning. *ITcon*, *13***,** 578-593.

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

Hobbs, M., Brown, E., and Gordon, M. (2006) Using a virtual world for transferable skills in gaming education. The Higher Education Academy, *ITALICS*, *5*(3), Retrieved February 10, 2009, form: http://www.ics.heacademy.ac.uk.

Holmberg, K., and Huvila, I. (2008, October 6). Learning together apart: Distance education in a virtual world. *First Monday, 13*(10). Retrieved March 6, 2009, from http://www.uic.edu/htbin/cgiwrap/bin/ojs/index.php/fm/article/view Article/2178/2033.

Holmström, H., and Jakobsson, M. (2001). Using models in virtual world design. In R. H. Sprague (Ed.), *Hawaii International Conference on System Sciences 34* (pp. 9-17). USA: HI, Maui.

Hoog, J., Falkner, C., and Seifried, P. (2007). Collaborative spaces as learning environments: How schools of architecture may find their way into the virtual world. In A. Okeil , A. Al-Attili, and Z. Mallasi (Eds.), *Em'body'ing Virtual Architecture: The Third International Conference of ASCAAD'07* (pp. 365-380). Egypt, Alexandria: ASCAAD.

Jabi, W. M. (2004). A framework for computer-supported collaboration in architectural design (Doctoral Dissertation, The University of Michigan, 2004).

Jakobsson, M., and Skog, D. (2000). *What makes a house? Approaching architectural design in Virtual Worlds,* Retrieved October 11, 2009, from Information Systems Research Seminar in Scandinavia, Norway: Ulvik in Hardanger, http://www.informatic.umu.se/nlrg/house_iris.pdf.

Johnson, B. (2005). Design ideation: the conceptual sketch in the digital age. *Design Studies, 23*, 613-634.

Jourabchi, K. (2006). Virtual architecture; a human-machine interaction. In H. R. Arabnia, and R. R. Hashemi (Eds.), *Proceedings of the 2006 International Conference on Information and Knowledge Engineering (IKE), Las Vegas, Nevada, USA* (pp. 334-342). USA: CSREA Press.

Jung, Y. (2008). Influence of Sense of Presence on Intention to Participate in a Virtual Community. In IEEE (Eds.), *Proceedings of the 41st Annual Hawaii International Conference on System Sciences* (p.325-). USA, Washington, DC: IEEE Computer Society

Kalay, Y. E. (2004). Virtual learning environments, *ITcon, 9*, 195-207.

Kalay, Y., and Marx, J. (2001). The role of place in cyberspace. In H. Thwaites and L. Addison (Eds.), *VSMM'01: Proceedings of the Seventh International Conference on Virtual Systems and Multimedia, Berkeley, CA* (pp. 770-779). USA, Washington, DC: IEEE Computer Society.

Kemp, J., and Livingstone, D. (2006). Putting a second life "metaverse" skin on learning management systems. In D. Livingstone and J. Kemp (Eds.), *Proceedings of the Second Life Education Workshop: SLCC, San Francisco, The University of Paisley* (pp. 13-18).

Kolko, B. E. (1995). Building a world with words: The narrative reality of virtual communities, *Worlds and Days,* 25/26, 13(1-2), 105-126.

Koschmann, T., Myers, A., Feltovich, P., and Barrows, H. (1994). Using technology to assist in realizing effective learning and instruction: A principled approach to the use of computers in collaborative learning. *The journal of learning sciences, 3*(3), 227-264.

Krotoski, A. (2005). The social life of virtual worlds. *Intersection: Journal of Contemporary Screen Studies,* (2). Retrieved October 13, 2009, from http:// mypages.surrey.ac.uk/psp1ak/The%20Social%20Life%20of%20Virtual %20Worlds%20Intersection.pdf.

Kvan, T. (2001). The pedagogy of virtual design studios. *Automation in Construction*, *10*, 345-353.

Kvan, T., HungYip, W., and Vera, A. (1999). Supporting design studio learning: An investigation into design communication in computer-supported collaboration. In C. Hoadley (Ed.), *CSCL'99, Stanford, Palo Alto, California* (pp 328-332). USA: Routledge.

Kvan, T., Mark, E., Oxman, R., and Martens, B. (2004). Ditching the dinosaur: Redefining the role of digital media in education. *International Journal of Design Computing*, **7**. Retrieved February 10, 2009, from http://www.arch. usyd.edu.au/kcdc/journal/.

Leigh, J, Johnson, A. E. Vasilakis, C. A., and DeFanti, T. A. (1996). Multi perspective collaborative design in persistent networked virtual environments. In *Proceedings of IEEE Virtual Reality Annual International Symposium '96, Santa Clara, CA, University of Leeds, Electronic Visualization Laboratory* (pp. 253-260). USA, Los Alamitos, CA: IEEE Computer Society Press.

Leinonen, P., Järvelä, S., and Hakkinen, P. (2005). Conceptualizing the awareness of collaboration: A qualitative study of a global virtual team. *Computer Supported Cooperative Work*, *14*(4), p. 301–322.

Lombard, M., and Ditton, T. (1997). At the heart of it all: the concept of presence, *Journal of Computer-Mediated Communication, 3*(2). Retrieved Februrary, 20, 2009, from http://jcmc.indiana.edu/vol3/issue2/lombard.htlm.

Maher, M.L., and Gero, J.S. (2002). Agent models of 3D virtual worlds. In G. Proctor (Ed.), *ACADIA 2002: Thresholds: Design, Research, Education and Practice, California State Polytechnic University, Pomona, CA, USA* (pp 127-138).

Maher, M.L., and Gu, N. (2002). Virtual worlds = architectural design + computational elements. In M. Luther, T. Dawson, J. Ham, M. Moore, J. Rollo, and G. Treloar *Proceedings of ANZAScA* (pp. 305-312). Geelong, Victoria, Australia: Deakin University.

Maher, M.L., Rosenman, M. Merrick, K., and Macindoe, O., and Marchant (2006). DesignWorld: An augmented 3D virtual world for multidisciplinary collaborative design.In A. Kaga and R. Naka (Eds.), *CAADRIA '06: Proceedings of the 11th Conference on Computer-Aided Architectural Design Research in Asia*, *Osaka, Japan* (pp.133-142). Japan, Kumamoto:University of Kumamoto.

Maher, M. L. and Simoff S. (1999) Variations on a virtual design studio. In J-P. Barthes, Z. Lin and M. Ramos (Eds.), *Proceedings of Fourth International Workshop on CSCW in Design* (pp.159-165). Universite de Technologie de Compiegne.

Maher, M. L., Simoff, S., Gu, N., and Lau, K. H. (2000) Designing virtual architecture. In B-K. Tang, M. Tan and Y-C. Wong (Eds.), *Proceeding of CAADRIA2000, Casa, Singapore* (pp. 481-490). Singapore: National University of Singapore.

