A CYBER CAMPUS TO SUPPORT STUDENTS EXPERIENCING BARRIERS ACCESSING EDUCATION

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Abstract

There are many barriers hindering access to education for some students, significantly affecting their learning experience (Cross, 1981). To mitigate the effects of such barriers, e-learning technologies are widely used. One example of this is the use of cyber campuses. These are 3D environments where students can meet and share information, and synchronously communicate and collaborate (Prasolova-Førland et al., 2006). It has been suggested that the learning experience of students using these cyber campuses is related to their perceptions of *presence*, *awareness*, *communication* and *sociability* (De Lucia et al., 2009).

The educational capabilities of cyber campuses have been investigated thoroughly in the literature (Gregory et al., 2014). However, little is know about the extent to which cyber campuses can support students experiencing barriers hindering access to education. To investigate this, the *SHU3DED* (Sheffield Hallam University 3D Education) cyber campus was developed, and a mixture of quantitative and qualitative research was performed. A series of experimental studies were performed to *i)* evaluate the efficacy of *SHU3DED* to support online learning activities, *ii)* understand the barriers hindering access to Higher Education, and *iii)* ascertain the extent to which a cyber campus can alleviate some of these barriers and support students participate in online learning activities.

The findings of this research project revealed several barriers impeding access into Higher Education, together with a set of environment characteristics that contribute to the students' online learning experience. The findings imply that a cyber campus can be a sound social space that supports participation in online learning activities for students experiencing situational and institutional barriers accessing education. The findings provide strong indications that a cyber campus has the potential mitigate some of the barriers that challenge or exclude students from accessing education, allowing them to participate in social online learning activities. As a result of this research project, a list of suggestions for the design and arrangement of cyber campuses have also been devised.

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Declaration

The objective of this study was to investigate the extent to which cyber campuses can support students experiencing barriers hindering access to Higher Education. The author certifies that this thesis is not submitted for any other degree, and is an individual contribution with the support of the project supervisors: Dr Martin Beer and Dr Elizabeth Uruchurtu. The author certifies that to the best of his knowledge, the sources and references used are acknowledged and cited in this thesis.

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Chapter 1 - Introduction

1.1. Overview of the Research Problem

The use of technology for education has drawn a lot of attention in the past decade, concentrating on how to enhance learning activities and support students' needs. While universities offer a range of on-campus degrees, there are still students who experience barriers accessing education and participating in learning activities, missing important educational experiences. The barriers hindering access to education for these students are complex and wide ranging (McGivney, 1993). Discussing each barrier individually is difficult and lengthy; therefore, several scholars have attempted to categorise them. The most cited approach is the Cross' framework (1981: 97-100), which classifies barriers into situational, institutional and dispositional (Table 2.1). Situational barriers concern the general situation and life context of the individual. Institutional barriers concern the institutions' policies and procedures that exclude or discourage certain groups from participating. Dispositional barriers concern the student motivation and attitude towards learning, and learning activities in terms of negative evaluation of appropriateness and engagement. Although this framework can be considered oversimplistic, it is a useful starting point for considering and discussing the problems of non-participation in education (McGivney, 1993).

One of the ways to support students experiencing barriers accessing and participating in education is the use of E-Learning. E-Learning utilise technologies that enable students to construct and share knowledge through synchronous and asynchronous methods (Lau et al., 2013). This provides opportunities for accessible education that increases learning independence (Pearson and Koppi, 2002). However, conventional E-Learning tools such as learning management systems (LMS), massive open online courses (MOOC) and asynchronous communication mediums lack effective socialisation and interaction. Considering that students learn in socially constructed ways, Multi User Virtual Environments (MUVEs) in the form of cyber campuses has been introduced to enhance the social aspect of E-Learning (De Freitas et al., 2010).

Cyber campuses are meeting points operating on MUVEs, where students gather, share information, communicate and collaborate in 3D shared spaces (Prasolova-

Førland et al., 2006). Using their virtual embodiments (avatars), students navigate and interact with their peers and the environment, developing the feeling of *'being there'* (Prasolova-Førland et al., 2006; János and ZSolt, 2013). Taking these attributes into account, cyber campuses can be considered as effective tools to support online learning (Pearson and Koppi, 2002; Livingstone et al., 2008). It has been suggested that the learning experience of students using these cyber campuses is related to their perceptions of presence, awareness, communication and the feeling of belonging to a community (De Lucia et al., 2009). Presence relates the development of the subjective feeling of *'being there'* in the virtual world (Witmer and Singer, 1998). Awareness relates to the anticipation of the existence, location and actions of other users in the environment. Communication concerns the verbal and non-verbal communication established within the MUVE (De Lucia et al., 2009). Sociability relates to the ability of the environment to be a social space that provide the feeling of belonging to a learning group to its users (Kreijns et al., 2007).

The design of educational MUVEs is an important issue, however these environments are not specifically created for education and further customisation is required to transform them into cyber campuses (Riley and Kluge, 2008; Minocha and Reeves, 2010). The predominant design approach is mainly user-centred, including evaluation and iteration of the environment according to feedback (Minocha and Reeves, 2010). Therefore, cyber campuses are designed in a non-systematic manner, and there are limited design specifics and guidelines (Prasolova-Førland et al., 2006; Minocha and Reeves, 2010; Fominykh et al., 2011; Fominykh et al., 2012b).

The educational potentials and capabilities of cyber campuses have been investigated thoroughly in the existing literature. However, a question remains as to the extent to which cyber campuses can effectively support students experiencing barriers accessing education. In addition, further research is necessary to investigate what are the characteristics of the environment that support the learning experience of students experiencing those barriers, and how to design cyber campuses to support them.

1.2. Purpose and Research Question

This research project is set out to investigate the extent to which a cyber campus can support participation in online learning activities for students experiencing barriers accessing education. To investigate this, the following research question has been formulated to guide this research project:

> ***RQ: To what extent can cyber campuses support participation in online learning activities for students experiencing barriers accessing Higher Education?***

To ascertain this research question, the following objectives and research plan were formulated.

1.3. Research Objectives and Plan

1.3.1. Research Objectives

> ***O_1: Identify some of the situational and institutional barriers hindering access and participation to Higher Education.***

Extensive review of the literature was undertaken, investigating the barriers that hinder access and participation in education. Moreover, the opinions of people experiencing barriers were investigated to understand the source, nature and impact of these barriers in the students learning experience.

> ***O_2: Determine the extent to which a cyber campus can support online learning activities.***

A cyber campus prototype was developed, and a series of experimental studies were performed to evaluate the environment's potential to support online learning activities.

> ***O_3: Identify the main characteristics of cyber campuses that can support participation in online learning activities for students experiencing situational and institutional barriers accessing education.***

An extensive investigation of the existing literature was conducted, together with empirical investigation including the contribution of people experiencing barriers in accessing education, to determine the characteristics of the environment that support students effectively participating in online learning activities.

1.3.2. Research Plan

In order to complete the above objectives, a viable research plan to break them into manageable tasks was developed, and a time plan of this research project is included as Appendix 3.1

- Investigate barriers hindering access and participation in Higher Education.

The literature behind barriers impeding access and participation in Higher Education was investigated to understand their nature, source and impact on the students learning experience.

- Investigate the concept of virtual worlds for learning and learning support.

An extensive review of the literature to understand the educational capabilities, potentials and challenges of virtual worlds was performed, to identify research gaps.

- Design the research methodology.

The methodology to conduct this research project was designed, determining the instruments, experimental procedures, data collection and analysis methods.

- Design a cyber campus.

Following examples of best practices, observations and design guidelines from the literature, a cyber campus prototype was developed to be used as a proof of concept and to conduct the empirical portion of this research project with.

- Identify and invite the target group to participate.

People experiencing situational and institutional barriers impeding access to education were recruited to participate in the experimental stages of this research project. Appropriate ethical approval was obtained and participants' consent was sought through the form included as Appendix 6.4.

- Conduct a cyber campus evaluation involving members of the target group.

The potential of the cyber campus to support online learning was evaluated through a series of online learning activities performed within the virtual world.

- Conduct a qualitative investigation involving members of the target group.

A qualitative investigation was followed to explore peoples' experiences with situational and institutional barriers hindering access and participation in Higher Education, the educational capabilities of the virtual world, how a cyber campus can mitigate the effects of some of those barriers, and support students participating in online learning activities.

- Analyse results.

The collected data was analysed using qualitative and quantitative data analysis methods.

- Discuss the findings of this research project.

Considering the findings of this research project, research conclusions have been made to address the research question set out in this Chapter.

- Identify limitations and future work.

The associated limitations and future work that can be performed as a result of this research project have been identified and presented.

1.4. Research Contributions

The major contributions of this research project are practical, theoretical and academic, and can be summarised as follows:

- Practical Contributions
  - A list of suggestions for the design and development of learning efficient cyber campus environments and relevant educational activities have been devised and are included as Appendix 8.
  - Demonstration of the ability of a virtual world to support online learning activities as a proof of concept.
  - The development of *SHU3DED* cyber campus prototype.
- Theoretical contributions:
  - Improves, applies, confirms and contributes to the reliability and validity of the De Lucia et al. (2009) evaluation framework.
  - Applies and supports the relevance of the Cross (1981) situational and institutional barriers of accessing education in modern days.
- Academic Contributions:
  - A number of peer-reviewed papers were published (Appendix 1), and presentations to the academic community were performed.
  - This research project created knowledge for others to consider and to build upon it.

1.5. Thesis Structure

This thesis begins by establishing the need to investigate the use of virtual worlds as a learning tool to support students experiencing situational and institutional barriers accessing education.

Chapter 2 provides a comprehensive review of the existing literature. This Chapter discusses the barriers hindering access and participation in education, the use of technology to support online learning, the use of virtual worlds in education in the form of cyber campuses, and their learning capabilities. The characteristics that contribute to effective cyber campuses are also discussed, together with the literature behind the design of such environments, and their limitations. This Chapter also identifies a gap in the literature, and puts forward the need to be investigated.

Chapter 3 discusses the research methods that are chosen to conduct this research project. This Chapter presents the theoretical framework and describes how data will be collected and analysed to perform this investigation.

Chapter 4 describes the design and development of *SHU3DED* cyber campus prototype to conduct the empirical portion of this research project.

Chapter 5 describes the initial evaluation of *SHU3DED*. This Chapter presents details of two studies that have been performed to initially evaluate the environment's efficacy to support online learning activities. These studies served as initial evaluations and indications to improve the research design for further experimentation.

Chapter 6 presents details of the extended evaluation of *SHU3DED*. A series of online learning activities were conducted with the participation of people experiencing situational and institutional barriers accessing education. Statistical analysis has been performed to investigate the users perceptions of presence, awareness, communication and sociability of the environment. Users perceptions of the design of the environment, productivity and satisfaction of the experience were also collected and analysed.

Chapter 7 describes the qualitative study that has been conducted following the extended evaluation of the environment. A series of virtual focus group sessions were conducted within the virtual world, with the participation of people who experienced the *SHU3DED* during the extended environment evaluation study.

Chapter 8 discusses the findings and concludes this thesis by providing a research summary and presenting the contributions of this research project. The associated limitations are also discussed together with future work that could be performed as a result of this research project.

1.6. Chapter Summary

This Chapter provided an overview of the research problem discussed in this thesis, presented the purpose, research question, and objectives of this investigation. This Chapter also presented the main contributions of this research project and outlined the structure of this thesis.

The next Chapter presents an extensive review of the existing literature, to begin the discussion of identifying the extent to which a cyber campus environment can support participation in online learning activities for students experiencing situational and institutional barriers hindering accessing education.

Chapter 2 - Literature Review

2.1. Introduction

Technology in education has been introduced to effectively support and enhance learning experiences with great success over the past few years. While universities offer a range of on-campus degrees, there are students who experience barriers accessing the educational institution, missing important learning experiences through personal interaction with their fellow colleagues and tutors. To support students, universities provide flexible and accessible learning opportunities through online learning support tools, using E-Learning technologies. This enables students to access, construct and share knowledge from remote locations. Among the multiple emerging E-Learning technologies, the use of MUVEs has been introduced in the form of cyber campuses, to improve the social aspect of online learning, and to enrich and enhance online learning activities.

This research project is set out to explore the potential of cyber campuses to provide access and participation to online learning activities and support students experiencing barriers accessing education. To investigate this, a comprehensive review of the existing knowledge is presented in this Chapter. The review begins with investigation of barriers hindering access and participation to education, to understand the source, nature and impact in the students' learning experience. Following this, the use of technology in education is investigated to understand the tools and processes that are available to support online learners. Next, an in-depth investigation of the use of virtual worlds in the form of cyber campuses as a tool to support online learning is presented. Reviewing the literature enabled to develop a sound understanding of the origins of the topics, identify key sources and the current state of the art in the field. This enabled a synthesis of information to identify research gap and produce the justification of this thesis.

This Chapter is organised as follows: Section 2.2 discusses the barriers hindering access and participation in education. Section 2.3 discusses how technology has been introduced in education to support online learning. Section 2.4 presents the concept of virtual worlds, introduces a range of MUVE technologies and their educational use. This Section also discusses the concept of cyber campuses, providing some examples of best practices. The characteristics that contribute to the educational efficacy of a MUVE are also presented and discussed in this Section. Section 2.5 discuses the literature behind the design of cyber campus environments. Section 2.6 presents the associated disadvantages of cyber campuses, and Section 2.7 concludes this Chapter.

2.2. Barriers in Learning

There are many reasons why some students cannot access education and participate in learning activities, missing these important experiences that develop through inter-personal interactions, access to physical resources and learning materials. Although universities provide support tools for materials reviewing and information sharing, the important learning experiences that are obtained when a student attends lectures and learning activities is limited. Face to face participation in education is an invaluable experience, where students not only obtain important information, but also develop their understanding and skills through social interaction. In this research project, the barriers impeding students from accessing education were investigated to determine the extent to which a cyber campus environment can be used to support them.

2.2.1. Categorisation of Barriers

There are many barriers that restrict or exclude students from attending and participating in education. It is a complex and wide ranging concept that has been investigated by many researchers over the years (Johnstone and Rivera, 1965; Cross, 1981; Brookfield, 1986; Charner and Fraser, 1986; Byrd, 1990; McGivney, 1993; Green, 1998; Rubenson, 1999; Gorard et al., 2006; Billingham, 2009; Baryana, 2013; Desjardins and Rubenson, 2013). Discussing each barrier individually is difficult and lengthy; therefore, several scholars have attempted to categorise them. Johnstone and Rivera (1965), for example, categorised barriers into internal and external. Internal barriers relate to the students' attitudes towards learning, and external refer to barriers external to the control of the individual. A later study by Carp, Peterson and Roelfs (1973) identified a number of individual and combined barriers that affect participation, suggesting that cost, time, attitudes, home and work responsibilities, and the time to complete a degree are the most significant. The results of this study have been further investigated by Cross (1981: 97-100), who categorised barriers into situational, institutional and dispositional (Table 2.1).

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Table 2.1 – Perceived barriers to learning (Cross, 1981: 99)

Situational barriers concern the general situation and life context of the individual at a particular time, including his/her social and physical surroundings. Institutional barriers concern the institutions' policies and procedures that exclude or discourage certain groups of students from participating. Dispositional barriers concern the student motivation and attitude towards learning, which also relate to the learning activities in terms of negative evaluation of appropriateness and engagement in learning. However, the author indicates that some of the barriers can be included into more than one category. She also explains that the categorisation may be considered rather arbitrary, however she tried to place the items in the category that seems most straightforward. Nevertheless, literature suggests that the Cross framework is a strong tool to allow understanding of the concept of barriers to participation (Gibson and Graff, 1992; McGivney, 1993; Rubenson, 1999; Gorard et al., 2006; Sloane-Seale, 2011; Baryana, 2013; Desjardins and Rubenson, 2013). Many empirical studies have been conducted in the field, but the seminal work of Cross is the most frequently cited (MacKeracher et al., 2006; Rubenson and Desjardins, 2009).

In addition to Cross's categories, Darkenwald and Merriam (1982) noted an additional category, namely '*informational barriers*', concerning the inability of institutions to effectively provide adequate educational information to students, and the lack of learning opportunities awareness. A later study by Byrd (1990) investigated perceptions towards barriers in participation based on the Cross framework and the barriers identified in the study of Carp, Peterson and Roelfs (1973), implying that the most frequent barriers relate to lack of time, degree completion time, cost of education, fatigue, home and work responsibilities.

In the research project presented in this thesis, the Cross (1981) framework was utilised to categorise and discuss the barriers hindering access to education. It has been identified during the review of the literature that this framework best describes and categorises barriers, hence its adoption in this research project to investigate them. According to McGivney (1993: 17), *"although they have been described as oversimplified, these categories provide a useful starting point for considering the problems of non-participation"*.

The next Section discusses situational, institutional and dispositional barriers to develop a practical understanding of their source, nature and impact on students learning experience. However, it is important to consider the interrelatedness of classification that occurs due to the complexity of some barriers (Baryana, 2013). For example, the classification of a particular barrier on two categories may occur, depending its nature (MacKeracher et al., 2006). Thus, it is important to investigate them from the students' point of view (Baryana, 2013).

2.2.1.1. Situational Barriers

According to McGivney (1992), perhaps the most obvious situational barrier is the financial aspect of education. There are two types of costs: direct and indirect. Direct costs refer to tuition fees, cost of transportation, cost of books etc. (Hand et al., 1994; Warhurst, 2009). Indirect costs refer to stationary, examination fees, even the day-to-day costs (Gorard et al., 2006; Warhurst, 2009). A recent study (Terriquez et al., 2013) reveals that financial constraints are one of the most important reasons deterring students from attending education, where as much as 41% of the study population revealed that they cannot afford to attend the educational institution. Even when students receive financial aid, worries how to balance coursework, work and bills remains. It has also been identified that students from economically disadvantaged segments of the population are less likely to attend university (Lynch and O'Riordan, 1998; Frenette, 2004; Drolet, 2005; McCoy and Byrne, 2011), compared to students coming from higher socioeconomic backgrounds who are more likely to complete academic degrees (Andres and Adamuti-Trache, 2008).

Distance from the educational institution is another situational barrier, which includes the cost of living away from home, the cost and time of travelling etc. (Millar and Falk, 2000; Long et al., 2002; Reay et al., 2002; Cullinan et al., 2013b). For example, students living in remote areas have to leave home or travel to the institution, experiencing increased expenses (Forsyth and Furlong, 2000), because the costs of travelling tend to increase as distance to university increases. Frenette's studies (2004, 2006) based on the relationship of distance between home and educational institution, revealed that students who live away from their university, are less likely to attend it. Frenette (2006) indicates that transportation costs might be a factor that influence attendance, primarily for low income families. Furthermore, Sa et al. (2006) suggests that distance to university influences the probability of high school leavers to continue on to university education, and according to Cullinan et al. (2013a), travel distance has a negative influence for school leavers to continue their studies.

Another situational barrier concerns the issue of maintaining a balance between family and work with education (Cumming, 1992; McGivney, 1999; Dench and Regan, 2000; Long et al., 2002). Raising a family and attending university, requires both time and effort and its draining the energy of the student (Chisholm et al., 2004). Also there are occasions where lack of support from the family is also an issue (Furst-Bowe, 2002). Rubenson and Desjardins (2009) indicate that lack of time is one of the strongest reasons for not participating, because it is difficult and stressful to maintain balance between work, family, education and personal life. In addition, it is common among Higher Education students to work to manage their financial obligations (Yorke and Thomas, 2003). Financial concerns of mature students, for example, mostly include household income, employment and family (McDonald, 2003). Mature students also need to make various adjustments to fit learning in to their schedule, and due to dependents or relationships may not be able to find time (Gorard and Rees, 2002).