Maher, M.L., Gül, L.F., and Bilda, Z. (2006). Studying Design Behaviour in Collaborative Virtual Environments. In R. N. Pikaar, E. A. P. Koningsveld and P. J. M. Settels (Eds.), *Proceedings of 16th World Congress on Ergonomics (IEA2006 Congress)* (no page numbers). Maastricht, Netherlands: Elsevier, Ltd. CD publication.

Madrazo, L. (1999). Types and instances: A paradigm for teaching design with computers, *Design Studies*, *20***,** 177-193.

Mansfield, R. (2008). How to do everything with Second Life. USA, New York: McGraw-Hill Companies.

Manson, H. (2007). Experiential education in second life. In J. Kemp and D. Livingstone (Eds.), *Proceedings of the 3rd Annual Meeting of the Second Life Community Conference*, *SLCC,* Chicago, IL (pp. 14-18).

Mikulski (2007, March). *Modern Virtual Environments: An Architectural Perspective, Second Life and Beyond.* Retrieved March 20, 2008, from http://www.theslsa.com/Modern%20Virtual%20Environments.pdf.

Moloney, J. (2001). 3D game software and architectural education. In G. Kennedy, M. Keppell, C. McNaught and T. Petrovic (Eds.), *Proceedings of the 18th Conference of the Australasian Society for Computers in Learning in Tertiary Education* (pp. 121-124). Melbourne, Australia: The University of Melbourne.

Moloney, J., Amor, R., Furness, J., and Moores, B. (2003). Design Critique inside a multi-player game engine. In R. Amor (Ed.), *Proceedings of the CIB W78 Conference on Construction IT Bridging the Distance, Waiheke Island, New Zealand* (pp. 255-262). New Zealand: University of Auckland.

Morgan, G.A., and Griego, O.V. (1998). *Easy Use and Interpretation of SPSS for Windows: Answering Research Questions with Statistics.* Hillsdale: Erlbaum.

Nederveen, S. (2007). Collaborative design in Second Life. In H.A.J. de Ridder and J.W.F. Wamelink (Eds.), *Second International Conference World of Construction Project Management 2007* (no page numbers), TU Delft, The Netherlands.

Norman, F. (2001). Towards a paperless studio. In M. Kihl (Ed.), *Proceedings of The ARCC Spring Research Conrerence, The College of Architecture and Urban Studies at Virginia Tech, Blacksburg, Virginia* (pp. 85-91). USA: Architectural Research Centers Consortium.

Novak, M. (1991). Cyberspace: First steps. In M. Benedikt (Ed.), *Liquid Architectures in Cyberspace,* (pp. 225 -254). USA, Cambrige, MA: MIT Press.

O'Coill C., and Doughty, M. (2004).Computer game technology as a tool for participatory design. In B. Rüdiger, B. Tournay, and H. Ørbæk (Eds.), *Architecture in the Network Society. Proceedings of the 22nd Conference on* (*eCAADe) Copenhagen, Denmark* (pp.12–23). *Copenhagen: The Royal Danish Academy of Fine Arts School of Architecture.*

Ondrejka, C. (2008). Education unleashed: Participatory culture, education, and innovation in *Second life*. In K. Salen (Ed.), *The Ecology of Games: Connecting Youth, Games, and Learning* (pp.229–252). Cambridge, MA: The MIT Press.

Oxman, R. (2008). Digital architecture as a challenge for design pedagogy: theory, knowledge, models and medium. *Design Studies*, *29*(2), 99-120.

Rymaszewski, M., Au, W. J., Wallace, M., Winters, C., Ondrejka, C., and Batstone-Cunningham, B. (2007). *Second Life: The official guide.* USA, New Jersey: Wiley and Sons, Inc.

Rasmussen, I., Krange, I., and Ludvigsen, S. R. (2003). The process of understanding the task: How is agency distributed between tools, students and teachers in technology-rich learning environments? *International Journal of Educational Research, 39*(8), 839-849.

Reffat, R. M. (2005). Collaborative digital architecture design teaching within virtual environments. In A. Bhatt (Ed.), *CAADRIA 2005*: *Computer Aided Architectural Research in Asia* (pp. 65-74). India: New Delhi: TVB School of Habitat Studies.

Reffat, R. M. (2007a). Computing in architectural design: Reflections and an approach to new generations of CAAD. *Journal of Information Technology in Construction, 11***,** 655-668.

Reffat, R. M. (2007b). Revitalizing architectural design studio teaching using ICT: Reflections on practical implementations. *International Journal of Education and Development using Information and Communication Technology, 3*(1), Retrieved May 25, 2008, from http://ijedict.dec.uwi.edu/viewarticle.php?id =276andlayout=html

Rosenman, Merrick, K., Maher, M-L., Ahmed, A., Shen, R., Macindoe, O., Marchant, D., Nampremphree, K. (2006). *Multidisciplinary collaboration using agent-based virtual worlds*. Paper presented in the Proceedings of the Second International Conference Clients Driving Innovation: Moving Ideas into Practice, Australia: Gold Coast, Queensland. Retrieved January 4, 2009, from http://www.irbdirekt.de/daten/iconda/CIB1650.pdf.

Schmidt, M., Kinzer, C., and Greenbaum, I. (2007). Exploring virtual education: First hand account of 3 Second Life classes. *Proceedings of the 3rd Annual Meeting of the Second Life Community Conference* (pp. 104-106). *SLCC: Chicago, IL*

Steinkuehler, C. A. (2004). Learning in massively multiplayer online games. In Y. B. Kafai, W. A. Sandoval, N. Enyedy, A.S. Nixon and F. Herrera (Eds.), *Proceedings of the 6th International Conference of the Learning Sciences* (pp. 521-528). USA, Mahwah, NJ: Erlbaum.

Savery, J. R., and Duff, T. M. (1995). Problem based learning: An instructional model and its constructivist framework. Educational Technology, *35,* 31-38.

Slater, M. (1999). Measuring presence: A response to the Witmer and Singer presence questionnaire. *Presence: Teleoperators and Virtual Environments*, *8*(5), 560-565.

Steuer, J. (1992). Defining virtual reality: dimensions determining telepresence. *Journal of Communication*, *42*(4), 73-93.

Tanaka, J. (1997). *From (im)possible to virtual architecture*. Retrieved March 5, 2009, from: http://www.um.u-tokyo.ac.jp/publish_db/1997VA/english/02.html.

Tanaka, J., and Tajima, N. (1996). Cyberspace and the city / architecture / the body. *Intercommunication, 24*, 74-83.

Teymur, N. (2001). *4x4 – Towards a working theory of architectural education.* Retrieved February 6, 2008, from AEE 2001 Conference: http://cebe.cf.ac.uk/aee/pdfs/teymur1.pdf.

Thalmann, D. (1999). *The role of virtual humans in virtual environment technology and interfaces.* Retrieved February 20, 2009, from http://vrlab.epfl.ch/Publications/pdf/Thalmann_EC_NSF_99.pdf.

Thomas, D., and Brown, J. S. (2009). Why virtual worlds can matter. *International journal of media and learning, 1*(1), 37-49.

Violante, M. G., Vezzetti, E., and Tornincasa, S. (2005). *3D interactive technologies: Supporting e-learning with collaborative virtual environments (CVE),* Paper presented at the Congreso Internacional de Ingenieria Grafica de INGEGRAF Lugio. Retrieved January 3, 2009, from http://www.ingegraf.es/pdf/titulos/COMUNICACIONES%20ACEPTADAS/RV35.pdf.

Van Kokswijk, J. (2003, March). *Interrreality: The hybrid total experience of the physical and virtual reality.* Retrieved January 5, 2009, from http://www.kokswijk.nl/behaviorism.htm.

Wadley, G. (2008). *Talking and building: Two studies of collaboration in Second Life.* Retrieved from: http://hcid.informatics.indiana.edu/cscw08/CSCW08_

Ward, T. B., and Sonneborn, M. S. (in press). Creative expression in virtual worlds: Imitation, imagination and individualized collaboration. *Psychology of Aesthetics, Creativity, and the Arts.* Retrieved May 7, 2009, from http://bama from.ua.edu/~tward/ward_sonneborn_paca.pdf.

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

Williams, A. P., Gu N., Sher W. D., and Gül, L. F. (2007). Confluence of the real and virtual. Paper presented at *IASDR'07: International Association of Societies of Design Research 2007. Proceedings*, Hong Kong. Retrieved February, 12, 2009, from http://www.sd.polyu.edu.hk/iasdr/proceeding/ papers/The%20Confluence%20of%20the%20Real%20and%20the%20Virtual .pdf.

Witmer, B. G. and Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence, Teleoperators, and Virtual Environments*, *7*(3), pp. 225–240.

Woo, S., Lee, E., and Sasada, T. (2001). The multi-user workspace as the medium for communication in collaborative design. *Automation in Construction, 10*, 303-308.

Yu, K.-C., Hsiao, H.-S., and Tsai, F.-H. (2005). The Implementation and Evaluation of Educational Online Gaming System. IN IEEE (Ed.) *ITRE 2005, 3rd International Conference on Information Technology: Research and Education* (pp. 338-342). Taiwan, Hsinchu: IEEE Computer Society.

Zhu, Q., Wang, T., and Jia, Y. (2007). Second life: A new platform for education. *IEEE*, p. 201-204.

APPENDIX A

Appendix A1. Pre-Task Questionnaire for the Pilot Study

Bilkent University
Faculty of Art, Design and Architecture
Department of Interior Architecture and Environmental Design

The questions concern your computer usage background. Please read and answer the following questions carefully.

Name:…… Design Studio Year:……

Avatar Name:…… Age:……

[ ] Male [ ] Female

1. How long have you been using computers? For……year(s) [ ] Never used

2. For what reason(s) do you use computers?
[ ] Office Software
[ ] Internet
[ ] Games
[ ] Drawing
[ ] Others (please specify)……

3. How long have you been using the Internet? For……year(s) [ ] Never used

4. For what reason(s) do you use the Internet?
[ ] Fun
[ ] Research
[ ] E-mail
[ ] Chat/Online discussion
[ ] Online games
[ ] Others (please specify)……

5. Where do you usually use computers?
[ ] at home
[ ] Other (please specify)……

6. Please specify computer programs you are using
[ ] Word
[ ] Excel
[ ] AutoCAD
[ ] 3Ds Max
[ ] Other (please specify)……

7. How would you rate your skills in using a computer?
[ ] Poor
[ ] Mediocre
[ ] Good
[ ] Excellent

8. Did you hear about Second Life before? [ ] Yes [ ] No

9. Did you use Second Life before? [ ] Yes [ ] No

10. Did you use any of the following tools similar to Second Life? (Please indicate the name of the tool)
[ ] Game……
[ ] Online learning……
[ ] Distance learning……
[ ] Other (please specify)……

Appendix A2. Post-Task Questionnaire for the Pilot Study

This questionnaire gives an opportunity to express your experience of using SL as a design environment in architectural design education. Please indicate whether you agree or disagree with each statement. Use following scale to guide your responses to each statement. (5= strongly agree, 4= agree, 3= neutral, 2= disagree, 1= strongly disagree)

Name/Surname:

1. In the design course,

	strongly agree 5	4	3	2	strongly disagree 1
I found using Second Life as an enjoyable experience					

2. User-Interface Satisfaction

2.a. Please rate your overall impression towards using Second Life as a design environment?

	5	4	3	2	1	
Easy-to-use						Difficult
Easy-to-learn						Difficult
Flexible						Rigid
Quick						Time-consuming
Stimulating						Dull
Clear						Confusing
Helpful						Not helpful
interesting						Uninteresting
Fun						Boring
Engaging						Not engaging
Interactive						Not interactive
Realistic						Non realistic

2.b. Please rate the difficulty of the following operations while designing?

	easy 5	4	3	2	difficult 1
1. Communication tools					
2. Designing menu					
3. Controlling the avatar					
4. Controlling the camera					
5. Navigation					
6. Movement					
7. Other(s)					

3. Process

3.a. While designing in Second Life

	strongly agree 5	4	3	2	strongly disagree 1
1. I would prefer to design individually					
2. I had a hard time getting familiar with the environment					
3. I could effectively participate in decision making					
4. I could follow the design process					
5. I found it easy to construct and manipulate the design					
6. I was aware of the participant roles					
7. Seeing the other groups' design was useful					
8. Task related conversations were less					
9. It was useful to test the design by trial and error					
10. The time was enough to complete the project					
11. There was need for tutor support					
12. There was need for group friends' support					

3.b. While designing in Second Life, using an avatar

	strongly agree 5	4	3	2	strongly disagree 1
1. increases the sense of "being there"					
2. facilitates communication					
3. increases awareness					
4. enriches view-points					
5. is useful for scaling					
6. increases feeling of realism					
7. helps identifying group friends					

3.c. While designing in Second Life, the sounds

	5	4	3	2	1
1. increase the sense of "being there"					
2. help communication					
3. increase awareness					
4. increase feeling of realism					
5. simplify tasks					
6. simplify orientation					

3.d. While designing in Second Life, 3D graphical environment

	5	4	3	2	1
1. increases the sense of "being there"					
2. increases interaction					
3. increases awareness					
4. increases feeling of realism					