Situational barriers also concern the physical and health condition of the individual e.g. physical disabilities, mobility issues, health related issues, learning disabilities, aging etc. (Dench and Regan, 2000). Disabled people encounter many challenges in their everyday life depending to the type of their disability; including mobility and accessibility difficulties, cognitive impairments, social issues, communication, sensory or other problems (Greenwood, 1987; Morgan and S. Balandin, 1997; Jackson, 2006). Krueger & Stineman (2011) suggest that around one billion people worldwide have some type of disability. According to the United Nations Convention: "*persons with disabilities include those who have long-term physical, mental, intellectual, or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others*" (Leonardi et al., 2006 :1220). For instance, self care, transportation, access to education, house caring etc. may pose significant challenges for disabled people, however, these are taken for granted by some people without disabilities (Greenwood, 1987; Stendal, 2014). The attributes of the individual can pose difficulties that not only hinder attendance and participation to education but may also lead to community exclusion and isolation (Greenwood, 1987; Jackson, 2006).

2.2.1.2. Institutional barriers

At the time the Cross framework was developed (1981), educational institutions were providing fewer options compared to what is offered today (Shepherd and Nelson, 2012). In recent years, universities provide distance learning courses, online learning support tools, blended programs etc. which are much more accessible and flexible compared to the educational opportunities available during the 1980s. However, many barriers are still relevant. For example, the financial aspect of education, such as the increased tuition fees and additional charges for learning resources, is still a major issue. In many occasions, there is a lack of government and public funding to support students and in cases where opportunities are available, applying for them requires complex policies, i.e. who is entitled and what application procedures to follow (Potter and

Ferguson, 2003). Also, complex registration and admission requirements, lack of learning opportunities information and inadequate educational advice also exist (McGivney, 1999; Potter and Ferguson, 2003; Gorard et al., 2006). As a result, students may drop out or miss opportunities to enrol on courses of interest (Gorard et al., 2006). There is also the issue of educational institutions failing to offer courses of interest to students (OECD, 2003). The lack of curriculum availability and flexible learning opportunities affects students because learning is mainly designed for regular participation, and is difficult for people who need to make adjustments to fit education in their schedule (Cumming, 1992; Gorard et al., 2006). University attendance policies for example, require students to attend almost every class (Wyatt, 2007). Potter and Fergusson (2003) elucidates that flexible learning opportunities does not mean lowering the educational standards, but understanding the needs of students who live differently from traditional learners. To support students, universities offer part time learning opportunities as opposed to full time participation, and distance learning courses. There is also the issue of recognising previous education, foreign degrees and credits completed on different institutions (McGivney, 1999; Potter and Ferguson, 2003). In addition, lack of services including administrative services, resources, electronic infrastructure and technical services also exist (McGivney, 1999; Furst-Bowe, 2002). Some examples of institutional barriers include: students who do not want to attend full time, degree completion time, inflexible educational schedule, lack of information about offered classes, lack of curriculum, strict attendance requirement, difficult enrolling processes, and failure to meet admission criteria (Carp et al., 1973; Cross, 1981; MacKeracher et al., 2006).

Older students, students with health problems or mobility disabilities experience group specific institutional barriers, impeding their access and participation to education (Dench and Regan, 2000; Borell and Hemmingson, 2002; Welsh et al., 2006; Coster et al., 2013). Concerns have been expressed about the environment's ability to address their needs (Rimmer et al., 2000; Meyers et al., 2002; Welsh et al., 2006), to the extreme of reporting it as *"inherently inaccessible"* (Rimmer et al., 2004: 421). Problems in access and mobility in institutions have been identified relating to physical barriers (Meyers et al., 2002). Many of them arise from the architectural designs in which mobility around facilities is not available or not implemented properly, especially for people requiring special adjustments (Egilson and Traustadottir, 2009). Also, lack of specific services tailored to the students needs, inflexible transport, access and lack of facilities are also identified (Cumming, 1992; Brewin et al., 2008; Egilson and

Traustadottir, 2009). Borell and Hemmingson (2002) suggests that the way learning is designed poses problems to the experience of some students, who reported lack of environmental adjustments in many aspects of their daily educational activities. A similar study revealed several physical barriers i.e. lack of elevators, inaccessible classrooms and labs, long distances to cover, parking, travelling through facilities and other related concerns (West et al., 1993). The Equality Act 2010 indicates that education providers need to make reasonable arrangements to support students experiencing difficulties attending and participating in education. To contribute to this problem, the Disability Rights UK (2015) organisation categorises student disabilities as shown on Table 2.2, and suggests a series of adjustments specific to the type of the disability that can be implemented.

Impairment specific proposed adjustments	Autism or Asperger syndrome
	Blind or visual impairments
	Deaf or hearing impairments
	Learning difficulties
	Medical conditions
	Mental health condition
	Physical impairments
	Specific learning difficulties
	Speech, language and communication impairments

Table 2.2 – Types of disabilities (Disability Rights UK, 2015)

Social issues within the institutions with direct impact on students' participation in education also exist (Pivik et al., 2002; Connor and Ferri, 2007; Coster et al., 2013; Cramm et al., 2013). These barriers concern discrimination and inappropriate attitudes (Connor and Ferri, 2007; Morina Diez, 2010), mostly due to lack of awareness and understanding of disability (Holt, 2003; Wilson, 2004), racial segregation (Thomas, 2005), gender stereotypes (Hyams, 2000), sexual preferences (Morris-Roberts, 2004) and others.

2.2.1.3. Dispositional Barriers

The last set of Cross categories are dispositional barriers, which refer to attitudes, social and psychological issues towards education, and the student's perception of their ability to attend and successfully complete learning activities (Cross, 1981). Dispositional barriers are hard to document and explain, but their significance is great and are considered the most difficult to overcome (MacKeracher et al., 2006; Desjardins and Rubenson, 2013), where *"the greatest barriers to participation in education maybe located deep within the self."* (Owens, 2000: 23). Common dispositional barriers are lack of interest, motivation and lack of personal goals (Dench and Regan, 2000; Long et al., 2002). In addition, previous experience where the teacher introduced the feeling of inadequacy to the student, embarrassment, shyness or shame when returning to education as an adult are also examples of dispositional barriers (Corridan, 2002; BTEI, 2013). In addition student's low self esteem or low self-confidence can cause nervousness or fear of failure, individuals might feel too old and busy to begin, lack of skills or the feeling of not being smart enough, not enough energy or stamina, not enjoying studying, tired of school, do not know what to learn, and hesitate to seem too ambitious are also examples of dispositional barriers (Cumming, 1992; Millar and Falk, 2000; McDonald, 2003). In addition, there are occasions due to negative perceptions where investing in education is seen as a burden (Selwyn and Gorard, 2005). Dispositional barriers can also apply to learning activities in terms of negative perceptions of usefulness, appropriateness, pleasurability and engagement (McDonald, 2003).

2.2.2. Review of Barriers

The nature and significance of barriers to access and participation in education have been investigated in this Section. It has been identified that this is a very important and complex field that should be taken under deep consideration by all stakeholders to ensure equal educational opportunities for all students. However, literature suggests that barriers still exist and deter, challenge, restrict or exclude students from accessing and participating in education. To support students, universities provide online courses and learning support tools, as a way to address institutional barriers. However, the institutions cannot address situational barriers due to being specific and unique to the individual. Thus, students need services to ease and smoothen their academic adjustment and experiences, and allow them to concentrate in their roles (Hardin, 2008).

For this reason, this was investigated among other concepts in this research project, to ascertain how the use of virtual worlds in particular can support students experiencing situational and institutional barriers hindering access to Higher Education. Dispositional barriers are out of the scope of this research project because the aim is to investigate barriers that can be addressed with the use of technology, and not to explore the psychological and motivational state of students.

2.3. Learning Technology

Technology and online courses have been adopted in education as an aid to construct, deliver and exchange knowledge in various forms. Technology in education does not only mean the use of computers, but it covers a broad range of technologies for storing, constructing, retrieving and sharing information electronically to support teaching and learning objectives (Karthikeyan, 2013). Therefore, it is necessary to investigate how technology is exploited to address situations where face-to-face interaction between students and teachers is challenged due to situational and institutional barriers hindering access and participation to education.

Technology in education provides opportunities to reduce some barriers that prevent people from attending university, such as the issues of time and place, due to flexibility and availability of online resources (Pearson and Koppi, 2002; Stendal et al., 2011; Stendal, 2012; Chao et al., 2014). Technology can contribute to offering equal educational opportunities by facilitating participation and establishing communication, interaction and collaboration in learning (Anderberg and Jönsson, 2005; Stendal, 2012). It is also identified that with the use of technology, students engage and participate more in the learning process (Lewis et al., 2005; Perera, 2013). Technology is seen as an aid to partially support the needs of students, and as such is widely implemented in education (Cope and Peter, 2002). This integration offers possibilities to develop approaches that support learning for all, and is a valuable asset that can help students achieve their full learning potentials (Gjedde, 2006; NSBA, 2012). It may also help to manage some barriers impeding access to learning and therefore, promote inclusion of all students in education (Benigno et al., 2007).

The use of technology to support teaching and learning enriches pedagogy by enabling access to content, knowledge sharing, information storage and retrieval, collaboration and communication (Osguthorpe and Graham, 2003). Thus, technology develops effective pedagogical practices and enables students to achieve learning (Mladenova and Kirkova, 2014). The integration of technology in education is called E-

Learning, which comprises a collection of tools for materials review and delivery in various multimedia forms (Garrison, 2011; Beetham and Sharpe, 2013). In its broadest form, E-Learning is a way of teaching and learning using all electronic media, aiming to provide flexibility and improve students learning experience and effectiveness (Singh, 2010; Lau et al., 2013). This research project investigates a particular E-Learning tool in the form of online learning through cyber campus environments, to understand the extent to which it can support students experiencing barriers hindering access to education. The next Section discusses the concept of online learning to understand how technology has been introduced in education to support learning.

2.3.1. Online Learning

In recent years, there has been an increasing trend of E-Learning technologies adoption in education to support online learning (Hung, 2012; Nath, 2012). Online learning technologies allow users to remotely access and share information, and deliver content in high quality (Ruiz et al., 2006; Garrison, 2011; Perera, 2013). These technologies support learning and eliminate geographical barriers by incorporating synchronous and asynchronous communication methods that support and enhance collaboration of learners over the Internet (Guri-Rosenblit, 2001; Wu et al., 2010; Foss et al., 2013; Perera, 2013). These technologies also enable students to access learning at anytime, from anywhere (Lau et al., 2013). In modern days, students expect and demand the use of technology, and literature suggests that adoption of E-Learning enhances learning and improves performance compared to students who do not use such technologies (Ngai et al., 2007).

Some of the commonly used E-Learning tools to facilitate online learning are: forums, emails, online text chat rooms (Dalsgaard, 2006), Voice Over IP (VOIP), screen and media capture, mobile learning, game based applications, Web 2.0 tools such as web blogs, wikis and social networking sites, online learning management systems (Foss et al., 2013), virtual reality and virtual worlds (Sampaio et al., 2010; Allison et al., 2012). In online learning environments, learners can asynchronously or synchronously access materials at anytime due to time and location independence (Ruiz et al., 2006; Nath, 2012). The ability of synchronous and asynchronous interaction, enables communication, collaboration and receiving support, which benefits and improves the quality of learning (Foss et al., 2013). It also benefits the instructors who can tutor, update materials and communicate with students from anywhere (Ally, 2004). These technologies are also flexible and cost effective; lowering learning delivery costs, enables materials production, reusability and ease of updating, enabling cost effective pedagogies (Welsh et al., 2003; Weller, 2004; Perera, 2013). With the use of these technologies, learning is rich and socially constructed, allowing students to interact, communicate and collaborate in the form of online communities (Angulo et al., 2009; Wang et al., 2012; Foss et al., 2013). Considering that students learn in socially constructed ways, one of the tools that have been introduced to support and enhance online learning is the use of virtual worlds in the form of cyber campuses. The next Section discusses the use of virtual worlds in education, to understand how these tools can be used to support online learning.

2.4. Virtual Worlds

> *"Virtual worlds are places where the imaginary meets the real"* (Bartle, 2004: 1).

Virtual worlds are multi-dimensional graphical environments that operate inside networked computerised systems and are designed to accommodate people, simulating places that are shared for multi-user interaction (Castronova, 2001; Bartle, 2004). These are persistent environments that exist even when no one is interacting with them, and are experienced by people represented by avatars, that are co-existing and interacting with each other in the same shared space (Bartle, 2004; Koster, 2004; Schroeder, 2008). Virtual worlds are commonly found as Massively Multiplayer Online Role-Playing Games (MMORPG), Multi User Dungeons (MUD), Multi User Dungeons Object Oriented (MOO), Multi User Virtual Environments (MUVE) and other forms; sharing attributes such as environment persistence, shared spaces, use of avatars, interaction among users, objects and the environment, and similarities to topographies and physics (Smart et al., 2007). Bell (2008: 1) combines these shared elements and defines virtual worlds as "*a synchronous, persistent network of people, represented as avatars, facilitated by networked computers"*. Avatars are defined as the "*online manifestations of self in a virtual world, and are designed to enhance interaction in a virtual space"* (Peterson, 2005: 30). The avatar is the link between the user and the community, is a mean of social interaction, it adds a sense of presence of the user in the environment, and is the user's viewpoint of the virtual world (Nowak, 2004; Dickey, 2005; Peterson, 2006).

The history of virtual worlds dates back to 1979 where the first virtual world was developed, known as MUD (Bartle, 2004). MUDs were text-based environments where all interaction occurred through a series of predefined text commands. By using TelNet services; users could network and participate in fantasy multiplayer tasks or quests such as killing a dragon, conquering a castle, saving the princess etc. (Sanchez et al., 2009). The development of TinyMUD environments was then introduced. These were social rather than gaming environments and were used as socialising spaces, allowing the creation of rooms and objects. This capability changed the relationship between users and the environment, where they were engaging in designing objects and socialising instead of playing a game (Bartle, 2004; Sanchez et al., 2009). Following the introduction of communication and object design capabilities, MOO environments started to appear providing content exchanging and interaction with objects created in the virtual world (Bartle, 2004). The advancement of virtual words continued with the introduction of MMORPGs. These are persistent 3D gaming virtual environments that enable users to connect and interact towards accomplishing shared goals. Due to the gaming nature, users form teams, collaborate and communicate during tasks to succeed. The need to collaborate to complete tasks established MMORPGs as strong social environments, where the interaction is continued asynchronously in forums. In conjunction with the technological advancement of greater Internet speeds and computer hardware, the progress of these environments influenced the development of non-gaming socialising platforms known as MUVEs (Bartle, 2004; Sanchez et al., 2009).

2.4.1. Multi User Virtual Environments

MUVEs are 3D virtual environments that allow multiple users to co-exist in shared navigational spaces and interact between them and the environment (Papachristos et al., 2013). MUVEs concentrate on the social aspect of the virtual space and users participate as ‘*residents*’ rather than role-playing gaming characters (Sanchez et al., 2009). Unlike MMORPGs, MUVEs are not games and do not have predefined rules and goals, but are open and without restrictions, and focus more on the interaction and creativity of users (Cheal et al., 2012). These environments are flexible and can simulate replication of realistic or imaginary circumstances with great details, for example, realistic representations of real life monuments (Kennedy et al., 2013), or imaginary places that significantly deviate from reality (Prasolova-Førland et al., 2006). De Freitas (2008), Messinger et al. (2009) and Dawley and Dede (2014) provide comprehensive lists of the various MUVEs available, both commercial and open source. The most commonly used commercial MUVEs are Second Life[1], Active Worlds[2] and Atlantis Remixed Project[3], which are owned, operated and maintained by commercial companies. On the contrary, open source MUVEs are available for anyone to deploy and use without any restrictions such as Opensim[4] and Open Wonderland[5]. Opensim, for example, is developed using a Second Life compatible protocol, therefore it offers almost the same functionality (Ullrich et al., 2008). The features and architecture of the different MUVEs are similar and include the ability to create and edit avatars, build, edit and manipulate content, communicate, interact and create groups. The virtual environment operates in the commercial or private servers and is accessible through the use of specific software (viewers) that render the environment in the user's computer screen.

Through the use of their avatars, residents can create, edit and manage content ranging from simple to complex designs, contributing to the development of real and/or imaginary topographies. An avatar performs various actions such as walk, run, fly, wave, jump etc. and is controlled by the user's keyboard and mouse, enabling the user to *'act'* in the virtual world (Bailey and Moar, 2001; Hew and Cheung, 2010). Schultze and Leahy (2009) summarise the typical features of avatars: customisable body shapes, public profiles, collections of objects in possession (inventory), animations and gestures to interact with other users and objects, communicate through voice, public and private chat. These functionalities allow residents to create a social life, participate and immerse in the virtual environment.

2.4.2. Educational Multi User Virtual Environments

In the process of enhancing interactivity, dynamism and socialisation of online learning tools, virtual worlds have been used during the years using the technology available at the time (Epper and Garn, 2004). For example, MUD and MOO environments have been initially developed, providing material exchanging and chatroom communication. These environments were capable of accommodating users on the same space simultaneously, contributing to the establishment of virtual communities (De Freitas, 2008). Based on the fundamentals of these environments, the use of MUVEs in education has started to rise using the technology available nowadays. These environments are not better or worse than other online environments, but are different, having a number of unique characteristics (János and ZSolt, 2013). Compared

[1] http://www.secondlife.com
[2] http://www.activeworlds.com
[3] http://www.atlantisremixed.org
[4] http://www.opensimulator.org
[5] http://www.openwonderland.org

to the early virtual environments, MUVEs offer improved graphics and functionalities, interaction, coexistence and socialisation among users, allowing them to synchronously interact and communicate with each other and the environment.

There is a large amount of information in the literature of virtual worlds in education. Dieterle and Clarke (2005) provides a comprehensive review of the application of early MUVEs for educational purposes. Mikropoulos and Natsis (2011) also provide a review of the MUVEs in education research state for the period 1999 - 2009. In addition, Wang and Burton (2012) provides a review of publications of the use of Second Life from its launch since 2011. The findings of these reviews suggest that MUVEs are effective tools to support learning, and have an important role in the future of online education (Perera, 2013). The use of MUVEs for teaching and learning provides opportunities to connect students and teachers and synchronously bring them together, allowing them to participate in knowledge construction and sharing (De Freitas et al., 2010; Kallonis and Sampson, 2010; Chau et al., 2013a). The establishment of communities in which people interact through computers has become common in today's society. Community in education plays an important role in learning, facilitating socialisation, information acquisition and knowledge sharing (Foss et al., 2013; Kreijns et al., 2013). Now that technology in the form of social networks and communities is widely used and accepted in everyday life for communication, friendships and interaction, virtual inclusion is not *"a poor relation to physical inclusion anymore"* (Sheehy, 2010: 4). However, the common MUVEs are not on their own sufficient enough to effectively support education by default, and require further adjustments to turn them into '*cyber campuses*' (Kallonis and Sampson, 2010; Petrakou, 2010; Perera et al., 2011b).

2.4.3. Cyber Campuses

> *"Picture a future in which students never meet a lecturer face to face in a class room, never physically visit the on-campus library; in fact, never set foot on the campus or into an institutional lecture-room or learning centre. Such is the future proposed by the virtual university scenario"* (Cunningham et al., 1998: 179)

Virtual worlds in education are not a new concept and their educational capabilities are under investigation. Virtual worlds for educational purposes are often called as '*cyber campuses*', referring to *"virtual worlds representing real educational institutions such as universities and schools"* (Prasolova-Førland et al., 2006 :1).