3.e. Designing in Second Life

	5	4	3	2	1
1. improves communication with group friends					
2. improves collaboration with group friends					
3. requires long training time					
4. needs too much dependency on the quality of hardware					
5. lacks human interaction					
6. provides social interaction (with people other than classmates)					
7. broadens one's perspective					
8. encourages learning					
9. enables knowledge transferring					
10. needs sufficient training courses					
11. is time-consuming					
12. suffers from frequent disruptions due to the Internet connection					
13. made me feel independent					
14. made me feel confident					
15. made me learn from my group friends and others					

4. Perceived Usefulness

Using Second Life as a design environment

	5	4	3	2	1
1. enabled me to accomplish tasks more quickly					
2. improved my performance					
3. increased my productivity					
4. enhanced my effectiveness					
5. made it easier to do my design task					
6. resulted in a more creative design					
7. resulted in a more successful design					
8. is useful in interior architectural design					

Name/Surname:

5. Students' Preferences on Using Second Life as a Design Environment

5.a. Would you prefer to design the project (avatar cafe) in another medium?

[ ] Yes [ ] No

If yes please specify the medium……

5.b. Would you prefer Second Life as a design medium in future work?

[ ] Yes [ ] No

If no please specify why……

5.c. How would you prefer to take this course?

I would prefer to [ ] meet solely in Second Life [ ] both meet in SL and in real-classroom

5.d. Do you have any suggestions to improve the use of Second Life in architectural design education?

……
……
……

5.e. Please state the most positive and negative aspects of Second Life as a design environment

Positive aspects:

1.
2.
3.

Negative Aspects:

1.
2.
3.

Appendix A3. Findings Related to Pre-Task Questionnaire for the Pilot Study

The demographic information showed that all the students enrolled in the course participated in the pilot study that consisted of 15 female and 5 male students (n=20). The mean age was 22 years (*m*=22.3, ranging from 20-24). The average for using computers is 11.15 years, the average for Internet use is 9.95 years (Table A3.1).

TABLE A3.1. Means for the Age, Years of Using Computers and the Internet

	Mean	Standard deviation	Min	Max
Age	22.30	1.41	20	24
Years of using computers	11.15	3.18	5	18
Years of using the Internet	9.45	2.32	5	14

All of the students stated that they use computers for accessing the Internet and for drawing. 14 of them are using computers for computer gaming and 17 for office software. The other areas of use are modeling, rendering and designing. Students are using the Internet generally for research and e-mailing. Other reasons for using the Internet are downloading, watching movies and online learning (Figure A3.1).

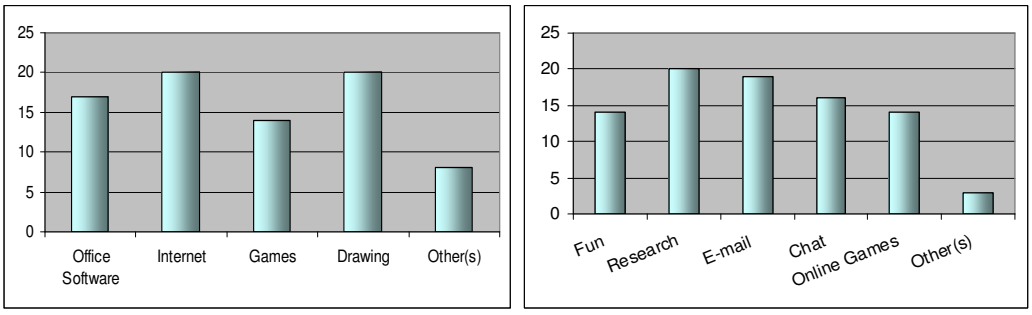


Figure A3.1. Reason(s) for Using Computers and for Using the Internet

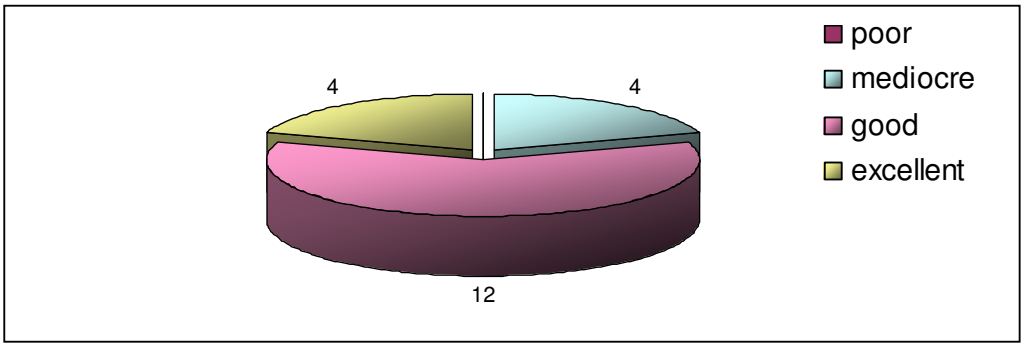


Figure A3.2. Computer Skills

For the pilot study, all of them were experienced in various software tools for their design projects. For the pilot study 8 of the students heard Second Life and out of 20 students 19 did not use Second life before.

Appendix A4. Findings Related to Post-Task Questionnaire for the Pilot Study

The students' overall satisfaction with the interface is consisted of 12 items including characteristics such as "*ease of use*", "*ease of learn*", "*flexible*", "*quick*", "*stimulating*", "*clear*", "*helpful*", "*interesting*", "*fun*", "*engaging*", "*interactive*" and "*realistic*" (Table A4.1).

TABLE A4.1. Means (*m*) and Standard Deviations (σ) of the User-Interface Satisfaction (n=20).

Variables	*m*	σ
Easy-to-use	2,80	1,19
Easy-to-learn	3,25	1,2
Flexible	2,40	1,14
Quick	2,20	1,15
Stimulating	3,10	1,37
Clear	3,00	1,25
Helpful	2,60	1,14
Interesting	3,75	1,25
Fun	3,70	1,12
Engaging	2,95	,94
Interactive	4,10	1,02
Realistic	3,00	1,02

Note: (1=difficult to 5= easy; 1= rigid to 5= flexible; 1= time-consuming to 5= quick; 1= dull to 5= stimulating; 1=confusing to 5= clear; 1=not helpful to 5= helpful; 1=uninteresting to 5= interesting; 1=boring to 5= fun; 1=not engaging to 5= engaging; 1=not interactive to 5= interactive; 1= unrealistic to 5= realistic).

The operational tools were assessed in 6 items involving operational tools of "*communication tools*", "*designing menu*", "*controlling the avatar*", "*controlling the camera*", "*navigation*" and "*movement*" (Table A4.2).

TABLE A4.2. Means (*m*) and Standard Deviations (σ) of Operational Tools (n=20).

Variables	*m*	σ
Communication tools	3.85	1.03
Designing menu	3.40	1.18
Controlling the avatar	3.10	1.02
Controlling the camera	2.95	1.09
Navigation	2.95	0.94
Movement	3.35	1.03

Note: For all items 5-point scale (1= difficult to 5= easy) were used.

The study included both individual and collaborative tasks and the questions of this session mainly focused on the students' overall experience and the process in the distributed collaborative environment of SL that allows learners to maintain information about the others' interactions on a common design problem and the corresponding tasks was analyzed (Table A4.3).

TABLE A4.3. Means (*m*) and Standard Deviations (σ) of the Process (n=20).

Variables	*m*	σ
I would prefer to design individually	2.55	1.31
I had a hard time getting familiar with the environment	2.40	0.88
I could effectively participate in decision making	4.10	0.96
I could follow the design process	4.30	1.08
I found it easy to construct and manipulate the design	3.35	1.34
I was aware of the participate roles	3.85	1.08
Seeing the other groups design was useful	3.35	1.38
It was useful to test the design by trial and error	3.00	1.16
The time was enough to complete the project	3.90	1.11
There was need for tutor support	3.35	1.22
There was need for group friends' support	3.70	1.03

Note: For all items 5-point Likert-type scale (1= strongly disagree to 5= strongly agree) were used.

The assessment of being in the design environment, represented by avatars was done through 7 items (Table A4.4). This part consists of the statements including if avatars "*increase the sense of being there*", "*facilitate communication*", "*increase awareness*", "*enrich view points*", "*are useful for scaling*", "*increase feeling of realism*" and "*help identifying group friends*".

TABLE A4.4. Means (*m*) and Standard Deviations (σ) of using avatar (n=20).

Variables	*m*	σ
increases the sense of being there	4.05	0.88
facilitates communication	3.75	1.06
increases awareness	3.85	1.03
enriches view-points	3.90	1.02
is useful for scaling	4.05	1.23
increases feeling of realism	3.50	1.19
helps identifying group friends	4.00	0.97

Note: For all items 5-point Likert-type scale (1= strongly disagree to 5= strongly agree) were used.

The opportunity of communicating with sounds was assessed (Table A4.5). This part consists of 6 items including "*increase the sense of being there*", "*help communication*", "*increase awareness*", "*increase feeling of realism*", "*simplify tasks*", "*simplify orientation*" which are derived from the previous literatures.

TABLE A4.5. Means (*m*) and Standard Deviations (σ) of using sounds (n=20).

Variables	*m*	σ
increase the sense of being there	2.90	1.91
help communication	3.00	1.86
increase awareness	2.85	1.75
increase feeling of realism	2.90	1.86
simplify tasks	2.75	1.74
simplify orientation	2.80	1.70

Note: For all items 5-point Likert-type scale (1= strongly disagree to 5= strongly agree) were used.

The 3D environment offered by Second Life was assessed under the category including statements such as, "*increases the sense of being there*", "*increases interaction*", "*increases awareness*" and "*increases feeling of realism*" (Table A4.6).

TABLE A4.6. Means (*m*) and Standard Deviations (σ) of 3D Graphical Environment (n=20).

Variables	*m*	σ
increases the sense of being there	4.00	1.07
increases interaction	4.05	0.82
increases awareness	4.00	0.79
increases feeling of realism	4.05	0.75

Note: For all items 5-point Likert-type scale (1= strongly disagree to 5= strongly agree) were used.

Students assessed how the process contributed to each student's learning experience (Table A4.7).

TABLE A4.7. Means (*m*) and Standard Deviations (σ) of the Students' Learning Outcomes (n=20).

Variables	*m*	σ
improves communication with group friends	4.25	0.55
improves collaboration with group friends	4.15	0.74
requires long training time	3.40	0.88
needs too much dependency on the quality of hardware	3.95	1.09
provides social interaction	3.70	1.03
broadens ones' perspective	3.45	0.99
encourages learning	3.65	0.93
enables knowledge transferring	3.70	1.08
needs sufficient training courses	3.60	0.68
is time-consuming	3.50	1.19
suffers from frequent disruptions due to Internet connection	3.95	1.19
made me feel independent	3.45	1.09
made me feel confident	3.35	1.13
made me learn from my group friends and others	3.70	0.97

Note: For all items 5-point Likert-type scale (1= strongly disagree to 5= strongly agree) were used.

TABLE A4.8. Means (*m*) and Standard Deviations (σ) of Perceived Usefulness (n=20).

Variables	*m*	σ
enabled me to accomplish tasks more quickly	3.15	0.98
improved my performance	2.90	0.91
increased my productivity	3.00	1.16
enhanced my effectiveness	3.05	1.14
made it easier to do my design task	3.00	1.21
resulted in a more creative design	3.00	1.07
resulted in a more successful design	2.85	1.13
is useful in interior architectural design	3.20	1.10

Note: For all items 5-point Likert-type scale (1= strongly disagree to 5= strongly agree) were used.

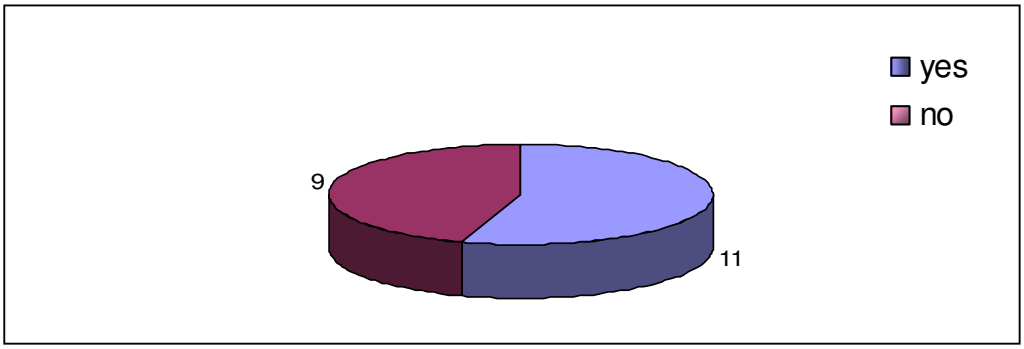


Figure A4.1. Students' Preferences on Designing in another Medium.