Cyber campuses aim to facilitate online learning through virtual environments that often replicate real life learning activities and settings, or experiences that significantly deviate from reality but contribute to effective teaching and learning (Prasolova-Førland et al., 2006; Jennings and Collins, 2007; Wang and Burton, 2012). The educational capabilities of cyber campuses to support and enhance online learning are identified and are well documented in the literature (Dickey, 2005; Boulos et al., 2007; Tashiro and Dunlap, 2007; Ritzema and Harris, 2008; Lorenzo et al., 2012; Chau et al., 2013b). Some of the most important attributes relate to increased social awareness and improvement of knowledge transfer and understanding, as a result of the verbal and non-verbal communication facilitated within the virtual worlds (De Lucia et al., 2009; Dalgarno and Lee, 2010). These attributes enhance social interactions and allow students who have difficulties establishing face-to-face communication to be connected (Woolgar, 2002; Van Den Brekel, 2007). The ability to support socialisation is also acknowledged in the literature (Prasolova-Førland and Divitini, 2003; Minocha and Tingle, 2008; Goel et al., 2013) together with its importance in the virtual worlds (Schroeder, 2002; Jäkälä and Pekkola, 2007; Chesney et al., 2009; Goel and Prokopec, 2009), resulting in the influence of the development of social spaces that positively impact learning outcomes (De Lucia et al., 2009). In addition, awareness of the existence of other users and objects in the virtual world, positively affects the dynamics of group communication, increasing motivation and productivity (Bouras and Tsiatsos, 2006). This also allows achieving the feeling of presence and co-existence in the virtual world (Witmer and Singer, 1998; De Lucia et al., 2009; Dalgarno and Lee, 2010).

Through the use of the avatars, students enjoy greater interactivity and richer visual experiences, which have a great impact on their activity in the virtual world (Carr et al., 2008; Dalgarno and Lee, 2010). This enhances learning effectiveness and has a positive impact in learning activities (Gütl et al., 2009; Kostarikas and Varlamis, 2011; McCaffery et al., 2011; Michel et al., 2011; Bredl et al., 2012). The avatar attracts and engages students attention, allowing them to participate in group activities and learn by testing hypotheses and observing the results of their actions (Hew and Cheung, 2010; Kostarikas and Varlamis, 2011; McCaffery et al., 2011; Dawley and Dede, 2014). It also adds a real life component to interactions, improving online learning (Tiffany and Hoglund, 2014). The avatar promotes the sense of social presence for the student in the environment because of the ability to provide non-verbal cues such as gestures and expressions (Peterson, 2008; Tseng et al., 2013). Avatar customisation and multimodal communication techniques are also attributes that influence social presence and awareness in the virtual world, as these can situate communications and construct a sense of co-presence (Biocca et al., 2003; Bailenson et al., 2008; De Lucia et al., 2009; Tseng et al., 2013). Through these affordances, the virtual world becomes more tangible, providing the feeling of presence in the virtual world (Taylor, 2002; Schultze and Rennecker, 2007). However, virtual worlds should not be considered as a replacement for real life experiences, but as support tools for particular social activities (Woolgar, 2002). For example, in occasions where real life interaction cannot take place, the use of avatars in the virtual world can provide more personal and unique experiences compared to 2D systems (János and ZSolt, 2013), and these are conditions that engage students in social interaction (Peterson, 2005; Hew and Cheung, 2010; Peterson, 2012; Tseng et al., 2013). The innovating and enjoyable experiences provided through virtual worlds encourage students to pursue education and improve their collaborative, socialisation and team working skills, which are very important for their development (English and Yazdan, 1999; Dalgarno, 2002). These environments enhance realism by providing better representation of the real world compared to traditional text chat systems, and this engages students in learning (Tashiro and Dunlap, 2007; Dalgarno and Lee, 2010; Chau et al., 2013b).

Enhanced multimedia tools such as 3D graphics, animations, video, audio etc. support learning in cyber campuses, which are visually richer than the standardised email, chat and forum based communication methods (Gorini et al., 2008; Duncan et al., 2012). These functionalities take place in an environment that allow students to re-try activities, experiment, learn by doing and observing others (Cross et al., 2007). In addition, a virtual world offers unlimited design possibilities as financial, material constraints and laws of physics are almost non existent (Wang and Burton, 2012). This allows the design of engaging, constructive and fun activities that encourage and promote involvement in learning (Antonacci and Modaress, 2008).

A summary of the characteristic that make cyber campuses a strong learning tool has been reported by Jarmon et al. (2009) and include the ability of the environment to host virtual interaction and collaboration, allowing users to test hypotheses without risks and costs, allowing experimentation, stimulating imagination and creativity, and offering immersive experiences. These attributes establish cyber campuses as a strong collaborative tool for learning support (Livingstone et al., 2008; Dalgarno and Lee, 2010). These capabilities allow performing actions with immediate responses (De Lucia et al., 2009), and enable students to practice and improve their practical skills in activities that are difficult or even impossible to perform in real life (Antonacci and

Modaress, 2008). Last but not least, virtual worlds bring students and teachers together, facilitating collaboration which is essential in the learning progress (Kemp and Livingstone, 2006; Duncan et al., 2012). These attributes allow the use of learning patterns and situations from the real to the virtual world compared to conventional online learning environments (Boytchev et al., 2012), that fail to provide such experiences mainly due to lack of intuitiveness and limited features (Perera et al., 2011a; Perera, 2013).

Considering these attributes, cyber campuses are dynamic environments for learning, encouraging students to be creative, visualising their work, making them think out of the box and broadening their knowledge (Sanchez, 2007). In 2007, there was a strong belief that the use of cyber campus environments would have been the next big thing in online learning. However, these high expectations have never been met to the extent that many virtual worlds enthusiasts were hoping of (Gregory et al., 2014), and this is similar to the hype of web-based education in general (Allison et al., 2012). Nevertheless, virtual worlds are being successfully used in education, and some examples of effective use of such environments are presented in the following Section.

2.4.4. Examples of Cyber Campus Environments

Many educational institutions are using cyber campus environments for their needs. There are more than 500 cyber campuses in Second Life alone, used for a wide variety of purposes (Fominykh, 2012; Gregory et al., 2014). To find more information, an in depth investigation has been performed using mainly Internet research, investigation of project websites, research blogs, and visiting educational islands on virtual worlds. From this investigation, a number of institutions that have been involved with virtual worlds were identified. One particular source that was extremely useful was John Kirriemuir's '*Virtual World Watch Internet*' blog[6]. Kirriemuir conducted a series of '*snapshots*' reports of how and why researchers were using virtual worlds in UK Higher Education institutions from 2007 to 2010 (Kirriemuir, 2007a, b, 2008b, a, 2009a, b, c, 2010a, b). The evidence produced during Kirriemuir's investigation suggested that the trend of using virtual worlds was increasing at the time and virtual worlds were being adopted by the vast majority of the UK educational institutions (Kirriemuir, 2009c; Dalgarno et al., 2011). For example, the University of London was teaching using MUVEs and MMORPGs, investigating how members of online communities were encountering with the environment, participating and managing complexity (Carr et al.,

[6] http://www.virtualworldwatch.net/

2008). The University of Leicester used Second Life for teaching purposes, investigating the use of virtual worlds for genetics education by performing experimental scenarios in which a training area for students to collaborate and develop tasks was designed (Kirriemuir, 2011c). '*SEAL*' (Second Environment Advanced Learning) is another project of Leicester University aiming to enable '*advanced approaches to learning*' and help educators and learners to choose approaches that will meet their needs and demands (White, 2011). The University of the West of England recently launched a Masters in Education programme in virtual worlds, running entirely in Second Life, allowing students to explore curriculum design in virtual worlds, scripting, educational simulations and more (UWE, 2013). The University of Edinburgh used Opensim to hold a course based on trajectory and implications of digital technologies in virtual worlds, delivered entirely through the virtual world (DFL, 2010). The virtual world is also used to bring together people with shared interests and create alumni network to increase engagement of their community and promote the institution (VUE, 2007; VCE, 2011). Sheffield University is also involved with the '*Infolit iSchool*' project, teaching how to create presentations and interviews through virtual worlds. The project was planning to introduce optional sessions for masters students, organising events for librarians and teachers and hold mini conferences (Kirriemuir, 2011b).

The research group within the computer science department of the University of St Andrews utilise virtual worlds in the creation of historic scenes within 3D environments and conducts scientific research in the field (Kennedy et al., 2013; OVW, 2014). The university's students and researchers have also used virtual worlds for teaching purposes including human computer interaction, humanitarian disaster management, cultural heritage, archaeology, wifi experimentation, electro magnetic theory, programming algorithms, and other use (Oliver et al., 2013).

Other examples include Manchester University (AVALON, 2008), Lancaster University (Kirriemuir, 2011a), Worcester University (Kirriemuir, 2010b), Portsmouth University (Kirriemuir, 2010c), Kingston University (KingstonUniversity, 2008), Cornwall's College (Kirriemuir, 2010b), Newman University College (Kirriemuir, 2010c), the University of Leeds (Kirriemuir, 2010c) and the University of Bedfordshire (Kirriemuir, 2010b).

During this investigation, it has been determined that educational virtual worlds are used for a wide variety of purposes including: research, teaching, tutorial support, online learning support, virtual meetings, conferences, exhibitions and marketing. Some of these cyber campuses were available for public access and have been observed extensively. This allowed investigation of the design, layout and arrangement of the environments and activities. However, it has been identified that despite the fact that many educational institutions have presence in virtual worlds, they do not specifically aim to support students who cannot access education due to barriers, rather than concentrating on running courses or learning activities in a distance learning mode.

2.4.4.1. OTIS Project

To better understand the structure and arrangement of educational virtual environments, a review of online learning environments other than 3D virtual worlds has also been performed. The concept of a virtual school as demonstrated by the Occupational Therapy Internet School (OTIS) was identified and investigated as an example of an effective online learning environment. OTIS was an innovative and sophisticated system for its time (1999), capable of managing resources, handling communications and supporting learning activities through a virtual environment over the Internet (Armitt et al., 2001). The system was based on the text-based multiplayer '*dungeons and dragons*' game environment, having a consistent virtual world that was mainly designed by users (Isbell et al., 2000). OTIS allowed users to navigate and coexist in virtual rooms and establish communication through chat and email. To support the system operations, OTIS used CoMentor (Armitt et al., 2001), a shared learning environment responsible for communication, resource management and sharing (Skinner, 1997). The system allowed students to connect and group to discuss items of common interest, and records of these discussions were kept for students to revisit them whenever necessary. The system consisted of a series of rooms such as library, lecture and meeting rooms, exhibition areas, entrance hall, courtyard, each with different functionalities and/or set of course materials (Armitt et al., 2002).

Investigating OTIS demonstrated how technology was employed to support online learners through the virtual school concept. OTIS effectively supported learning through technologies that are still used in today's online learning environments such as synchronous and asynchronous interactions, content delivery and reviewing. Whilst crude by modern standards, this interface allowed synchronous learning to happen effectively for international groups of students who never met, within the constraints of the network capabilities of the time. Nevertheless, OTIS learning material management, delivery and reviewing methods are similar to modern online learning management environments. OTIS communication through text chat is similar to modern MUVEs, however OTIS did not support voice communication. Also, the navigation in OTIS included only '*click to visit*' mechanism for navigating between rooms. In addition, users were not embodied and their existence was not visible in the form of an avatar, but on a specific frameset showing a list of the people who were currently in the room. This differs from the modern MUVEs ability to represent users in the environment, allow '*human like*' navigation and interaction and provide a map with the location of others. OTIS did allow users to create private meeting rooms, which could also record discussion for later reviewing. This is something that cannot be easily replicated in modern MUVEs, at least not without extensive programming skills to develop such functionality. OTIS was a very capable platform but is clearly now out-dated. However, its functionality provides examples of how to effectively support online learning through the virtual school concept.

2.4.5. Review of Virtual Worlds in Education

Virtual worlds are synchronous persistent computer simulated environments that allow users to coexist in the same shared space and interact between them and the environment. There are a number of virtual worlds, which their development date back to the late 1970s, and their technological advancement to date is truly astonishing. The latest and most sophisticated virtual worlds are mainly used for gaming and social purposes; however, the use of MUVEs has been recently introduced in the form of cyber campuses to support education.

Cyber campuses are specially designed meeting points that operate on MUVEs and allow students to synchronously participate in learning activities together with their colleagues and teachers. Cyber campuses allow students to communicate, collaborate and socialise in the virtual world, provide enhanced multimedia learning tools and functionalities, improving their online learning experiences. These attributes provide enjoyable, constructive and engaging learning experiences that make cyber campuses appropriate online learning tools. Many educational institutions have implemented their own cyber campuses and use them for a wide variety of purposes mostly including: research, teaching, tutorial support, online learning support, virtual meetings, conferences, blended learning, exhibitions and marketing. However, they do not specifically aim to support learning for students experiencing barriers hindering accessing education.

2.4.6. The Characteristics of Effective Cyber Campus Environments

In the process of this investigation, it has been identified that the cyber campuses are effective educational tools, having attributes that can support online learning activities and enhance the students learning experience. According to De Lucia, Francese, Passero and Tortora (2009: 222), in a MUVE, learning is strongly related to students' perceptions of presence, awareness, communication and the feeling of belonging to a community (sociability). De Lucia and his colleagues (2009) suggests that these characteristics contribute to the development of learning-efficient virtual worlds. These characteristics may contribute to increasing the social dimension of E-Learning activities (Murad, 2013), therefore it is important to investigate the literature behind them to better understand their significance and impact in the environment and the students learning experience.

2.4.6.1. Presence

One of the most important attributes of 3D virtual environments is the strong sensation of presence they provide to users, which is a key feature that separates and distinguishes virtual environments from other online learning environments (McLellan, 1996; Witmer and Singer, 1998; Mikropoulos, 2006). In the literature on virtual environments, presence is considered as the psychological perception of being in the virtual world (Sheridan, 1992; Witmer and Singer, 1998), in which the individual immerses *"in a very high bandwidth stream of sensory input, organised by our perceiving systems, and out of this `bath' of sensation emerges our sense of being in and of the world"* (Whitelock et al., 2000: 2). It is considered as the extent to which the individual feels present in the virtual environment rather than the physical (Steuer, 1992), providing the "*illusion of 'being there', whether or not 'there' exists in physical space or not"* (Biocca, 1997: 18). It is also described as the *"the perceptual illusion of non-mediation"*, where an individual fails to acknowledge that a mediated experience is mediated (Lombard and Ditton, 1997: 32).

Over the years, there have been many attempts to understand and define the concept of presence in virtual environments. Presence has been defined in terms of personal presence (Slater, 1999, 2004), tele-presense (Sheridan, 1992; Steuer, 1992), spatial presence (Biocca et al., 2003), social presence (Short et al., 1976), environmental presence (Heeter, 1992), co-presence (Bulu, 2012) and transportation (Lombard and

Ditton, 1997; Nowak, 2001; Lombard et al., 2009). One of the most widely cited and discussed approaches comes from Witmer and Singer (1998: 225), who define presence as *"the subjective experience of being in an environment when physically situated in another"*. This concerns the experience of the individual's attention shifting from physical to the virtual environment, without requiring the absolute attention displacement from the physical setting, but a concurrent experience of events in both environments. Consequently, the individual immerses and is involved in the activity. Witmer and Singer (1998) propose that the stronger the feeling of immersion and involvement, the greater the sense of presence. Immersion relates to the physical aspect of the environment and the psychological sense of being in the environment, providing the feeling and sense that the user has left the real setting and is present in a virtual environment (Hedberg and Alexander, 1994; Sadowski and Stanney, 2002). However, immersion is often confused with presence (Bouvier, 2008). McCreery (2013) illustrates immersion with the example of reading a book and engaging in the story to the extent of loosing focus on the real world. Immersion is achieved through the stimulation of the user's senses to generate the illusion of the perception of the environment (Bouvier, 2008). Immersion is necessary to experience presence and involvement of users in meaningful activities within the virtual world. Involvement is described as the psychological state experienced during the user focus on activities and events that occur within the virtual environment. (Witmer and Singer, 1998).

The impact of presence in learning is examined by many researchers (Sheridan, 1992; Hedley et al., 2002; Woods et al., 2003; Scoresby and Shelton, 2011; McCreery et al., 2013), for example, in the context of online learning (Annand, 2011; Chen et al., 2011; Kim et al., 2011), course satisfaction in distance learning (Lyons et al., 2012) and how to mediate learning (Bulu, 2012). The overall results of these studies suggest positive relationship between presence and user experiences, positive learning results and perceived satisfaction, and enjoyable and rich educational experiences. Presence is positively associated with learning success, because it motivates and stimulates engagement in learning (Schrader and Bastiaens, 2012). Witmer and Singer (1998) identify links between presence and student learning, suggesting a relationship between learning outcomes and user degree of presence in the virtual environment. Presence enhances collaboration and socialisation (Livingstone et al., 2008), and is strongly related with learning, where *"increasing presence also increases learning and performance"* (De Lucia et al., 2009: 222). However, presence alone does not ensure better learning results (Schrader and Bastiaens, 2012).

2.4.6.2. Awareness

In the context of computer supported collaborative systems, awareness refers to the user becoming aware of a particular instance or occurrence that happens in the environment (Schmidt, 2002). It relates to the process of knowing who is around, what activities are taking place, and who is talking to whom that may lead to impromptu interactions, relationships and development of communities (Dourish and Bellotti, 1992; Shah, 2013); issues that should not be neglected in geographically dispersed groups (Bly et al., 1993). Thus, Schmidt (2002) conceives the term as being aware of the social context that triggers informal interactions and communication, and also develops shared cultures. In his key text, Schmidt (2002) summarises several awareness types that exist in the literature, and De Lucia et al. (2009) discusses the application and importance of some of them in the context of educational MUVEs. In particular, De Lucia et al. (2009) stress the importance of: social, peripheral, action and group awareness. Social awareness relates to the knowledge of '*who is there*' and '*what is going on*', allowing users to locate others and understand their actions just by looking at them. De Lucia et al. (2009) suggest that social awareness increases when the environment provides non-verbal communication capabilities to supplement verbal communication. This includes avatar gestures, expressions and postures, which are features that cannot be textually represented in non-graphical environments (Di Blas and Poggi, 2007). Especially the use of avatars, improves the user awareness of surroundings, existence and actions of others in the virtual world (Tromp et al., 2003; Schroeder et al., 2006; Koutsabasis et al., 2012).

Peripheral awareness is also important and De Lucia et al. (2009) stress the need of being aware of the location of others in a MUVE. Virtual worlds allow peripheral awareness of others existence and activity, allowing to *"see at a glance what is occurring"* (Benford et al., 1994: 3). In addition, the ability to understand the actions of others (action awareness) enable to know what is happening to objects of interest, the actions taking place in the environment, and by whom (De Lucia et al., 2009; Zarraonandia et al., 2011). The ability to design and manipulate objects for example, provides a sense of awareness of what actions are taking place (Koutsabasis et al., 2012). Furthermore, group awareness relates to the ability to know updates of collaborators actions, in order for other users to perform their part of work (Gutwin and Greenberg, 1995; Romero et al., 2012). Thus, group awareness is an important factor that provides the ability of distinguishing various roles among the members within the environment (Greenberg et al., 1996; De Lucia et al., 2009).

2.4.6.3. Communication

Another important attribute of virtual worlds is that they provide, establish and handle synchronous communication among users (Dalgarno and Lee, 2010). This allows effective communication and collaboration to be facilitated within the virtual world (Konstantinidis et al., 2010b), creating *"more vivid, lively and interesting discussions through spontaneous communication"* (Johnson et al., 2011: 14). Especially in online education, communication allows collaboration and knowledge sharing. Virtual worlds support different communication modes involving the use of avatars to embody verbal and non-verbal communications (Schroeder, 2002; Dalgarno and Lee, 2010; Konstantinidis et al., 2010b; Detienne et al., 2012; Bosch-Sijtsema and Sivunen, 2013; Wigham and Chanier, 2013). Verbal communication is synchronously established using voice through *'proximity transmission'*, making the conversation audible within a range. The user can also hear others louder when reducing the distance between their avatars or by looking directly at them. Moreover, voice conversations among members of a group located on different spaces is available together with private voice communication (Wadley and Gibbs, 2010; Wigham and Chanier, 2013).