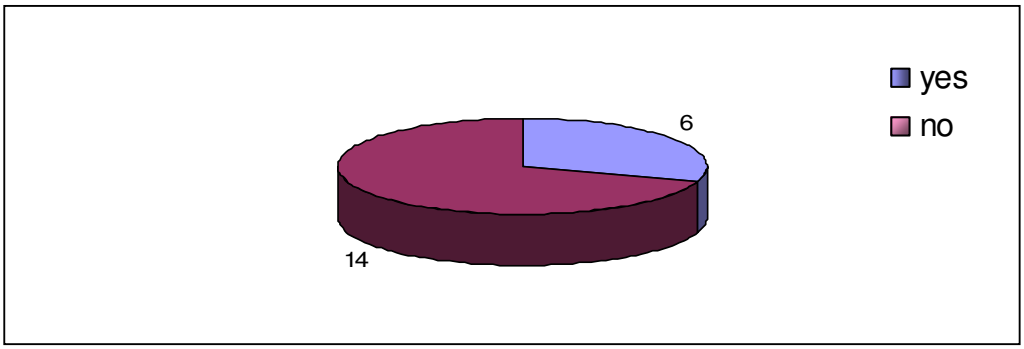


Figure A4.2. Students' Preferences of Using SL for Future Works.

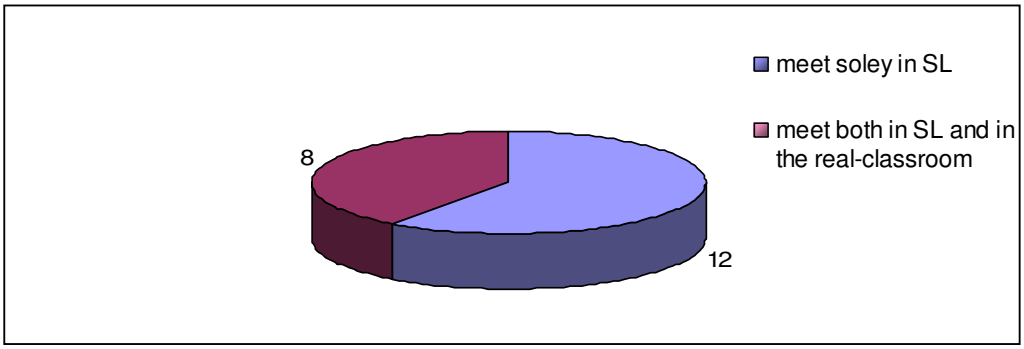


Figure A4.3 Students' Preferences of Taking the Course of SL.

APPENDIX B

Appendix B1. Pre-Task Questionnaire for the Main Study

Bilkent University
Faculty of Art, Design and Architecture
Department of Interior Architecture and Environmental Design

The questions concern your computer usage background. Please read and answer the following questions carefully.

Name:…… Design Studio Year:……

Avatar Name:…… Age:……

[ ] Male [ ] Female

1. How long have you been using computers? For……year(s) [ ] Never used

2. For what reason(s) do you use computers?
[ ] CAD programmes
[ ] Internet
[ ] Games
[ ] Other(s) (please specify)……

3. How long have you been using the Internet? For……year(s) [ ] Never used

4. For what reason(s) do you use the Internet?
[ ] Fun
[ ] Research
[ ] E-mail
[ ] Chat/Online discussion
[ ] Forums and Blogs (Web logs)
[ ] Social Networking (Facebook, Myspace, etc.)
[ ] Online games
[ ] Other(s) (please specify)……

5. Where do you usually use computers?
[ ] at University
[ ] at home
[ ] Other(s) (please specify)……

6. Please specify computer programmes you are using
[ ] AutoCad
[ ] 3Ds Max
[ ] Sketch-up
[ ] Other(s) (please specify)……

7. How would you rate your skills in using a computer?
[ ] Poor
[ ] Mediocre
[ ] Good
[ ] Excellent

8. Did you hear about Second Life before? [ ] Yes [ ] No

9. Did you use Second Life before? [ ] Yes [ ] No

10. Did you use any of the following tools similar to Second Life? (Please indicate the name of the tool)
[ ] Game……
[ ] Online learning……
[ ] Distance learning……
[ ] Other (please specify)……

Appendix B2. Post-Task Questionnaire for the Main Study

This questionnaire gives an opportunity to express your experience of using SL as a design environment in architectural design education. Please indicate whether you agree or disagree with each statement. Use following scale to guide your responses to each statement. (5= strongly agree, 4= agree, 3= neutral, 2= disagree, 1= strongly disagree)

Name/Surname:

1. In the design course,

	strongly agree 5	4	3	2	strongly disagree 1
I found using Second Life as an enjoyable experience					

2. User-Interface Satisfaction

2.a. Please rate your overall impression towards using Second Life as a design environment?

	5	4	3	2	1	
Easy-to-use						Difficult
Easy-to-learn						Difficult
Flexible						Rigid
Quick						Time-consuming
Stimulating						Dull
Clear						Confusing
Helpful						Not helpful
Interesting						Uninteresting
Fun						Boring
Engaging						Not engaging
Interactive						Not interactive
Realistic						Non realistic

2.b. Please rate the difficulty of the following operations while designing?

	easy 5	4	3	2	difficult 1
1. Communication tools					
2. Designing menu					
3. Controlling the avatar					
4. Controlling the camera					
5. Navigation					
6. Movement					
7. Other(s)					

3. Process

3.a. While designing in Second Life, using an avatar

	strongly agree 5	4	3	2	strongly disagree 1
1. increases the sense of "being there"					
2. facilitates communication					
3. increases awareness					
4. enriches view-points					
5. is useful for scaling					
6. increases feeling of realism					
7. helps identifying group friends					

3.b. While designing in Second Life, 3D graphical environment

	5	4	3	2	1
1. increases the sense of "being there"					
2. increases interaction					
3. increases awareness					
4. increases feeling of realism					

4. Perceived Usefulness

Using Second Life as a design environment

	5	4	3	2	1
1. enabled me to accomplish tasks more quickly					
2. improved my performance					
3. increased my productivity					
4. enhanced my effectiveness					
5. made it easier to do my design task					
6. resulted in a more creative design					
7. resulted in a more successful design					
8. is useful in interior architectural design					

Name/Surname:

5. Students' Preferences on Using Second Life as a Design Environment

5.a. Would you prefer to design the project in another medium?

[ ] Yes [ ] No

If yes please specify the medium……

5.b. Would you prefer Second Life as a design medium in future work?

[ ] Yes [ ] No

If no please specify why……

5.c. How would you prefer to take this course?

I would prefer to [ ] meet solely in Second Life [ ] both meet in SL and in real-classroom

5.d. How did you find simultaneous evaluation?

……
……
……

5.e. Do you have any suggestions to improve the use of Second Life in architectural design education?

……
……
……

5.e. Please state the most positive and negative aspects of Second Life as a design environment

Positive aspects:

1.
2.
3.

Negative Aspects:

1.
2.
3.

Appendix B3. Interview with the Tutor

1. What is your overall impression about the students' performances in using SL as a design environment?

.....
.....
.....
.....

2. What were the operational tools in which students satisfied or suffered while designing in SL?

.....
.....
.....
.....

3. How would you evaluate students' experiences of designing in a 3D platform with avatars?

.....
.....
.....
.....

4. Do you have any suggestions to improve the use of SL in architectural design education?

.....
.....
.....
.....

Appendix B4. Post-Task Questionnaire Percentage Distribution of the Difficulty in Using Operational Tools of SL for the Main Study

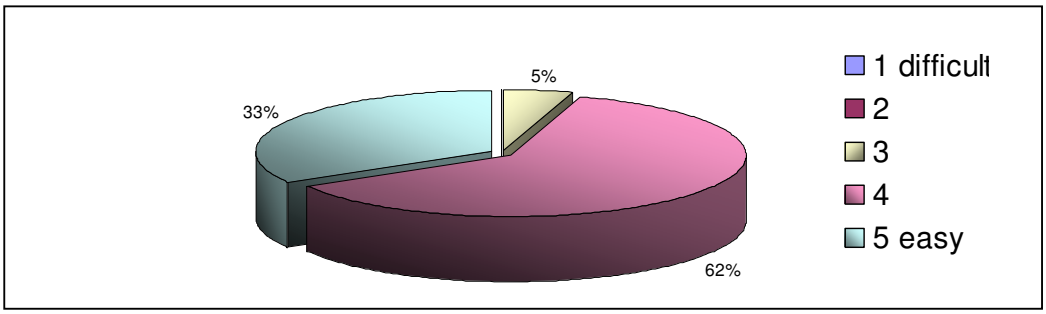


Figure B4.1. Percentage Distribution of the Difficulty in Using Communication Tools