Synchronous text chat is also available through the public chat, group chat and instant messages (IM). The public text chat is used to send messages to avatars situated within proximity distance, while group text chat allows communication of spatially separated group members. In addition, IMs allow establishing private textual communication with other users. (Wadley and Gibbs, 2010). De Lucia et al. (2009), suggest that the exchange of verbal messages contains emotional context that needs to be understood and they emphasise the need to supplement verbal with corresponding non-verbal communication. The importance of non-verbal communication using gestures is identified and it plays an important role in communication (Hiltz, 1993; Antonijevic, 2008; Bente and Kramer, 2011). Gestures refer to any variety of movements that people perform while talking (Kendon, 1996). In the context of virtual worlds, *"gesture is a combination of an automatic association of sound and movement of one's avatar, triggered by a selection in a list of words, such as 'laughing' or 'yawning'"*(Detienne et al., 2012: 446). Gestures provide the ability to transfer information that is important to understand others, and also to express emotions (Roth, 2001; Merola and Poggi, 2004). It is a fact that face-to-face communication is different than communication established within computerised environments in terms of transferring information (Baltes et al., 2002). However, Allmendinger (2010: 43) suggests the assumption that "*computer-mediated nonverbal signals in instructional situations can also affect turn-taking* *management, feedback, cognitive support, and the communication of emotions"*. Non-verbal interaction is a fundamental component of human interaction allowing to convey emotions (Guye-Vuilleme et al., 1999), and modern computerised environments provide this (Montoya et al., 2011). In virtual worlds, Antonijevic (2008) divides non-verbal communication modes in user and computer generated gestures. User generated gestures relate to the various acts that the user deliberately performs e.g. reducing distance or position the avatar between others to join conversation, waving, dancing etc. Computer generated modes relate to predefined system actions, for example, when the user is typing through the public text chat, the system automatically generates a typing gesture, forcing the avatar to move as if is typing on a keyboard.

The ability of virtual worlds to facilitate synchronous communication through verbal and non-verbal interactions is an important attribute compared to traditional computer supported communication mediums. Especially the use of avatars as a mean of exchanging emotional states (gestures, expressions, postures) improves communication in the environment (De Lucia et al., 2009).

2.4.6.4. Sociability

Students tend not to learn individually but in collaboration, therefore the developers of online learning tools should devote attention to sociability and community development (Redfern and Naughton, 2002). Online communities are groups of people who interact through online environments, have shared purposes, are guided by norms and policies, communicate, share information, knowledge and advice (Preece, 2000; Lev-On, 2013). Members of online communities are interested in shared goals and activities, have similar interests and personal aspirations, are actively participating in the community and have strong bonds. They also have access to shared resources and support the exchange of knowledge and services, following a community established social convention and language (Preece, 2000; De Souza and Preece, 2004). Through online communities, people not only obtain information but also establish connections and relationships (Sproull and Faraj, 1997). Hiltz (1994: 22) suggests that social interaction is important to establish shared understanding and knowledge construction, because "*this is the natural way for people to learn"*. Wegerif (1998) implies that the first step to establish collaborative learning is to form a sense of community among students. Without the feeling of belonging to a community, students are more likely to feel alone, anxious, adopt defensive attitudes and not participate in learning. Thus, the establishment of online communities in educational context is a key ingredient in promoting collaborative learning, knowledge construction and sharing (Gunawardena, 1995). It can also help in the development of essential group dynamics that contribute to reducing the loneliness and isolation of students (Rovai, 2001).

To establish online communities, the medium needs to provide technology capable of supporting effective communication and information sharing (Redfern and Naughton, 2002; Kreijns et al., 2013). Kreijns et al. (2002: 13) argues that the social affordances of a computer supported collaborative learning (CSCL) system are the properties of the environment *"that act as socialcontextual facilitators relevant for the learner's social interactions"*. Kreijns et al. (2004) provide an example that likens the social affordances that occurs within CSCL environments with the coffee machine of an office, where employers gather around and converse informally. Hobaugh (1997) identifies that lack of effective dynamics between group members leads to ineffective results, and researchers tend to forget the importance of group interaction and dynamics within collaborative environments (Kreijns et al., 2007). The environment should support communication, collaboration and access to information, but also not to forget the importance of supporting the social aspects of learning. If the environment focus only on media richness and does not utilise elements of sociality, then it is simply a communication tool and not a social space (De Lucia et al., 2009), which is essential to improve learning (Berge and Collins, 1995; Harasim, 1996).

According to Biocca (2001), the awareness of the existence of others together with the sense of engaging with them is important to form a sense of social presence in the environment. Social presence is defined as the "*degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships"* (Short et al., 1976: 65). In the context of online learning environments, social presence relates to the degree to which a learner feels connected with colleagues and teachers as part of an online learning community (Sung and Mayer, 2012) and the factor of social presence affects the social interaction that occurs within the environment (Gunawardena, 1995; Tu, 2000). It is determined that if social presence is low, the concept of social learning and social interaction does not occur. Social presence is required to establish social interaction and this plays an important role in social learning (Tu, 2000). In addition, Kreijns et al. (2007) stress the concept of '*tele-proximity*' (Tang and Rua, 1994). This concerns proximity that is artificially designed with the use of technology to develop group awareness of instantly knowing what activities are being performed by whom, leading to spontaneous and informal interaction and communication. Sociability is an attribute of CSCL systems; it is the extent to which the system facilitates social interaction that contributes to the development of a sound social space, characterised by "*strong interpersonal relationships, trust and a sense of cohesion*" (Kreijns et al., 2013: 231).

2.4.7. Review of the Characteristics of Effective Cyber Campuses

During the literature review, the characteristics that contribute to the development of learning-efficient virtual worlds have been investigated. According to De Lucia and his colleagues (2009), in a MUVE, learning is strongly related to the users perceptions of presence, awareness, communication and sociability.

The feeling of presence relates to the user sense of *'being'* in the virtual environment when physically situated in another. It is the extent to which the individual feels present in the virtual environment rather the physical, failing to acknowledge that a mediated experience is mediated, and is one of the most important characteristics of virtual worlds. Presence is positively associated with learning success as it motivates and engages the student in enjoyable and immersive experiences. Presence also enhances collaboration and socialisation of users in the virtual environment, increasing their learning and performance.

Awareness is also another important characteristic of virtual worlds, and relates to the awareness of the existence and actions of other users in the environment. This characteristic allows users to understand what is going on in the virtual world and who is around them. It also allows being aware of the location of others; understand their actions and roles in the virtual environment.

Communication concerns the verbal and non-verbal communication established within the virtual environment. The ability of the virtual world to allow the establishment of synchronous communication between users through multimodal communication means is a very important characteristic that contributes to effective collaboration, knowledge sharing and socialisation in online learning activities.

Sociability refers to the ability of the environment to support effective socialisation and provide the feeling of belonging to the learning community to its users. This allows the development of learning communities with strong bonds and shared goals, promoting collaborative learning, knowledge construction and sharing. This also contributes to developing social spaces that reduce loneliness and promote effective group dynamics and group cohesion within the virtual environment.

2.5. The Design of Cyber Campuses

The design of cyber campuses is an important issue that is taken under deep consideration from scholars and stakeholders (Dede, 1996; Li and Maher, 2000; Bouras et al., 2006; Prasolova-Førland et al., 2006; Monahan et al., 2008; Molka-Danielsen et al., 2009; Minocha and Reeves, 2010; Fominykh, 2012). Selecting virtual worlds as the tool to support education provides the place to facilitate learning (Minocha and Reeves, 2010). However, these environments are not specially created for education, therefore the place needs to be designed (Riley and Kluge, 2008; Minocha and Reeves, 2010). Thus, additional design and arrangements need to take place to transform the virtual world into a cyber campus environment.

In the literature, there are few guidelines focusing on the design and arrangement of cyber campus environments (Redfern and Naughton, 2002; Prasolova-Førland et al., 2006; Prasolova-Førland, 2008; De Lucia et al., 2009; Minocha and Reeves, 2010; Fominykh et al., 2011; Fominykh, 2012). The predominant design approach is mostly user-centred and includes the process of trying, evaluating and redesigning the environment according to feedback (Minocha and Reeves, 2010). A common design approach is the use of real life places and events metaphors in the virtual world (Li and Maher, 2000; Prasolova-Førland et al., 2005; Gu et al., 2007). Therefore, most cyber campuses replicate existing educational spaces, facilities and activities, attempting to create familiar and recognisable learning atmospheres to students (Prasolova-Førland et al., 2006; Prasolova-Førland, 2008; Fominykh et al., 2011). In addition, environments that significantly deviate from reality but exploit the educational potentials of virtual worlds also exist (Büscher et al., 2001; Prasolova-Førland et al., 2006; Girvan and Savage, 2010; Konstantinidis et al., 2010b). However, because there are many design approaches, cyber campuses are designed in a non-systematic manner (Fominykh et al., 2012b). For example, Fominykh (2012) suggests that the appearance of a cyber campus should be authentic to create familiar educational atmospheres to students. Fominykh's (2012) guidelines suggest that the important facilities are realistically designed, and also when needed, buildings with limited reality resemblance can be designed to serve specific purposes. The virtual world is suggested to be alive and appealing and have places for socialisation. Correspondence between facilities and the informational resources available is also suggested. Furthermore, community resources and tools to support students, together with facilities that aid navigation in the environment are recommended. In the same line, Prasolova-Førland's (2008) suggestions concentrate on the outlook, structure and the roles of the places in a cyber campus. Prasolova-Førland (2008) suggests that the environment design and structure resembles a real university, conveys its atmosphere and ensures that the major units of the campus are recognisable. She also suggests that the cyber campus clearly represents the features of the university with corresponding facilities and that navigation in the environment is natural and intuitive.

Minocha and Reeves (2010) propose a list of design principles that focus on the interpretations of learning spaces in the virtual world, the relationship between pedagogy and design of the setting, the visual realism of the space and activities, and how to design learning spaces. Minocha and Reeves (2010) suggests that the design capabilities of virtual worlds can help in recreating historical simulations and visualisations, and that the realism of the environment should take account of the activity or the discipline. Minocha and Reeves (2010) explain that creating a learning space is one part of the process of creating a learning and teaching place in the virtual world; implying that the educators create the environment but the students create the place through their use.

To guide virtual world designers in arranging cyber campuses, De Lucia et al. (2009) recommends applying the guidelines of arranging collaborative environments proposed by Redfern and Naughton (2002). Redfern and Naughton (2002) suggests that to develop an effective collaborative environment, the structure should consider the pedagogical requirements of learning communities. To accommodate for this, they propose the design of three distinctive areas: a common campus to support informal interactions and information sharing within the community, collaborative zones in which students should collaborate and share resources, and lecture rooms to be used for formal learning purposes. De Lucia et al. (2009) further propose the design of recreational areas aiming to facilitate communication and socialisation among students to influence sociability and group cohesiveness in the environment.

Considering these guidelines, cyber campus environments can be designed and arranged to serve a range of educational purposes. However, apart from the few empirical studies discussed in this Section, little is known about the design and arrangement of cyber campus environments (Minocha and Reeves, 2010). In addition, these guidelines do not specifically address the characteristics that make cyber campuses effective learning support tools. In their key study, De Lucia et al. (2009) draw the need to cater for the characteristics that contribute to the effectiveness of cyber campuses as discussed in Section 2.4.6, but do not provide specific instructions or guidelines on how to do this. Moreover, no previous research has been identified focussing on how to design and arrange cyber campuses to support students experiencing barriers hindering accessing education.

2.6. Disadvantages of Virtual Worlds

It has been identified so far that adopting a virtual world for educational purposes can be a useful tool to support online learning. However, there are some disadvantages in the use of cyber campuses and virtual worlds in general that must be taken under deep consideration before adopting these tools for education.

When investigating the disadvantages of networked computerised systems, the first limitation that appears concerns the operational dependency in technology. Virtual worlds are based on 3D environments and the Internet, and therefore are computer and network dependent. Thus, technical issues are likely to arise that could interrupt or slow down the operations, with all the associated impact that this may have in user experience. High-end computer with modern hardware is required to support the resource hungry graphics of virtual worlds, together with a fast Internet connection to support interactions among users and the environment (Johnson, 2006; Kemp and Livingstone, 2006; Boulos et al., 2007; De Freitas, 2008; Baker et al., 2009; Papp, 2010; Dalgarno et al., 2011; Duncan et al., 2012). These requirements are essential otherwise users will experience '*lag*', a term used to describe when communication, interaction and movements in the virtual world are slowed down. Also, unstable versions of viewers can cause crashes, and firewalls and network problems can also affect environment accessibility (Warburton, 2009; Samur et al., 2010; Sobkowiak, 2012). These issues suggest that there may be inconsistency between experiences, because these problems may occur in combination, and affect each user differently (Warburton, 2009).

Another limitation relates to the learning curve required to familiarise with the system controls and the environment (Konstantinidis et al., 2010b; Petrakou, 2010; North-Samardzic et al., 2014). Several studies discuss the issue of steep learning curve reported in users initial interactions with virtual worlds (Baker et al., 2009; Wang and Braman, 2009; Dalgarno et al., 2011; Sobkowiak, 2012; Sutcliffe and Alrayes, 2012). Especially for people with limited computer skills, the learning curve can be significant because they need to learn the features and tools offered by the system in order to behave '*normally*' in the virtual world (Johnson, 2006; Baker et al., 2009; Papp, 2010).

Another very important challenge is negative attitudes towards adoption of virtual worlds for learning (Cheng, 2014). Some users prefer traditional learning, perceive it difficult to use, or simply they do not like using such tools for learning (Baker et al., 2009; Cheng, 2014). Furthermore, teachers expressed concerns based on workload increase, lack of teaching skills and lack of control over teaching and students in such environments (Baker et al., 2009; Gamage and Eranda, 2010). It is difficult if not impossible to determine if the student is working through the virtual world and this makes control of the classroom even harder (Duncan et al., 2012). In addition, a number of usability issues have been identified concerning the viewers (De Freitas et al., 2009; Wood, 2010). Wood et al. (Wood, 2010; Wood and Bloustien, 2012; Wood and Willems, 2012) studies identify usability and accessibility issues concerning the inability of viewers to support visually impaired users, users who need synchronised captions and lack of object descriptions, leading to exclusion rather than inclusion in the environment (Söderström, 2009).

Because virtual worlds are not designed for teaching and learning, they have to be adapted (Petrakou, 2010). In conventional online learning environments, the learning materials are available in many forms such as course sections, grade books, forums, download areas etc. However, virtual worlds fail to utilise many of these features, limiting course designers to the use of specifically designed tools that offer functionalities which are insufficient for their needs (Riley and Kluge, 2008). In addition, it is not possible to convey all courses through a MUVE, because activities conducted within the virtual world might not be appropriate enough compared to real life (Duncan et al., 2012)

Nevertheless, the technical and usability issues of virtual worlds will be gradually overcome (Dalgarno et al., 2011), but one of the most important disadvantages of online learning tools in general, is the inadequacy to replicate real life interaction. Even in virtual worlds where users interact and communicate through their avatars, they cannot see the actual body movements or the facial expressions of others, causing confusion (Rheingold, 2008; Samur et al., 2010). Also, online interactions may not represent interactions as can occur in real life (Lang and Hughes, 2004). The importance of human interaction is essential and this cannot be effectively replicated in virtual worlds (Kruse, 2004).

Distractions in the virtual worlds are also a challenge (Riley and Kluge, 2008). In cyber campuses, students can spend more time than initially intended mostly because the 3D graphics can hold their attention (Riley and Kluge, 2008; Lee, 2009; Tan et al., 2012). Since virtual worlds offer many functionalities of which some are unrelated to learning, this can often lead to distractions (Riley and Kluge, 2008; Duncan et al., 2012). Fominykh et al. (2012a) identifies that users are distracted from within a virtual world by their visual surroundings and the existence of others, and from outside the environment with access on websites, games etc. In Stam's study (2012: 179) in particular, a student suggested that: *"somehow, those distractions need to be minimised so that the real learning can begin to happen."* .

Security of users and the environment also pose a number of challenges. Helmer and Light (2007: 25) explains that *"residents of virtual worlds are vulnerable to hackers, fraudsters, protesters and unscrupulous marketers as anyone else who takes the risk of plugging their computer into the Internet"*. Herold (2012) also emphasise the issue of inappropriate behaviours in virtual worlds because of its openness. Additionally, incidents of stalking, cyber bullying, verbal harassment and other harmful activities were reported over the years (Sobkowiak, 2012). These issues mainly occur due to the anonymity offered by the virtual world in terms of false identity, where some users take advantage of the hidden identity and misbehave in the environment (Donath, 1999; Kohler et al., 2009; Warburton, 2009; Prasolova-Førland et al., 2010).

Considering these disadvantages, it can be identified that virtual worlds suffer from a number of limitations that need to be considered prior adoption for educational purposes. However, it is necessary to consider that the majority of these limitations apply in almost every online learning platform. Therefore, the use of cyber campuses can offer enhanced, flexible and accessible education to students, in occasions where the majority of these limitations would have occurred during traditional online learning activities.

2.7. Chapter Summary

This Chapter provided a comprehensive review of the existing literature, and investigated the barriers hindering access and participation to education, the concept of virtual worlds in the form of cyber campuses for education, and examples of such tools and their design. Moreover, the environment characteristics that contribute to the efficacy of a MUVE for online learning and the associated disadvantages of these tools were also investigated. This review presented evidence of the current research state of those areas.

During this investigation, it has been identified that there are many barriers impeding access and participation to education. To understand them, the Cross (1981) framework was investigated, which classifies barriers into situational, institutional and dispositional (Table 2.1). Situational barriers concern the general situation and life context of the individual. Institutional barriers concern the institutions' policies and procedures that exclude or discourage certain groups from participating. Dispositional barriers concern the student motivation and attitude towards learning and learning activities in terms of negative evaluation of appropriateness and engagement.

To support students, educational institutions provide a number of online learning support tools facilitating E-Learning. Among the multiple emerging E-Learning technologies, the use of MUVEs has been introduced in the form of cyber campuses. Cyber campuses are meeting points operating on MUVEs, in which students coexist, collaborate, communicate, construct and share knowledge in a 3D environment, increasing social interaction through synchronous communication and collaboration. These environments also offer immersive and visually rich online learning experiences in social, engaging and dynamic ways of learning. This is achieved by utilising a series of advanced technologies and tools to support online learning activities within the 3D environment. Many educational institutions are using virtual worlds and this trend is increasing in time. It has been identified that educational institutions use MUVE mostly to conduct research, teach, hold virtual meetings, conferences, exhibitions and marketing purposes.

According to De Lucia et al. (2009), in a MUVE, learning is strongly related to students' perceptions of presence, awareness, communication and the feeling of belonging to a community. Presence relates to the user sense of *'being'* in the virtual environment. Awareness concerns the awareness of the existence and actions of others in the environment. Communication refers to verbal and non-verbal communication established within the environment. Sociability relates to the ability of the environment to support effective socialisation and provide the feeling of belonging to the learning community. Considering these attributes, cyber campuses are identified as effective tools to support online learning.

However, there are several disadvantages that have to be taken under serious consideration when using cyber campuses. The cyber campuses are technology and network dependant; there is a learning curve and resistance to adoption due to lack of skills, complexity of operations and learning style preferences. In addition, cyber campuses like all computer mediated learning tools lack of effective human interaction, may also pose a number of distractions in learning, and have security and usability issues.

Summarising the review of the existing literature, it has been identified that there is limited empirical research focusing on the extent to which cyber campuses can support students experiencing situational and institutional barriers hindering access to education. In addition, apart from few empirical studies, little is known on how to design effective cyber campus environments. Moreover, there are no guidelines specifically addressing those characteristics that make cyber campuses effective learning tools to support these students.

To ascertain these gaps in the existing literature, a number of objectives have been devised and are presented in the next Chapter, together with the research approach, methodology and the design of this research project.

Chapter 3 - Research Methods

3.1. Introduction

The last Chapter presented a comprehensive review of the literature, focussing on barriers hindering access and participation to education, and the use of cyber campuses for online learning support. However, a question remains as to the extent to which cyber campuses can support learning for students experiencing situational and institutional barriers accessing education. Moreover, little is known on how to design cyber campuses to support them. This Chapter outlines a detailed account of the theoretical framework and practical methods planned to use for the empirical part of this research project to investigate these research gaps.