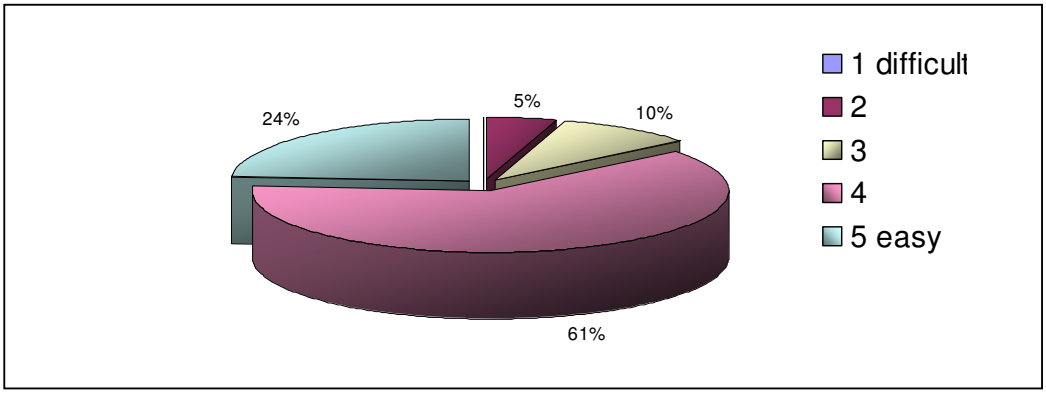


Figure B4.2. Percentage Distribution of the Difficulty in Using Designing Menu

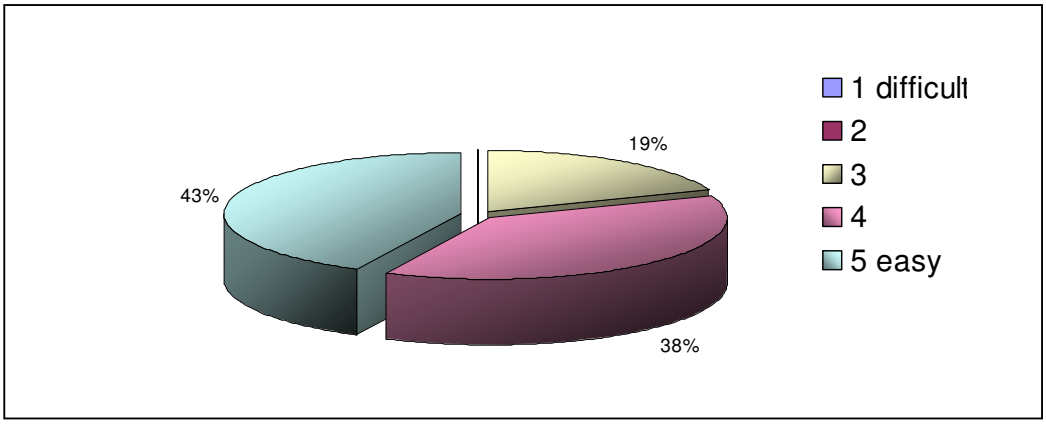


Figure B4.3. Percentage Distribution of the Difficulty in Controlling the Avatar

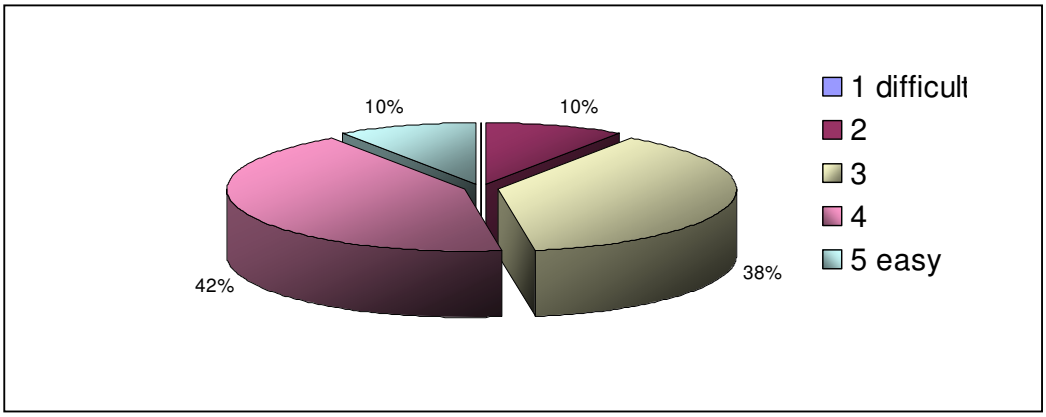


Figure B4.4. Percentage Distribution of the Difficulty in Controlling the Camera

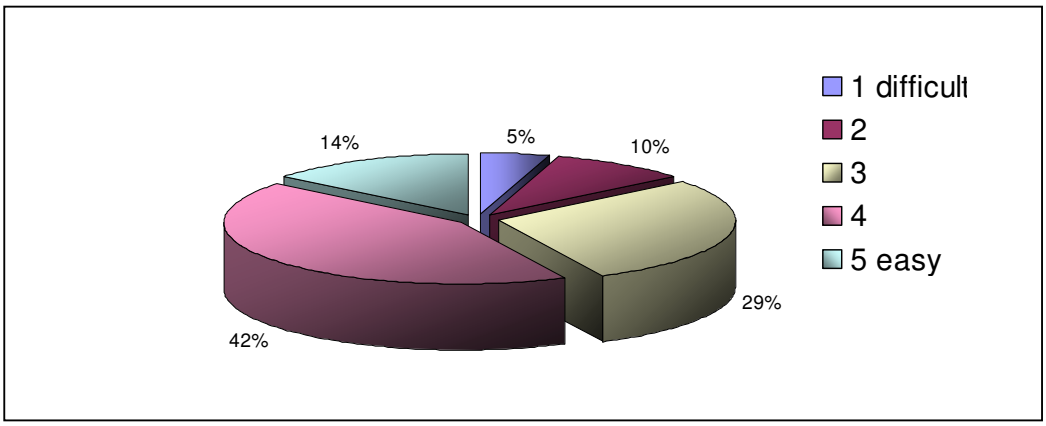


Figure B4.5. Percentage Distribution of the Difficulty in Navigation

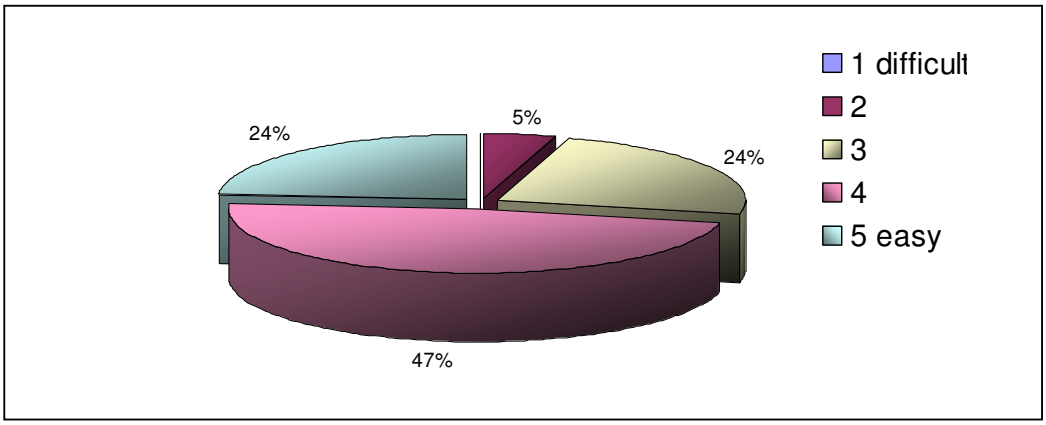


Figure B4.6. Percentage Distribution of the Difficulty in Movement

APPENDIX C

Appendix C1. Pilot Study Projects

Task-1

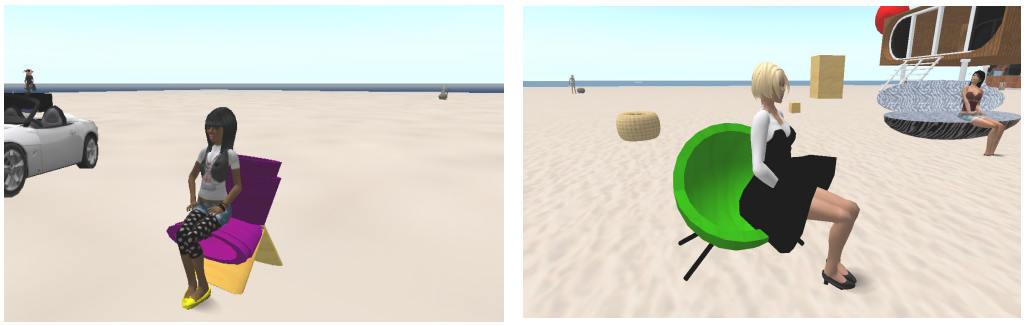


Figure C1.1. Individual Task (Designing a Chair) - Views From Two Sample Projects.

Task-2

Figure C1.2. Collaborative Task (The "Avatar Café" Project) - Views From Two Sample Projects.

Appendix C2. Main Study Projects

Task-1

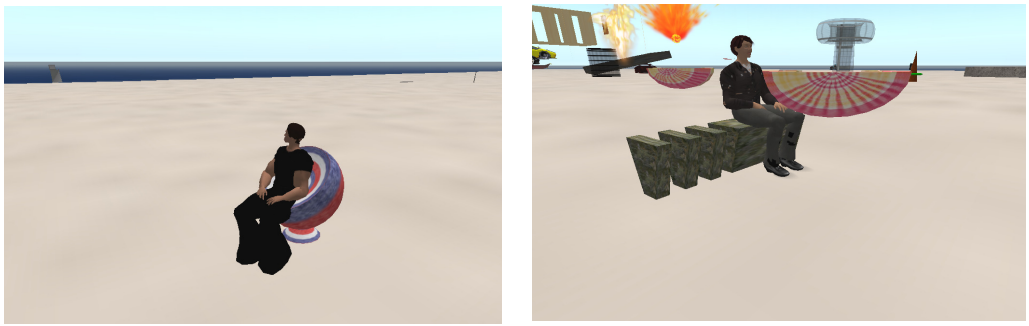


Figure C2.1. Individual Task (Designing a Chair) - Views From Two Sample Projects.

Task-2

Figure C2.2. Individual Task (Kiosk Project) - Views From Two Sample Projects.

Task-3

Figure C2.3. Collaborative Task - Views From Two Sample Projects.

Task-4

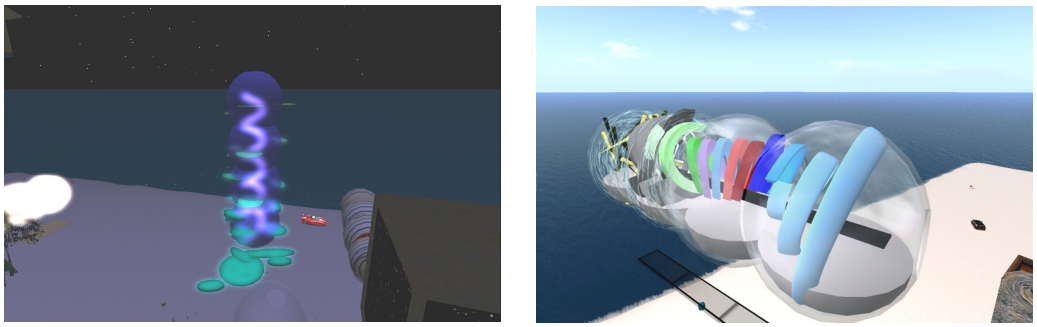


Figure C2.4. Collaborative Task - Views From Two Sample Projects.