Section 3.2 describes the research approach; presenting the research question and objectives formulated to conduct this investigation. Section 3.3 discusses the ethical considerations pertaining this research project. Section 3.4 discusses the need to design a cyber campus environment to use as the mean of conducting experiments with. Section 3.5 presents the quantitative part of this investigation. Section 3.6 describes the qualitative part of this research project, and Section 3.7 concludes this Chapter.

3.2. Research Approach

In an attempt to understand the extent to which cyber campuses can support participation in online learning activities for students experiencing situational and institutional barriers accessing education, a combination of quantitative and qualitative research was chosen.

Quantitative research is appropriate when investigation to understand phenomena through statistical techniques is required. This research approach concentrates in collecting and analysing data to investigate relationships between theory and research in a deductive approach. It incorporates practices of the natural scientific model of positivism and adopts an objective conception of social reality. Quantitative methods are interested in prediction and aim to maximise objectivity, replicability and generalisability of findings (Bryman, 2008). Qualitative research is appropriate when the understanding of a new, unexplored and/or complicated issue is required (Creswell, 2009). It concentrates on investigating, understanding and interpreting the individual's opinion, experiences and thoughts about a particular topic of interest (Bryman, 2008). The empirical work of this research project was based on the hypothesis that cyber campuses can support participation in online learning for students experiencing situational and institutional barriers accessing Higher Education. To ascertain this, the following research question has been formulated:

> ***RQ: To what extent can cyber campuses support participation in online learning activities for students experiencing barriers accessing Higher Education?***

During the review of the literature, a research gap has been identified stressing the need to identify the extent to which cyber campuses can support participation in online learning activities for students experiencing situational and institutional barriers hindering access to Higher Education. Several studies investigated the learning capabilities of educational virtual worlds, but little is known on how these environments can facilitate participation in online learning activities to support these students. To ascertain this, the following research objectives were formulated:

> ***O_1: Identify some of the situational and institutional barriers hindering access and participation to Higher Education.***

A rich knowledge pool investigating situational and institutional barriers impeding access and participation to education is available in the existing literature. Investigating this objective enabled an understanding of the practical significance of these barriers and their impact on the students learning experience, and contributed to the understanding of their source, nature and characteristics. This allowed the development of understanding how a cyber campus environment can be used for online learning purposes, and how to mitigate the effects of these barriers.

> ***O_2: Determine the extent to which a cyber campus can support online learning activities.***

The above objective required the design of a cyber campus environment, and conducting experiments to evaluate its potential to support online learning. This had allowed evaluating the characteristics and specific aspects of the environment to support online learning. This also contributed to the understanding of the concept of online learning through cyber campuses, and to gain practical experience on the operation of these environments.

O_3: Identify the main characteristics of cyber campuses that can support participation in online learning activities for students experiencing situational and institutional barriers accessing education.

There are many studies investigating the attributes and characteristics of cyber campuses in educational context. However, there is limited empirical research; at least to the knowledge of this research project, investigating which are the most important characteristics of cyber campuses that can support participation in online learning for students experiencing situational and institutional barriers hindering access and participation to education.

An outline of this thesis is included as Appendix 3.1, and demonstrates a timeline of testing and evaluation sessions to complete the aim and objectives of this research project.

3.3. Ethical Considerations

To conduct this research project, empirical evidence were collected with the participation of volunteers in a series of experimental studies. In social research, ethical implications relating to anonymity, confidentiality and privacy are very important (Matthews and Ross, 2010) and were considered in this study. To conduct this research project, ethical clearance was obtained from the Sheffield Hallam University's Faculty of Research Ethics Committee (FREC) and is included as Appendix 3.2.

In this research project, all participants used imaginary avatar names to preserve their anonymity, and all references to participants in this thesis are made using their avatar name.

3.4. The Experimental Environment

To carry out this research project, a cyber campus environment was required to use as a proof of concept and as the medium to conduct a series of empirical studies with. However, the Sheffield Hallam University does not provide such an environment. In addition, obtaining access and permissions to use a cyber campus developed by others was not feasible. It would have been ideal to use a cyber campus as part of a university module to mediate activities and then evaluate the students' experience. However, at this stage of the research project, it was not feasible to do this because it was in the middle of the academic year, teachers were not keen to compromise the structure of their module, and also due to lack of interest. For this reason, it has been determined that a cyber campus environment had to be developed to conduct the empirical portion of this research project, and details about the environment are discussed in Chapter 4.

3.5. Environment Evaluation

The study discussed in this Section aimed to evaluate the efficacy of the cyber campus that was developed to support online learning. The design of the evaluation study was of quantitative nature in the form of descriptive research, intended to report measures of central tendency.

To conduct this evaluation, a number of online learning tasks to perform within the cyber campus were required and the design of a collaborative team building activity was prepared. This activity required students to connect in the virtual world; familiarise themselves with the environment, learn how to build and manipulate content, and collaboratively work together on a team-building task. The outcome of this activity was to teach users how to create and manipulate content in the virtual world and put this knowledge in practice towards the design of shared objects. Then, a subjective evaluation of their experience with the virtual world was performed.

3.5.1. Data Collection

To evaluate the potential of the cyber campus to support online learning, subjective evaluation through questionnaires was performed. The instruments have been adapted from Witmer and Singer (1998), Kreijns et al. (2007) and De Lucia et al. (2009), as part of the framework for the evaluation of the efficacy of a MUVE to support online learning proposed by De Lucia and his colleagues (2009).

3.5.1.1. Instruments

To collect data, two questionnaires were administered. Because the participants were remotely located, the questionnaires were administered online using a web survey tool, before and after they experienced the virtual world.

3.5.1.1.1. Pre Experiment Questionnaire

In order to determine specific aspects of the participants characteristics, a pre experiment questionnaire was administered prior to their interaction with the virtual world. This questionnaire aimed to collect data based on computers knowledge (PCK), 3D environments and video games usage (3DG), and tendency to get involved in activities (INV). This questionnaire was adopted by De Lucia et al. (2009) and is presented in Appendix 3.3. This was a self assessment questionnaire measured in 7-point Likert scale ranging from 1 (completely disagree) to 7 (completely agree), and the items corresponding to PCK, 3DG and INV were calculated by aggregating and summarising their mean value. Also, the participants' name and age were collected. Using this questionnaire enabled the understanding of whether the students' perceptions of the environment was associated with their previous experiences and skills with virtual worlds, computers and their tendency for involvement in activities.

3.5.1.1.2. Post Experiment Questionnaire

To collect perceptions of presence, awareness, communication and sociability, the post experiment questionnaire was adapted from Witmer and Singer (1998), Kreijns et al. (2007) and De Lucia et al. (2009), and was administered after the participants experience with the virtual world.

The version used in this research project comprised of 45 items and consisted of the following five scales:

1. Presence Questionnaire (PQ) (Witmer and Singer, 1998)
2. Awareness Scale (De Lucia et al., 2009)
3. Communication Scale (De Lucia et al., 2009)
4. Sociability Scale (Kreijns et al., 2007)
5. Collaborative Virtual Environment (CVE) scale (De Lucia et al., 2009)

The questionnaire used in this study differs slightly from the questionnaire used by De Lucia et al. (2009) (Appendix 3.4), and details of the scales used and justification of the reasons for modifications follows.

PQ (Appendix 3.5) measures the user degree of presence experienced in the virtual setting by addressing factors that influence immersion and involvement, namely control (CF), realism (RF), distraction (DF) and sensory factors (SF). In De Lucia et al. (2009) study, the initial PQ version introduced by Witmer and Singer (1998) was used, comprising 32 items. However, the PQ authors proposed an updated version of the scale featuring improved reliability (See Section 3.5.1.2 - Reliability), comprising 19 out of the 32 items. Therefore, the updated PQ version was adopted to ensure scale reliability and shorten the length of the overall questionnaire. PQ is measured using a 7-point Likert scale ranging from 1 (not much) to 7 (very much) (Appendix 3.10). The total presence score of each user was calculated by aggregating all presence items. The factors that contribute to presence (CF, RF, DF, SF) were also measured and investigated by aggregating the items that correspond to the individual factor.

The Awareness scale was adopted from De Lucia et al. (2009), and measured the level of awareness of the existence of others in the environment, what is going on in the virtual world and the various roles of others in the virtual environment (Appendix 3.6).

The Communication scale was also adopted from De Lucia et al. (2009), and measured the user perceptions of the system ability to provide interfaces that support easy and effective communication (Appendix 3.7).

The Sociability Scale proposed by Kreijns et al. (2007), measures the perceived degree of sociability of a computer supported collaborative environment and it comprises 10 items (Appendix 3.8). In De Lucia et al. (2009) study, the authors used 6 out of 10 items but did not report the reliability of the modified scale. Therefore, the initial scale as proposed by Kreijns et al. (2007) was adopted in this study instead, to ensure scale reliability.

CVE scale is adopted from De Lucia et al. (2009), and is a set of general questions that evaluate the design and interface usability of the environment (Appendix 3.9). The authors' proposed two additional items concerning user satisfaction and productivity during the experience, administered as part of the CVE scale, but examined independently (See items CVE8, CVE9 in Appendix 3.9).

Awareness, Communication, Sociability and CVE scales are measured using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

3.5.1.2. Instruments Evaluation

The evaluation of the data collection instruments in research is important because concerns are often raised in respect to the reliability and validity of data collection and analysis (Thyer, 2009). Reliability concerns the quality of measurement, consistency and reproduction of results. Validity is concerned with the effectiveness of the instruments, and relates to the degree to which a particular test measures what it claims to measure (Bryman, 2008). Thus, it was important to evaluate the instruments of this study to ensure rigour of findings.

3.5.1.2.1. Reliability

To test the reliability of the results of this study, the Cronbach's alpha (α) coefficient test was used. This test allows measuring the square correlation between observed and true scores to identify whether the items comprising a scale are internally consistent and measure the same ideas (Cronbach, 1951; Bryman, 2008). The test reveals values ranging from 0 to 1, with the values closest to the latter being most desirable (Bryman, 2008). According to Hair et al. (1995), the test of an internally consistent scale should reveal around α=.80 or higher, with α=.70 being acceptable and α=.60, a questionable result.

Because the scales used in this study were standardised, their reliability has been tested in previous studies and the results are shown in Table 3.1. However, Awareness scale violates the Cronbach's threshold, indicating that the scale items are not correlated with each other. Nevertheless, De Lucia et al. (2009) computed the total consistency of Awareness, Communication and CVE scales, resulting to α=.89 (n=26) and accepted the combined scale reliability. The reliability of the pre experiment questionnaire is not reported by its authors (De Lucia et al., 2009) and is questionable.

Scale	**Cronbach's Index**
Presence Questionnaire	α=.88 (n=152)
Awareness	α=.58 (n=26)
Communication	α=.84 (n=26)
Sociability Scale	α=.92 (n=79)
Collaborative Virtual Environment	α=.83 (n=26)

Table 3.1 - Scales Reliability

3.5.1.2.2. Validity

In respect to the concept of validity of the results, the quality of the measures is assessed with the concepts of face, construct, concurrent, internal, external and predictive validity (Bryman, 2008). The face and concurrent validity of the instruments were confirmed in previous studies utilising the evaluation framework (De Lucia et al., 2009; Griol et al., 2012). Construct validity was confirmed in the literature. Internal validity was ensured considering that the questionnaires are standard. The external validity criterion did not apply in this study due to its nature, aiming to evaluate the environment and not to attempt generalisation. Predictive validity was also not of interest to this study.

3.5.1.3. Sample

People were the source of data collection of this evaluation study; therefore, it was necessary to discuss the sample of this study. The sample is a subset of the population that is more manageable to investigate rather than the whole population and is selected using probability or non-probability methods. Probability methods refer to the chance of every member of the population to be included in the selection. The types of probability sampling techniques include simple random sampling, systematic sample, stratified random sampling and multi-stage cluster sampling. The employment of probability sampling, allows the researcher to generalise findings to the wider population (Bryman, 2008). The sample size determine the validity of the results applicability to the wider population, which according to Bryman (2008: 179), *"as the sample size increases the sampling error decreases"*. Sampling error refers to the differences between the characteristics of the sample and the population that has been drawn (Bryman, 2008).

Non-probability methods refer to all forms of sampling that are not conducted according to probability canons and do not allow generalisation but allows making important inferences about the sample investigated. Non-probability sampling methods include convenience, snowball, quota and theoretical sampling (Neuman, 2005; Bryman, 2008).

This study aimed to evaluate the environment's efficacy to support online learning and not to attempt generalisation of findings. Therefore, a convenience sampling strategy was chosen, and involved the recruitment of people available to the researcher. Convenience sampling ensures good response rate but cannot provide generalisation of findings. This approach does not ensure adequate representativeness of the population, however sufficient sampling can produce interesting findings and allow making reasonable assumptions (Bryman, 2008).

3.5.2. Data analysis

Data collected was imported to SPSS statistical software for analysis. Data collected from the pre experiment questionnaire was analysed first, by aggregating items to their corresponding characteristic (PCK, 3DG, INV) and summarise their mean value. The post experiment questionnaire was then analysed. The data distribution of all scales was examined first together with test for normality of the distribution; as the degree of data normality determines what statistical analysis methods should be employed, and because statistical interpretations of data that deviates from normality becomes less robust (Tabachnick et al., 2006). There are two statistical analysis methods: parametric and non-parametric. Parametric methods assumes that the data distribution is normal, otherwise the interpretation of the results might be unreliable or invalid (Razali and Wah, 2011). Non parametric methods test hypotheses without making statistical assumptions and are used when data has unknown distribution, or is not normally distributed (Bryman, 2008). Therefore, it is essential to test the data distribution for normality before employing any statistical analysis procedures.

There are three methods to check normality assumptions: graphical, numerical methods and normality tests (Razali and Wah, 2011). Graphical methods employ the use of quantile-quantile (Q-Q) plots, histograms, box-plots and stem-and-leaf plots that can be used to visually inspect data but cannot provide conclusive evidence for normality assumptions. Numerical methods test the data distribution to determine its normality in a more formal way, by testing the kurtosis and skewness coefficients. By calculating the *z-value* of both coefficients, it can be determined if the data distribution is approximately normal. The kurtosis and skewness of the distribution was evaluated using the $z > 1.96$ criterion. To calculate the *z-values*, the coefficient's measure is divided by its standard error (SE) (Field, 2009). In addition, specific normality and goodness of fit (GoF) tests that check data distribution for normality in formal ways are also available. There are several tests in the literature but the most common are the Shapiro-Wilk test, Kolmogorov-Smirnov test, and Lilliefors test. Empirical evidence suggests that Shapiro-Wilk test is the most powerful, but its power is low for small samples (Mendes and Pala, 2003; Keskin, 2006; Razali and Wah, 2011). Romeu (2003) suggests the use of the Kolmogorov-Smirnov GoF test because is specialised in small samples, is a versatile, and widely used tool to assess normality. This test examines if the data distribution fits a theoretical normal distribution. A limitation of the original test is that is sensitive to extreme values but it was corrected by Lilliefors to render less conservative results (Peat and Barton, 2008). The null hypothesis of this test is that data is normally distributed and to reject it, the p value should be below 0.05. The Lilliefors corrected Kolmogorov and Smirnoff GoF test is provided through SPSS and was employed in this study.

Descriptive statistics were employed to analyse the perceptions of presence, awareness, communication and sociability. If the data distribution is approximately normal, the central tendency, which is the estimate of the average values of the distribution, were investigated through examination of the mean and standard deviation (Sd). The mean value is the representative of an average value of a distribution. It is the most common way of describing central tendency and was investigated first (Jaggi, 2003; Bryman, 2008). To accurately estimate the data dispersion of a distribution, the Sd was used to show the relation that a set of scores has to the mean of the sample. Sd can help the researcher ascertain how much does the values differ from the mean (Jaggi, 2003; Bryman, 2008). In addition, Pearson's product moment correlation coefficient to test relationships between variables was examined. This coefficient measures the linear correlation between two variables by providing a value ranging between +1 and -1, indicating positive and negative correlations respectively. Zero value denote no correlation (Bryman, 2008).

If the data distribution is found not to be normally distributed, the central tendency should be investigated through examination of Median and Sd. Relationships between variables are then tested using the Spearman's rank-order correlation which is the nonparametric version of the Pearson's correlation test.

3.6. Qualitative Study

After the subjective evaluation of the users experience with the virtual world, a follow up exploratory study of qualitative nature was performed. The aim of this study was to understand the situational and institutional barriers hindering access and participation to Higher Education, and how a cyber campus may be used as a tool to support participation in learning activities for students experiencing such barriers.

3.6.1. Data Collection

To explore the topic of interest in qualitative research, there are a number of data collection methods that enable to collect rich and quality data based on peoples' feelings and opinions, including interviews, observations, action research and focus group (Bryman, 2008). This Section describes the method of data collection that was used in this study.

3.6.1.1. Instruments

3.6.1.1.1. Virtual Focus Group

Focus group research is a qualitative technique that explores data coming from multiple perspectives by investigating peoples' perceptions, opinions, emotions and attitudes (McDaniel, 1979; Longhurst, 2003). It investigates how people experience and understand a particular topic, allowing the researcher to develop deep understanding of how people feel the way they do (Bryman, 2008). Typically, focus groups involve small groups of people (6-12), discussing a topic that has been set by the moderator, allowing *"large and rich amounts of data in the respondents' own words"* (Stewart et al., 2007: 16) to be collected in a friendly environment, in which the conversations are recorded (Kitzinger, 1995; Bryman, 2008; Matthews and Ross, 2010; Silverman, 2011). Participants are usually somehow similar e.g. sharing common experiences or interests, or may have same characteristics or similarities of the moderator's interest (Asbury, 1995). The aim is to collect data to enable deep understanding of the topic rather generalising findings, and is as a cost effective way of data collection because people are interviewed in groups and not individually (Krueger, 1994).

When the researcher has no access to people, technology can be of assistance to conduct qualitative investigations through online focus groups. This enables people at distance to participate and contribute to the discussions, usually using computers connected to the Internet (Matthews and Ross, 2010). It is a cost effective method that enables reaching people on broad geographic scope, in a comfortable and convenient way of participating, using asynchronous and synchronous communication. Asynchronous communications include thread-based communications such as emails, distribution lists, newsgroups and forum discussions, where contributors can post a response at anytime. Synchronous methods relate to real time communication tools such as VOIP, online text chat rooms and instant messengers (Stewart and Williams, 2005; Bryman, 2008; Matthews and Ross, 2010).

Virtual worlds are a popular form of synchronous communication and can be used for focus group research. Due to the nature of virtual worlds, the meeting environment can be literally anything, providing the possibility to design comfortable and friendly environments to accommodate participants (Williams, 2003; Stewart and Williams, 2005). This has tackled the lack of space, appearance and movement of participants which is the major drawback of the conventional online focus group methods (Liamputtong, 2011).

During online discussion, participants responses are automatically transcribed and are collected error free (Fox et al., 2007; Bryman, 2008). In addition, the participants and moderator are less likely to be affected by the characteristics of others, enabling collection of less biased results. Especially the anonymity during discussions influences openness in the responses, allowing to collect rich and quality data (Edmunds, 1999). It also provides social equality as the individual's characteristics are preserved (Oringderff, 2008).

In this study, the use of virtual focus group research was the chosen method to collect data. Because participants were geographically dispersed, the cyber campus was the meeting point. Based on the size of the sample, the numbers of virtual focus group sessions were decided accordingly, to include 4-6 participants in each session.

3.6.1.1.2. Questions Development

To conduct this study, a semi-structured questioning approach was used. It is common practice for moderators to have the questions prepared to speed up the operations, but they should still give personalised answers to individuals (Matthews and Ross, 2010). Considering the literature behind barriers hindering access and participation to education, the use of virtual worlds for learning purposes, the research question and objectives of this research project, a number of questions have been prepared to guide this study and are presented in Appendix 3.11. The questions followed an introductory, key and conclusive questioning structure. The chat communication was recorded and automatically transcribed for analysis.

Preparing a questioning structure allowed all questions to be discussed in similar fashion and keep a structure of the discussion, avoiding topic shifting and time misuse.

3.6.1.2. Sample

The importance of sampling in qualitative research is significant (Marshall, 1996). Like quantitative research, there are probability and non-probability sampling techniques in qualitative research (Merriam, 2009). The most common sampling technique in qualitative research is non-probability sampling, involving purposeful selection of participants with experience in the particular phenomenon under investigation (Bryman, 2008; Merriam, 2009). The sample size required in qualitative research is often small, however this depends on nature of the research (Marshall, 1996; Bryman, 2008).

Purposeful sampling through criterion selection was employed in this study, recruiting people who participated in the evaluation study discussed in Section 3.5. The recruitment criteria of this study required the participation of Higher Education students or graduates, who experience or have experienced barriers hindering access and participation to education.

3.6.2. Data Analysis

After identifying the data collection methods of this study, the method to analyse data was then identified. The aim in qualitative data analysis is to identify themes, insights, common phrases and behavioural or non-verbal clues based on group's responses, that can be used as direct quotes or as part of a greater theme discussion (Williams and Katz, 2001).

The results were first analysed to investigate experiences with barriers hindering access to education. The study findings were categorised and discussed based on the Cross (1981) framework as discussed in Section 2.2.1. The data was then analysed to investigate perceptions and opinions regarding the environment's characteristics of presence, awareness, communication and sociability, and how these may contribute to support learning and mitigate barriers impeding access and participation in education. Moreover, data was further analysed to identify any additional characteristics that may contribute to the student learning experience and help to alleviate barriers.

There are several methods to analyse focus group data, and there is a debate on which analysis method is most appropriate (Liamputtong, 2011). Stevens (1996: 172) suggests that to analyse focus group data, *"any number of qualitative analysis strategies can be adapted"*. Bechhofer (1974: 73) argues that research process is a *"messy interaction between the conceptual and empirical world"* and not a clean sequence of procedures. It is also determined that there is no right or wrong data analysis approach in qualitative research (Poggenpoel, 1998).

A number of methods have been considered to conduct this study, including grounded theory, ethnography, participant observation, narrative, discourse analysis, conversation analysis and thematic analysis. Grounded theory is based on constant comparison and simultaneous data analysis and theoretical sampling, where the data that needs to be collected next is determined by the data already collected and the theory developed. This method is best used when investigating a particular topic without prior explanation and seeks to discover theory from data (Glaser et al., 1967). Therefore, because this study was based on previous theories, this method was not applicable. Ethnography and participant observation research involves the researcher in the social life of the situation under study. The researcher immerses in the situation for a period, observes behaviours, asks questions, interviews and documents to understand the particular group culture (Bryman, 2008; Guest et al., 2012). Narrative analysis covers a series of approaches that collect and analyse personal stories to understand peoples' lives and the world around them. Discourse analysis investigates forms of communication to emphasise how reality has been constructed through language. Conversation analysis investigates the interactions as naturally achieved for further analysis, mainly concerned in the hidden structures of the talk in interaction (Bryman, 2008). Because this research project was not interested in ethnography or participant observation, analysing personal stories, languages or verbal and non-verbal interaction among participants, these methods were also not appropriate.

3.6.2.1. Thematic Analysis

Thematic analysis is probably the most common data analysis method used in qualitative research (Guest et al., 2012). It enables identification, analysis and reporting of themes that emerge through data, aiming to uncover patterns of meanings based on experiences (Braun and Clarke, 2006; Matthews and Ross, 2010; Guest et al., 2011). It *"offers an accessible and theoretically-flexible approach to analysing qualitative data"* that does not require the same theoretical and technical knowledge as grounded theory, allowing even inexperienced researchers to produce quality results (Braun and Clarke, 2006: 77). This method identifies and describes implicit and explicit ideas from data (themes), and moves *"beyond counting explicit words or phrases within the data"* (Guest et al., 2011: 138). The features of this approach enable to understand peoples lives based on what they say, aims to ground interpretation of particularities within situations of interest through responders perspectives, and data is presented as social phenomena endorsed by conversational examples (Silverman, 2011; Wilkinson, 2011). It is also a flexible method that can be approached in both inductive and deductive ways (Hayes, 1997; Frith and Gleeson, 2004; Braun and Clarke, 2006), allowing the researcher to "*extract information to determine the relationship between variables and to compare different sets of evidence that pertain to different situations in same study"* (Alhojailan, 2012: 1). Data can be approached in semantic, latent, realist and constructionist ways, considering the explicit content of data (semantic) or investigate underlying meanings (latent), focus on realistic evidence in data (realistic) or how reality is constructed (constructionist) (Braun and Clarke, 2006). It also allows to compare data collected in two phases, and enable to investigate data similarities and differences before and after treatment (Creswell, 2009; Alhojailan, 2012). In addition, this approach is appropriate to use when the sample of interest is pre-determined (Alhojailan, 2012). According to Braun and Clarke (2006), the process of a thematic analysis involves six phases described in Table 3.2.

Phase:	Description:
Data readings.	Detailed reading and immersion in the data set occurs, to familiarise with all the aspects of the data and generate preliminary ideas.
Generating initial codes.	In this phase, the coding depends on the nature of the data approach, which is either inductive (data driven) or deductive (theory driven).
Searching for themes.	Data is investigated for emerging themes rather than codes. Initial categorisation of codes to potential themes then occurs.
Themes reviewing.	The themes are reviewed to identify redundancies. First the data extracts of each theme are read to ensure that are rational. Then, the entire data set is investigated for coherence and validity of the produced themes and the data.
Defining, refining and renaming themes.	After developing a thematic map of data, the process of defining, refining and naming the themes occur. This phase involves capturing the essence of each theme and determines which particular set of data each theme captures.
Produce the report.	The final stage concerns the writing of the report in which the researcher tells the story and attempts to convince the readers for the validity of the results.

Table 3.2 - Thematic analysis phases

3.6.2.2. Evaluation of Methods

In qualitative research, validity and generalisation of findings should be taken into account as it is important to consider the social impact of the findings to the population investigated (Carey, 1995). However, different perspectives on data validity and reliability have been investigated over the years (Bryman, 2008). For example, LeCompte and Goetz (1982) found similarities between qualitative and quantitative approaches to validation and compare this with experimental and survey research, discussing validation in terms of validity and reliability (LeCompte and Goetz, 1982; Bryman, 2008; Creswell, 2012). Other scholars identified additional criteria as they do not agree with the concepts of reliability and validity in qualitative research (Shenton, 2004; Bryman, 2008; Creswell, 2012). This Section discusses the evaluation of the methods adopted in this study through the concepts of reliability, validity and a set of additional criteria to ensure rigor of findings.

3.6.2.2.1. Validity

Validity in qualitative research concerns whether the researchers observe, identify and measure what they claim, consisting of internal and external validity (Mason, 2002). Internal validity concerns the extent to which there is match between the researcher's observations and the theories developed out of data. This is a strong aspect of qualitative research because researchers participate in the social life of a group, ensuring agreement between concepts and observations. External validity relies on the ability to generalise results to the population, where qualitative research suffers mostly because most researchers tend to employ small samples (LeCompte and Goetz, 1982; Bryman, 2008; Silverman, 2011). However, since the aim of exploring a topic through focus group research is to investigate and form ideas based on opinions, the issue of generalisation is not particularly important (Goldman, 1962; Calder, 1977).

3.6.2.2.2. Reliability

Reliability refers to the degree to which the findings are independent of chances and accidental production, consisting of internal and external reliability (Kirk and Miller, 1986). Internal reliability relates to the consistency and agreement of what has been said and what the researcher has understood. External reliability refers to the degree to which others can replicate the study. However, external reliability is very difficult to be achieved in qualitative research because is impossible to freeze the social setting and replicate it for further studies (LeCompte and Goetz, 1982; Bryman, 2008; Silverman, 2011). Reliability and validity of findings can be ensured by unbiased sample selection, the approach to the discussion, and data analysis. The data quality is dependent on several factors such as sample size and appropriateness, relevance and quality of questions, moderators experience and analysis strategy (Krueger, 1994; Morgan, 1995). In addition, the moderator's experience or the involvement of multiple moderators in the process can also affect reliability (Kidd and Parshall, 2000).

3.6.2.2.3. Additional Criteria

Some researchers however challenge the concepts of validity and reliability in qualitative research, mostly because they do not address them the same way (Shenton, 2004). For example, Lincoln and Guba (1985) argue that qualitative studies should be evaluated using different criteria, suggesting trustworthiness and authenticity criteria namely credibility, transferability, dependability and conformability as opposed to internal and external validity, reliability and objectivity (Bryman, 2008; Creswell, 2012).

Credibility relates to the trustworthiness of the collected data, where the researcher needs to ensure that codes of good practice have been performed during the analysis and providing the results to the group members for validation and confirmation (Lincoln and Guba, 1985; Shenton, 2004).

Transferability concerns the ability to obtain similar results after investigation on another context. Thus, researchers are encouraged to adopt '*thick description*' (Geertz, 1994), a term related to producing rich amount of data regarding details of the social group, in which other researchers may refer to identify the possibility of transferability of their study to other situations.

Dependability is suggested to ensure trustworthiness as opposed to reliability, and researchers should keep all records during the research (e.g. problems, notes, interviews, transcripts, data collection and analysis methods etc.) and have them accessible to others (Lincoln and Guba, 1985). This allows assessing and establishing the extent to which systematic procedures have been adopted and followed throughout the research.

Confirmability ensures that the researcher has showed good faith during the research, without any biased approaches or other matters influencing the findings. In addition to trustworthiness, Lincoln and Guba (1985) suggests authenticity concerning if the research is fair towards the different views of the members.

Considering reliability, validity and the additional criteria as a framework to conduct qualitative research, trustworthy and valid findings can then be produced. Using virtual focus group research to conduct this study, face validity was ensured because of the credibility of the comments from participants (Nyamathi and Shuler, 1990). Internal validity and reliability of the results were reviewed and confirmed by the supervisory team of this research project. External validity was not of interest to this study because it was not aiming for generalisation, but to understand group particularities. To ensure credibility, all codes of good practice were followed during data collection and analysis. To ensure transferability and dependability, thick description of the data collection and analysis process were produced, and all the communication logs and records of the discussions were kept and are available in the supporting material disc submitted with this thesis. In addition, unbiased and neutral approach during this study was adopted, and good faith was shown during data collection and analysis to satisfy the criterion of confirmability.

3.7. Chapter Summary

This Chapter outlined details of the research approach chosen to ascertain the extent to which cyber campuses can support students experiencing barriers hindering access to education. To conduct this investigation, a combination of quantitative and qualitative research was performed. It has been determined that to conduct the experiments required, a cyber campus environment had to be developed. A subjective evaluation through opinion-based questionnaires evaluating the efficacy of the environment to support online learning was first planned. This investigation focussed on peoples' perceptions of presence, awareness, communication and sociability of the environment. Details of how data collection and analysis were planned are provided, together with evaluation of the instruments and description of the sample involved.

A qualitative study employing virtual focus group research was also planned to follow, investigating experiences of barriers impeding access and participation to education, and the extent to which a cyber campus can support students experiencing these barriers. Details of the data collection and data analysis methods planned have also been provided, together with a discussion of how these methods were evaluated according to the criteria for evaluating qualitative data.

After establishing the theoretical framework and the design of this research project, experimentation and data collection were then planned. However, an important requirement was the development of a cyber campus environment to conduct empirical studies with, and details are discussed in the next Chapter.

Chapter 4 - The Cyber Campus Prototype

4.1. Introduction

In the previous Chapter, the theoretical underpinnings and approach of this research project were presented. This included the design and planning of quantitative and qualitative research to investigate the extent to which cyber campuses can support students experiencing barriers hindering access to education. To investigate this, it has been determined that a cyber campus environment was required to use as a mean to conduct a series of experimental studies with. Therefore, the *SHU3DED* (*Sheffield Hallam University 3D EDucation)* cyber campus was developed, and details are presented in this Chapter. This Chapter is organised as follows: Section 4.2 discusses the development of the environment including the platform used to deploy the system, its appearance and layout, together with the implemented tools to support educational activities. Section 4.3 presents an initial environment testing that was performed to ensure system stability, and Section 4.4 concludes this Chapter.

4.2. The Development of *SHU3DED*

As discussed in Chapter 3, the need to deploy a cyber campus environment was identified to conduct the empirical portion of this research project. During the review of the literature, a sound understanding of the use of virtual worlds in educational context has been developed, allowing the collection of ideas and influences for the design of such environments. The design and development of *SHU3DED* considered some of the best practices and examples of cyber campus environments and design guidelines from the literature. An additional driver of development was the virtual school concept as demonstrated by OTIS. This Section presents the platform used to deploy *SHU3DED*, its appearance and layout, and the implemented tools to provide educational functionalities to the environment.

4.2.1. Platform

To develop *SHU3DED*, an investigation was conducted to identify the most suitable virtual world to adopt. During the review of the literature, it was identified that the most commonly used platforms are Second Life and Opensim, and research was focused to those because of time restrictions, limiting the investigation of other platforms.

Second Life is probably the most popular MUVE designed by Linden Lab[7] and is considered the biggest virtual environment on the market, supported by millions of users. It is a commercial virtual world that everyone can access free of charge, or through premium accounts that offer exclusive virtual goods and other benefits. To connect, the user downloads and installs the *'Second Life Viewer'* software, creates an account, and joins the on-going virtual experience that involves real people's avatars, virtual islands, cities, buildings, and other artefacts. Second Life features its own currency (Linden Dollars L$) and marketplace that is selling content for users to purchase and use in the virtual world. It also provides the opportunity to obtain virtual land and use it for personal or commercial purposes.

In Second Life, users can build their own virtual objects through building tools offered by the viewer, allowing creating, editing and manipulating 3D objects in the virtual world. These can be designed using various shapes (prims) and images (textures) so the user can create any 3D object. Users can create objects and save them to their inventory while land owners' creations remain in the environment. The user can also include scripts using the '*Second Life Scripting Language'* (LSL), to enable behaviour in the designed objects and also can save them in their inventory for later use or reuse (LindenLab, 2015).

On the other hand, Opensim[8] (short for Open Simulator) is an open source server platform that generates 3D virtual worlds, which is free to deploy as a private or an open virtual world. Opensim is based on a Second Life compatible protocol, therefore it offers almost the same functionalities and operations (Ullrich et al., 2008). To implement Opensim, the system needs to be downloaded, deployed and configured accordingly. Opensim is a platform independent system; therefore it can be deployed in all major operating systems. The server then generates the 3D virtual environment. The server provides two available modes: standalone and grid mode. Standalone mode can be implemented on single workstations and is ideal for personal use with small numbers of avatars. Grid mode allows separating services on other workstations to accommodate

[7] http://www.lindenlab.com
[8] http://opensimulator.org/

higher number of users. To access the environment, many open source viewers are available e.g. *Imprudence Viewer*, *Firestorm*, *Hippo* and others, offering similar functionality as *Second Life Viewer*. The majority of the viewers are using standardised functionalities that offer the same predefined set of controls for navigation, communication, environment interaction and system configuration (Schmeil, 2012). Each viewer has some unique and specific features but generally have relatively small differences between them, mostly on the look and feel of the software. Similar to Second Life marketplace, Opensim also has a marketplace that offers objects that can be purchased using Opensim Money (M). For programming purposes, Opensim provides various scripting languages including *'Opensim Scripting Language'* (OSSL - LSL extension language), *C#* and *LSL*.

During the early stages of this research project, Second Life was first used to deploy and test an initial cyber campus prototype. The reason for adopting Second Life was due to its publicity and availability to use immediately. A virtual land was rented from a private virtual estate manager, and some initial designs were developed to familiarise with the building functionalities of the system. However, the estate manager decided to remove the prototype without any notice, arguing that the implementation was for commercial purposes. This raised a major concern of operations dependency, revealing the issue of limited control over the environment and the system, and this may have caused difficulties in future stages. Second Life is the most popular choice for developing educational virtual worlds, but in recent years it has been displaced by Opensim as the platform of choice mainly due to lack of control over process and associated costs (Allison et al., 2012; Perera, 2013). Allison et al. (2010) provide a comprehensive analysis of the two virtual worlds to assist the adoption decision. In this key text, Allison et al. (2010) indicate some important limitations specific to Second Life that should be considered including recurring financial costs, poor programmability, limited space and prims use, inflexible avatar names and age restrictions, and unreliable quality of experience. In order to have complete control over the server and the environment, minimise costs of operations and ensure security and privacy of the environment, Opensim was used instead.

To deploy Opensim, a dedicated server within Sheffield Hallam University network infrastructure was used and its specifications are shown on Table 4.1. The server was configured accordingly to allow users to connect from anywhere. However, this was a time consuming task due to difficulties in configuring the university's network firewall settings.

To provide voice functionality to the prototype, the Vivox[9] voice system was configured. Vivox is a free virtual world voice service that can be utilised in Opensim by obtaining specific permission from the service provider. The *'Wifi'*[10] add-on module was then implemented, allowing to manage Opensim user accounts through a simple front-end web interface. To access the virtual world, a number of viewers were tested and *Imprudence Viewer*[11] was adopted. The main reasons for its adoption were because it was the most stable viewer during technical tests; it has an easy to use user interface design and was identified less resource hungry when compared to others.

After deploying the server, Opensim initially provides a small island to start with, and the cyber campus environment had to be designed. The next Section discusses the appearance of *SHU3DED*, its layout and the implemented tools to offer educational functionalities.

System:	**Description:**
Operating System	Microsoft Windows Server 2008 R2 Datacenter (SP1)
Processor	Quad-Core AMD Opteron(tm), Processor 8356, 2.30 GHz (2 Processors)
Installed Memory (RAM)	6.00 GB
System Type	64-bit Operating System
Database	MySQL Version 5.1
Web server	ISS Version 4
Opensim Version	Opensim 0.7.3.1 Release (Interface Version 7)

Table 4.1 – Opensim server configuration

4.2.2. The Appearance of *SHU3DED*

In the process of designing the environment, an existing debate in the literature regarding the design of cyber campus environments and how it affects the users sense of presence was identified and considered. De Lucia et al. (2009: 232) argues that "*student perception to be in a usual didactic setting increases the realism and presence sensation*". On the contrary, Papachristos et al. (2013) suggests that students experience in virtual worlds is not affected by the design of the environment. Papachristos et al. (2013) conducted a comparative study investigating the environment design effect in

[9] http://support.vivox.com/opensim/
[10] http://opensimulator.org/wiki/Wifi
[11] http://www.kokuaviewer.org

terms of presence, learning outcomes and overall experience. The authors designed two different 3D educational settings (a traditional university auditorium style and a plain open-air setting) and experimented under authentic educational situations, comparing the impact of the environments to the students' experience. The results of this comparison were not statistically significant, therefore they suggest that the students experiences from learning activities and their attitudes toward the virtual world were not affected by the design of the setting; implying that it is not the design of the environment that primarily affects students experience in a cyber campus. Other researchers also expressed similar concerns regarding realistic spaces for educational purposes (Sköld, 2011). Konstantinidis et al. (2010b) claim that the use of realistic metaphors in virtual worlds in itself is not adequate to enhance learning, and Büscher et al. (2001) suggests that representation of real world phenomena in virtual worlds, limits the capabilities of the environment because its potentials cannot be fully exploited. Girvan and Savage (2010) agrees and recommends exploiting the features of virtual worlds and avoid replication to support pedagogies. Also, Thomas (2010) study fails to recognise the primacy of *'physical situatedness'* in learning through virtual worlds.

On the contrary, a number of studies argue the opposite. Abbattista et al. (2009) and Zhang et al. (2010) also evaluated the effectiveness of virtual worlds by reconstructing realistic educational facilities and activities, implying positive students perceptions towards attending equivalent didactical experiences as in real life in the virtual world (Di Cerbo et al., 2010). Other research also suggest that the realism of the virtual environment significantly influence the sense of presence (Slater et al., 1995; Hendrix and Barfield, 1996; Freeman et al., 2000; IJsselsteijn et al., 2001; Khanna et al., 2006; Lee and Kim, 2008; Slater et al., 2009; Vignais et al., 2010; Sköld, 2011; Beltrán Sierra et al., 2012; Blanca et al., 2013).

For this research project, a more neutral design approach was adopted, coming from the seminal work of Prasolova-Førland (2008), who suggests that the design is not the only factor that affects students evaluation of the environment. Prasolova-Førland (2008) recommends that the environment design influences social behaviours and contributes to the establishment of appropriate atmospheres, but also identifies that the abstraction of the environment is exciting and develops the feeling of limitless possibilities, reflecting the capabilities of the virtual worlds.

Considering the design guidelines identified during the literature review (Section 2.5), observations of best practices, the example of OTIS, and examples of other cyber campuses, the look and feel of *SHU3DED* is realistic, providing recognisable facilities and surroundings, and has easy and natural navigation. The rooms' design and functionality are mainly based on OTIS. The structure of the layout is based on Redfern and Naughton (2002) and De Lucia et al. (2009) additional propositions. Few additional areas have also been designed to better support the learning activities and more details regarding the layout are presented below.

4.2.3. The Layout of *SHU3DED*

The *SHU3DED* consists of a number of rooms and areas, each featuring different functionalities and purpose (Figures 4.1 - 4.3). In the main building, the lecture room (Figure 4.4a) and examination room (Figure 4.4b) are designed to look like a real life classroom, and are equipped with a number of educational tools discussed in the next Section (Section 4.2.4). A library room (Figure 4.5a) is available, and in addition, a meeting room (Figure 4.5b) allows users to gather privately. There is also the main hall where a reception area is situated, providing relevant information and materials to users (Figure 4.6a). On a separate building, there is the orientation area (Figure 4.6b) that provides information regarding the basic functionalities of the system. When users connect on *SHU3DED*, they are '*landed*' to the courtyard (Figure 4.7a). This is the meeting point where users gather before setting off to the areas relevant to their study in a session. Outdoor lecture (Figure 4.7b), activity (Figure 4.8a) and meeting rooms (Figure 4.8b) are also provided, together with recreational areas consisting of a café (Figure 4.9a), bar (Figure 4.9b) and a campsite (Figure 4.10a). A quiet area for users who are away from keyboard or do not want to be disturbed is also available (Figure 4.10b). In addition, a fantasy (Figure 4.11a) and sandbox areas (Figure 4.11b) in which functionalities such as flying and building content are not restricted are also available. To enable this, an extra island with no user behaviour restrictions was created and placed next to the existing island, therefore when users were navigating into this area, they could use the environment building and flying functionalities.

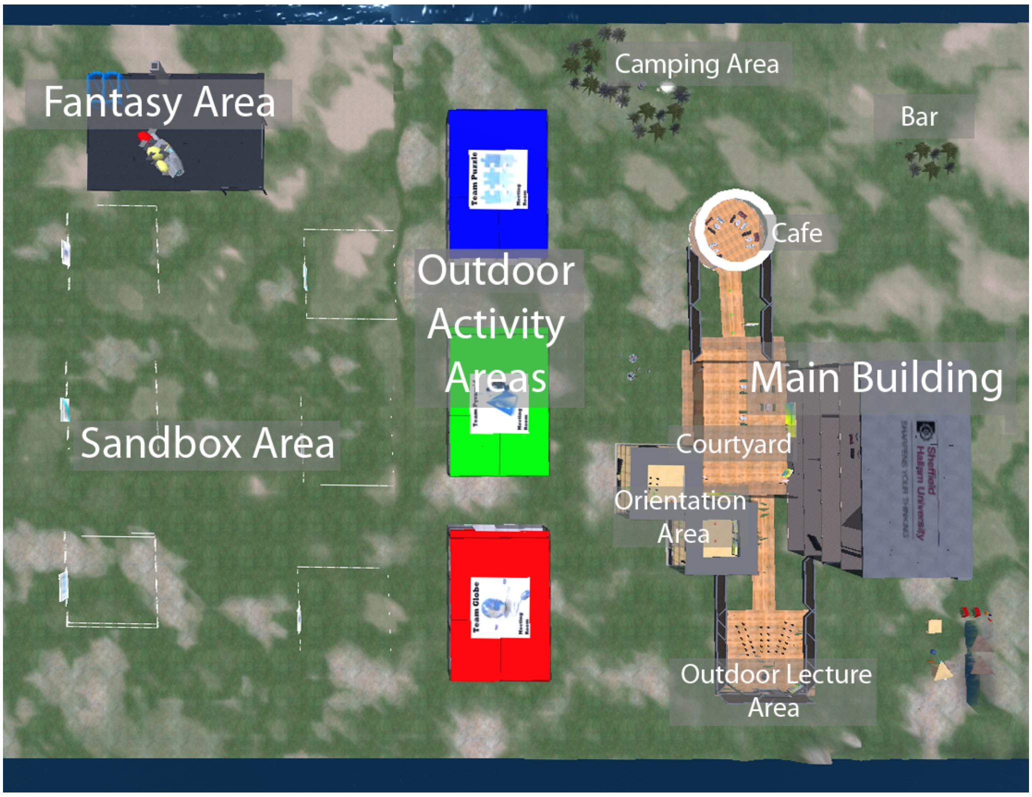

Figure 4.1 - SHU3DED overview plan

Figure 4.2 - SHU3DED main campus rooms

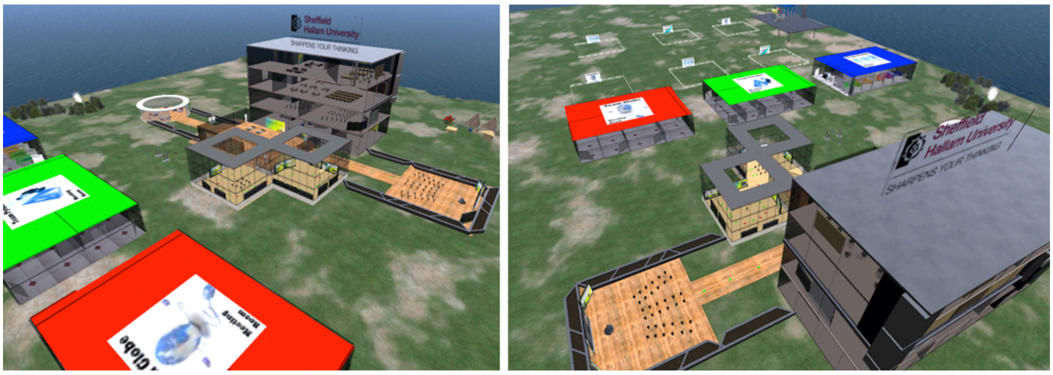

Figure 4.3 - The SHU3DED cyber campus

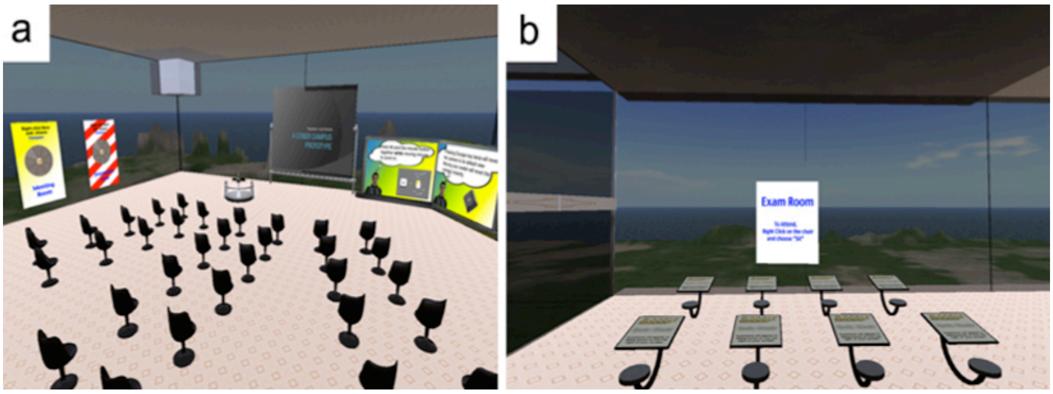

Figure 4.4 - The lecture (a) and examination room (b)

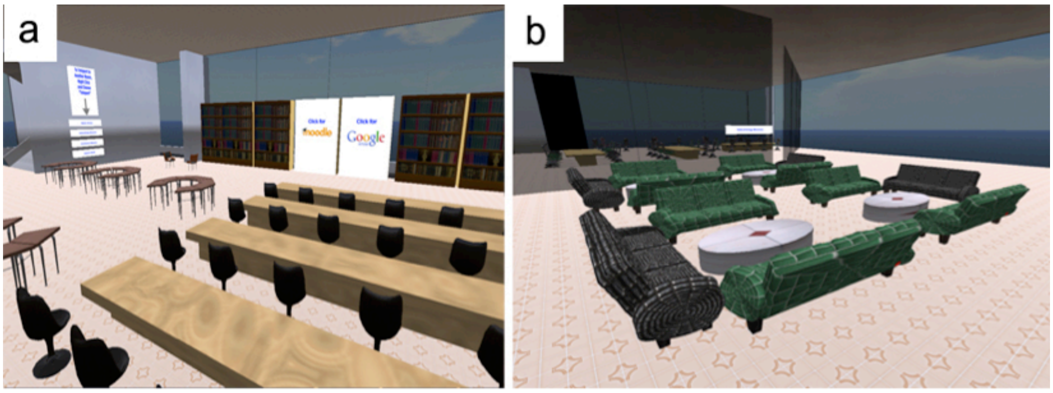

Figure 4.5 - The library (a) and meeting room (b)

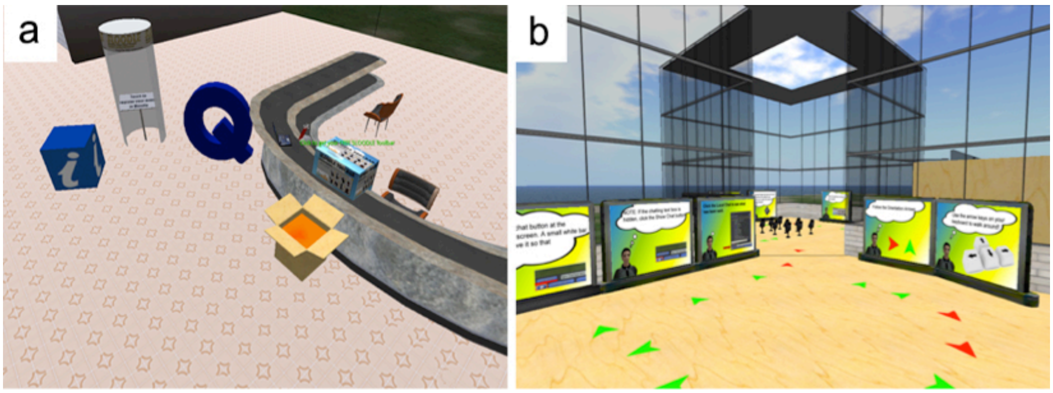

Figure 4.6 - The reception (a) and orientation area (b)

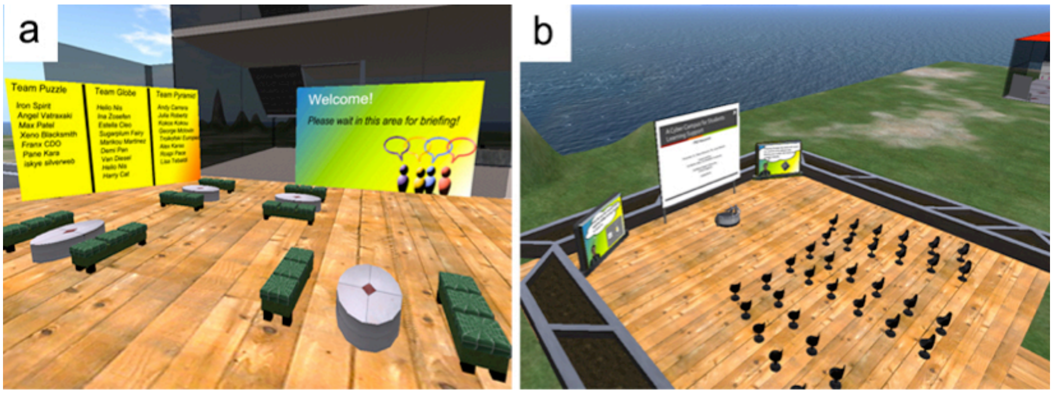

Figure 4.7 - The courtyard (a) and outdoor lecture area (b)

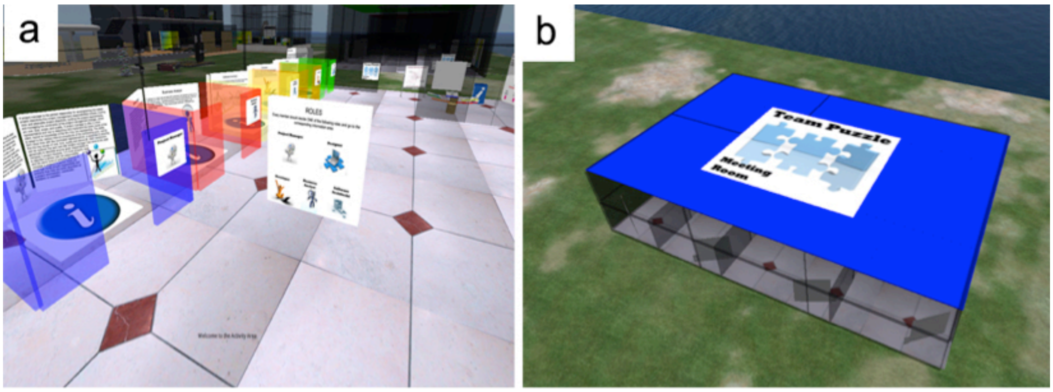

Figure 4.8 - The outdoor activity area (a) and meeting room (b)

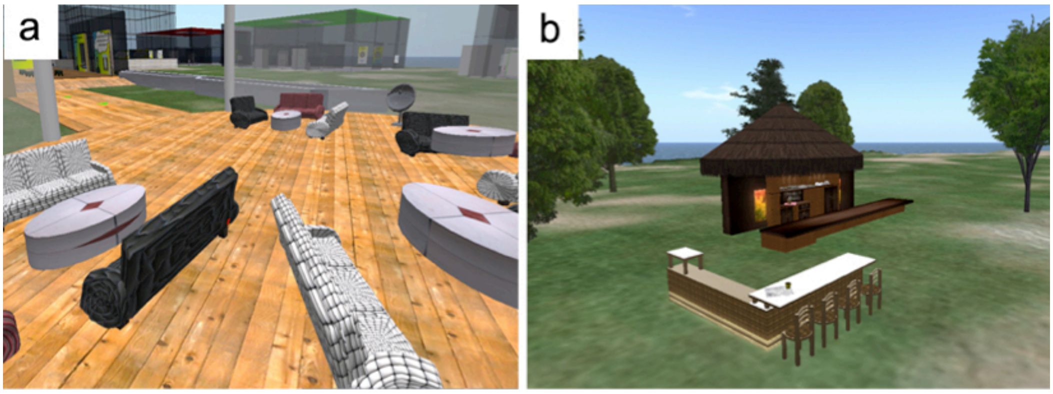

Figure 4.9 - The student café (a) and bar (b)

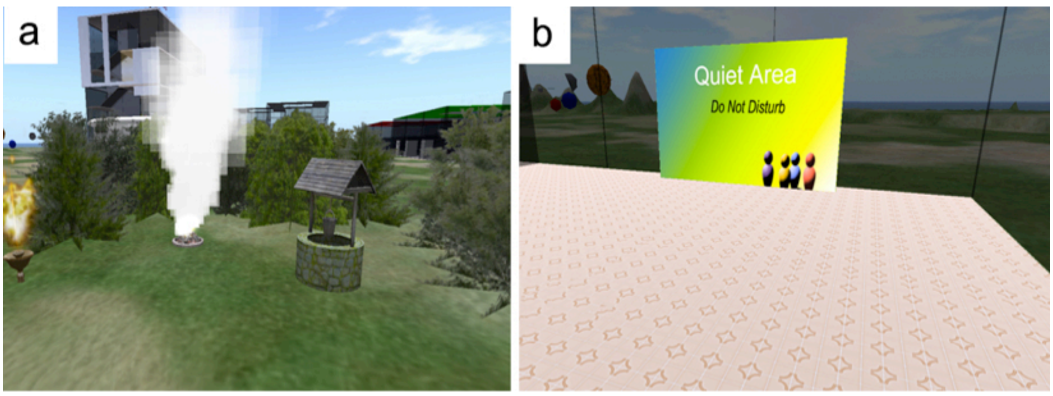

Figure 4.10 - The campsite (a) and quiet area (b)

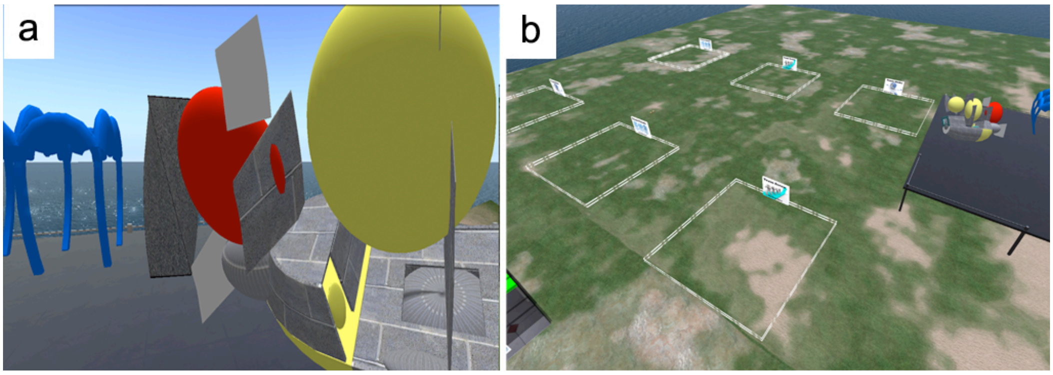

Figure 4.11 -The fantasy (a) and sandbox area (b)

4.2.4. The Educational Functionality of *SHU3DED*

Although Opensim has much functionality, the environment alone does not suffice as an educational platform and it has to be further customised. The majority of objects used to equip virtual worlds are available for free through the web, to use for non-commercial purposes. During the investigation of other cyber campuses, several tools that provide educational functionalities and support learning activities in virtual worlds were identified. The most common example is the Moodle and Sloodle integration (Morozov et al., 2013). Moodle[12] is an open source LMS that provides functionalities such as managing users, courses and learning material through an interactive web based environment. The deployment of Moodle caters for resource management and provides the opportunity to organise and prepare materials to support learning activities. Moodle can be partially integrated into virtual worlds using the Sloodle[13] components, offering a series of learning tools and functionalities to be ported in the virtual environment. Sloodle components establish communication with Moodle through objects in the virtual environment, allowing a number of activities to be retrieved within the virtual world. In particular, Sloodle allows to make presentations, collect feedback, complete quizzes, submit and manage assignments, link identities and other functionalities, transforming the virtual world into a dedicated virtual learning environment. Sloodle also allows to manage students who are present at the time of the activity (Afonso et al., 2009). A complete list of Sloodle tools and description of their functionality is shown on Table 4.2.

[12] http://www.moodle.org
[13] http://www.sloodle.org

Sloodle Tool:	**Description:**
Distributor	A tool in which the teacher can fill with items for students to obtain such as notecards, objects and other material.
Presenter	Presentation board that can be used for slideshows, video streaming and web pages viewing. Presentation slides are uploaded in Moodle and retrieved within the virtual world. Material can also be reviewed offline through Moodle.
Quiz Chair	A tool to undertake quizzes in the virtual world and record the performance in Moodle. Moodle can automatically grade responses.
Pile On Quiz	Multi user quiz.
Prim Drop	Allow students to submit assignments in the virtual world.
Web Intercom	Chatroom that merge communication as established within the virtual world to Moodle. This tool also records conversation for later reviewing.
Sloodle Toolbar	Head's Up Display (HUD) toolbar that the users attach on the top of their viewer. This tool enhances the virtual world interface by providing a range of classroom gestures; save notes to Moodle and lists the nearby avatars.
Sloodle Toolbar Lite	A lighter version of Sloodle Toolbar, limiting functionality only to classroom gestures.
Choice tool	Allows voting.
Tracker	Logs and tracks interaction in the virtual world.
Meta-Gloss	Glossary tool.
Awards	Awards system using points in scoreboard to assess students during activities.
Reg Booth	Tool that checks if avatars are registered in Moodle.
Access Checker	Tool that checks if avatars are allowed to be in the classroom, restricting access if unauthorised.
Login Zone	Registers avatars to Moodle as they appear in a pre-defined zone

Table 4.2 - Sloodle plugins description

The deployment of Moodle and Sloodle has enabled to equip the *SHU3DED* with appropriate tools to facilitate online learning activities. Moodle enables the design of a series of learning activities and Sloodle allows the use of intuitive objects to retrieve them in the virtual world. The *Sloodle Presenter* and *Registration Booth* are used in the classrooms of *SHU3DED* to allow presentations and monitor attendance accordingly. *Quiz Chairs* and *Pile on Quiz* are used in the examination area, retrieving tests designed through Moodle. The *Web Intercom* is implemented to record the chat communication as achieved within the environment, and the *Sloodle Toolbar Lite* was used to enable classroom gestures functionality to avatars.

4.3. Technical Testing

After the initial prototype was developed, a technical testing of the environment was conducted in two phases. The first phase comprised the use of automated client bots using pCampBot[14]. The pCampBot tool is a bot management framework that developers can use to emulate users behaviour in the virtual world such as walking, running, flying, chatting etc. To test the environment, 50 bots were generated in the virtual world, and the environment performance was monitored to identify lag or other bugs. While the bots were logged in the environment and engaged in random behaviour, it was observed that the server was behaving properly, i.e. there was no lag or resources overload; indicating that it could handle users coexisting and synchronously interacting. Therefore, a technical evaluation with the involvement of real users in the second testing phase was conducted.

At the time of the second testing phase, the environment was not yet configured to allow access from remote locations. Thus, 13 Sheffield Hallam University students (8 males - 5 females) situated in a university lab room were involved. The purpose was to test system stability and identify bugs during a collaborative team building activity. Each student had a computer at his/her disposal with the *Imprudence viewer* preinstalled, and the technical characteristics of the computers are shown in Table 4.3. The learning outcome of this activity was for participants to learn the basic navigation, communication, object design and manipulation functionalities of the virtual world, and to put the knowledge gained in practice during a collaborative activity.

[14] http://opensimulator.org/wiki/PCampBot

System:	Description:
Operating System	Microsoft Windows 7
Processor	Intel(R) Core(TM) i3-4130 CPU, 3.40 GHz
Installed Memory (RAM)	6.00 GB

Table 4.3 – Users computers specifications

4.3.1. Tutorial Booklet

A tutorial booklet containing all the information and instructions of the session was designed (Appendix 4.1) and administered to users, organised in four sections:

- *Part 1 - Account creation:* The first part of the booklet instructed participants to setup their accounts and login to the virtual world.
- *Part 2 - Basic Interaction:* This part explained how to navigate in the virtual world, use the local chat to communicate, change avatar clothes, use of the inventory and teleport.
- *Part 3 - Object Manipulation*: This part explained the basic object design and manipulation controls of *Imprudence*, i.e. adjust camera controls, create, position, rotate, resize, colour, change texture and duplicate a basic object.
- *Part 4 - Team Building:* The last part of the booklet instructed participants to mutually agree on an object design from a suggestion list and collaborate to build it. This part was issuing time restriction on the collaborative task (20 minutes).

In a recent study, Perera et al. (2014) have identified that providing in-world training instructions is likely to be more effective than document based approaches. However, this paper was not yet published at the time this evaluation was conducted, but was identified after. Nevertheless, the reasons that a document based approach was used in this occasion were the following: Firstly, the sandbox area of the environment was used to conduct this activity, and it was decided to keep it empty for users to build content rather than filling it with information boards demonstrating building instructions. A second reason was to ensure that users would follow exact procedures, numbered explicitly in the booklet, instead of choosing what to learn. Lastly, it was preferred that users could refer to the booklet when needed to review particular information rather than navigating away from the activity area to look for information or instructions they could have forgotten.

4.3.2. Procedure

Prior to the interaction of participants with study materials, informed consent was sought using the form included as Appendix 4.2. Next, the tutorial booklet was administered to them. Users followed the booklet's instructions and created their account, logged in the system and started learning the basic functionalities of the virtual world. Participants were instructed to choose from a set of predesigned avatar figures. Participants were allocated to small teams based on their physical location in the room to ensure that all communication would be facilitated through the public text chat. Participants then teleported to designated areas assigned for each team, and followed the booklet instructions on basic object design and manipulation. At the end of the tutorial, they learned how to communicate, design and manipulate basic objects. Participants were then instructed to put the knowledge gained into practice and work with their team members on a team building activity. Examples of the teams designs are shown in Figures 4.11 - 4.14.

Figure 4.12 - Example screenshots during team building activities

Figure 4.13 - Example screenshots during team building activities

Figure 4.14 - Example screenshots during team building activities

Observations during this session suggest that effective collaboration was achieved within each team. Participants divided the work among them to achieve the desired result, and used the public chat for help and co-ordination. Participants also showed enthusiasm and involvement in the design process. During this initial testing, the system was behaving properly i.e. no lag, crashes, delays or bugs. The environment interactions and outcomes were performed without delays, the system was rendering all avatars, and the nearby text chat communication was working properly.

4.4. Chapter Summary

This Chapter provided details of the design and development of *SHU3DED* cyber campus. The environment has been deployed in Opensim virtual world, and has a realistic look and feel, providing recognisable environments and conveying formal learning atmospheres. The cyber campus consists of a number of rooms that each provides different functionalities. To provide educational functionalities to the environment, Moodle and Sloodle components have been implemented.

An initial technical testing of the environment was conducted with the participation of 13 users through a team building activity. During the session, the performance of the environment was tested and no delays or bugs in the user interaction with the environment or communication were observed. Therefore the environment was considered stable to conduct further experiments. The next Chapter presents the results of the initial evaluation of the efficacy of *SHU3DED* to support online learning activities.

Chapter 5 - Initial Evaluation of SHU3DED

5.1. Introduction

The previous Chapter provided details of the design and development of *SHU3DED* cyber campus prototype. The development of this environment was crucial in this research project, in order to use it as a mean to conduct empirical investigations with. A technical testing of the environment was performed, and no problems were observed, implying that the environment was stable to proceed with further experimentation. Following the research plan as prepared in Chapter 3, the next stage in this research project dictated the evaluation of the efficacy of the prototype to support online learning activities. An experimental study was conducted (Section 5.2), initially evaluating the efficacy of *SHU3DED* to support online learning activities and is presented in this Chapter. However, due to some limitations of the research design of the study, an additional study was found necessary to be conducted to address these limitations, and is also presented in this Chapter (Section 5.3).

This Chapter presents the preparation, the procedures, and the results of these initial evaluation studies, together with their discussion and associated limitations.

5.2. Environment Evaluation Through a Collaborative Team Building Activity

The purpose of this study, as planned in Chapter 3, was to evaluate the users perceptions of presence, awareness, communication and sociability of *SHU3DED* through a collaborative team building activity, and details are presented in this Section.

5.2.1. Preparation

To facilitate participation in this study, some preparation was performed and more details are presented in this Section.

5.2.1.1. Preconfigured Viewer and Avatars

The users' participation in this study was facilitated through remote locations, therefore it was necessary to ensure that they would be able to connect to the system and avoid configuration mistakes. Thus, a preconfigured *Imprudence* installation, user accounts and avatar shapes were set up beforehand. The default steps to connect in the virtual world require downloading and installing *Imprudence*, configuration to access the virtual world, and creating an account. To address this, a bundled setup file that installs a preconfigured *Imprudence* viewer into the participants' computer was created and provided through the Internet. The configuration included the following:

- Login address: Imprudence provides login addresses for many virtual worlds by default. To avoid mistakes, the default addresses were removed and the SHU3DED login address was added as the only option to select for login.
- Voice Service: Voice service was enabled. By default, the voice service is not enabled in Imprudence; therefore, the user cannot speak or hear others in the virtual world.
- Graphics mode: To ensure that all users would be able to enjoy the experience without any interruptions related to hardware limitations of their systems, the viewer graphics mode was downgraded to medium detail level. This renders graphics in lower quality, removing graphical features that are resource hungry (e.g. shades, reflections, anisotropic filtering, anti-aliasing and reducing the graphics drawing distance). This may have reduced the quality of the experience in the virtual world but helped to ensure that users using computers with low technical specifications would be able to use the environment without problems.
- Default notifications: By default, Imprudence provides a series of popup notifications during the first launch. To avoid distractions, these popups were turned off.
- Accounts and Avatars: User accounts, and avatar shapes were created and assigned to participants. The login credentials were emailed to each user. During each account creation, a unique avatar figure was assigned to each user and tested to identify rendering or other technical issues with it. Sloodle Toolbar Lite was then

loaded on the top of the viewer for every avatar, to enable classroom gestures. For every team, one avatar was randomly selected as the leader and was wearing a distinctive outfit.

5.2.1.2. Refined Tutorial Booklet

A refined version of the instructions booklet used during the technical testing of the environment (Section 4.3.1) was electronically sent to participants in a PDF file, prior their interaction with the virtual world (Appendix 5.1). Changes to the booklet included instructions to download and install the preconfigured viewer and login the system. Also, instructions on how to navigate and communicate in the virtual world using the public chat and gestures were also issued. The steps of account creation, avatar clothing, inventory and teleporting were considered unnecessary and were omitted. The object manipulation and team building tasks of the booklet remained the same.

5.2.2. Participants

At the time this study was conducted, it was not feasible to recruit participants with experiences in situational and institutional barriers hindering access and participation to education. Therefore, five sessions with total participation of 25 Sheffield Hallam University students (14 males and 11 females) aged 18 to 38, divided in five teams were conducted instead (Table 5.1). It would have been ideal to include all participants in a single session; however, this was not feasible at the time this study was conducted.

Session	Team Name	Males	Females
1	Globe	3	1
2	Puzzle	4	1
3	Arrow	0	5
4	Diamond	4	2
5	Pyramid	3	2
Total N		14	11

Table 5.1 - Participating teams

5.2.3. Procedures

Before participants' interaction with the study materials, informed consent was sought through the Internet using the form included as Appendix 5.2. Participants were instructed to complete the online pre-experiment questionnaire, and follow the booklet instructions to setup the viewer and connect into the virtual world. Participants logged into the virtual world and followed the booklet tutorial to learn the basic functionality of the system. All communication took place through the public text chat. Participants' teleported to the sandbox areas, where they followed the booklet instructions on basic object design and manipulation. Participants were then instructed to use the knowledge gained in practice, and work with their team members on a collaborative team building activity. To complete this task, participants had to mutually agree on a design from the booklet suggestions list. The team building activity lasted for 60 minutes. At the end of the activity, each team's leader presented their design to the study moderator. Examples of the designs of each team are shown in Figures 5.1 - 5.3. At the end of the sessions, participants were asked to complete the online post experiment questionnaire. The sessions lasted for 120 minutes. The chat communication was recorded for analysis.

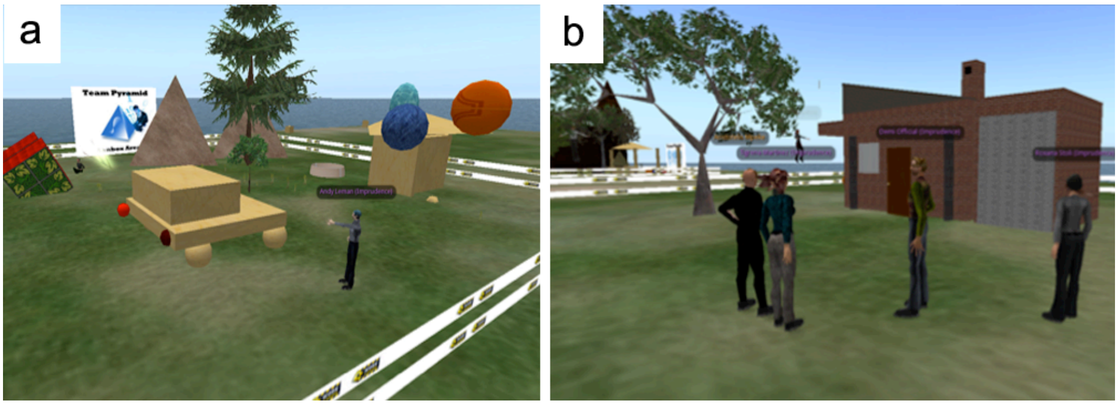

Figure 5.1 - Team Pyramid (a) and team Diamond (b) designs

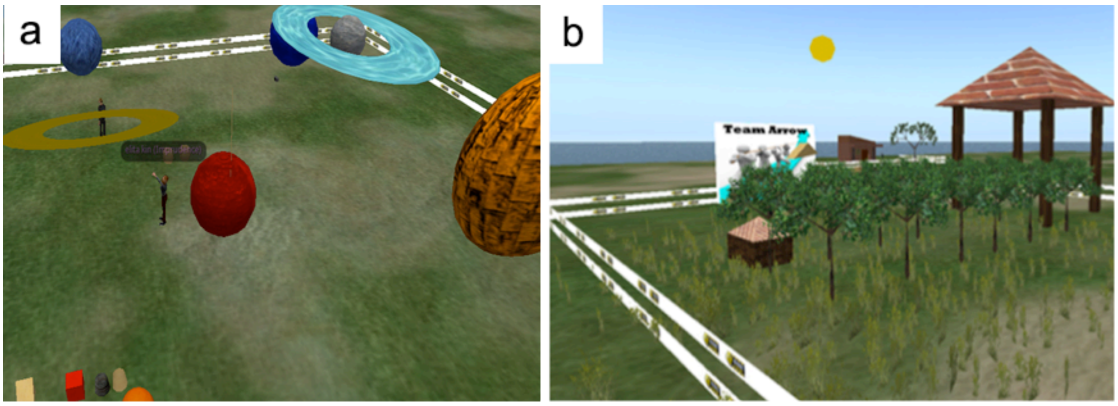

Figure 5.2 - Team Globe (a) and team Arrow (b) designs

Figure 5.3 - Team Puzzle

5.2.4. Results

The results were first aggregated and analysed, and then examined individually to explore differences between teams. The results of the pre-experiment questionnaire were analysed first and the results are shown in Table 5.2. Participants classified themselves as very experienced with the use of computers, with some experience with 3D environments and gaming, and having a tendency to get involved with the activities they undertake.

	PCK	3DG	INV
Mean	5.4	3.16	3.9
Sd	1.32	1.14	.92
Minimum	2.5	1	2.6
Maximum	7	5.5	6.2
Legend: PCK=PC knowledge, 3DG=3D environments and games knowledge, INV=Tendency to become involved in activities			

Table 5.2 - Pre experiment questionnaire results

The results of the post experiment questionnaire were then investigated. The results were verified for normality using a Lilliefors corrected Kolmogorov-Smirnov GoF test, numerical and visual inspection of data. The tests revealed that the data of all scales but Awareness were approximately normally distributed. Awareness failed to pass the GoF test, but numerical tests showed that the skewness and kurtosis of the distribution was within the acceptable *Z: ±1.96* criterion, and a visual inspection of the data revealed that the distribution was bell-shaped (Appendix 5.3). Thus, Awareness data distribution was also considered approximately normal and parametric tests were used.

The PQ was then analysed and the results are shown in Table 5.3. It can be observed that the total presence score is very high (Mean=108.32, Sd=7.77). The factors that contribute to presence are also presented in Table 5.3. Users positively perceived the sense of control (CF) in the environment (Mean=5.61, Sd=0.42) and similar results were obtained for sensory (SF) (Mean=5.85, Sd=0.56), realism (RF) (Mean=5.3, Sd=0.73) and distraction (DF) (Mean=5.59, Sd=0.88) factors, with relatively similar data dispersion.

		Mean	**Sd**	**Minimum**	**Maximum**
Presence	Total	108.32	7.77	92	124
	Scaled	5.7	.41	4.84	6.53
Presence Factors	CF	5.61	.42	4.73	6.36
	SF	5.85	.56	4.5	6.83
	RF	5.3	.73	3.5	6.5
	DF	5.59	.88	3.33	7

Table 5.3 - PQ results

The results concerning Awareness, Communication and Sociability are shown in Table 5.4. Users expressed mainly high awareness (Mean=4.26, Sd=0.4) and sociability (Mean=4.32, Sd=0.3) perceptions of the environment, and also positively evaluated communication (Mean=4.18, Sd=0.55), even when they used only the public text chat and gestures to communicate. The mean value of the scales is indeed very high (4.25) with low data dispersion (Sd=0.42). However, communication revealed the lowest mean with the higher data dispersion of all factors and was investigated further. Deeper investigation revealed that the non-verbal communication using gestures received mixed perceptions from the 44% of the sample (28% undecided, 16% negative), signalling problematic communication using gestures.

Factor:	**Mean**	**Sd**	**Minimum**	**Maximum**
Awareness	4.26	.4	3.33	5
Communication	4.18	.55	3	5
Sociability	4.32	.3	3.8	4.9

Table 5.4 - Results concerning additional evaluation factors

Table 5.5 summarises the results of the specific evaluation of the environment and the additional questions related to the productivity and general satisfaction of the experience. The mean of this category is high (4.42) with low data dispersion (Sd=0.39). It can be observed that users expressed positive perceptions towards the design of the prototype, were productive, and generally satisfied with the experience.

Factor:	**Mean**	**Sd**	**Minimum**	**Maximum**
Collaborative Virtual Environment	4.42	.35	3.71	5
Productivity	4.44	.65	3	5
Satisfaction	4.4	.64	3	5

Table 5.5 - Evaluation of the virtual environment

A one-way-ANOVA test was used to investigate potential differences between teams (Appendix 5.4); revealing no significant differences, therefore the aggregated data analysis was accepted. Additional analysis was also performed to investigate relationships between the sample characteristics with their environment perceptions. A Pearson's product-moment correlation coefficient was computed, and revealed positive correlation ($r = 0.52$, $n = 25$, $p = 0.008$) between users tendency to get involved with activities (INV) and their perceptions of presence in the virtual world (Appendix 5.5).

The chat communication records were also analysed, and revealed that participants have used the public text chat for decision-making, co-instruction and collaboration towards the design of the shared goals. Also participants showed great enthusiasm and involvement in the design process. Examples of effective collaboration and team input were observed during the activity, and are also demonstrated in the teams' final designs (Figures 5.1 - 5.3). It was also observed that participants were co-instructing and requesting help from each other during the process of the design:

> Participant 1*: "Participant 2, can you build it in the center? But don't make it too big"*
> Participant 2*: "Okay ☺ "*
> Participant 3*: "Participant 2, can you make the cube bigger and taller?"*
> Participant 2*: "Yes, like this?"*
> Participant 3*: "No, bigger, a size suitable for avatars."*

Towards the end of the sessions, appraisals among group members were recorded, demonstrating evidence of effective collaboration of all users in the virtual experience.

Participant 4: *"It was an amazing experience! This virtual environment is very promising! I am glad I have worked with you guys!! Great job"*

Participants also acknowledged the design possibilities and capabilities of the virtual world, and the ability to design experiences that deviate from reality:

Participant 5: *"This virtual world allows you to do whatever you want, it is very interesting… Can bring fantasies to life"*

Reliability test of the scales using the data collected through this study was also conducted, and the results are shown in Table 5.6.

Scale:	**Cronbach's α**
Presence	.77
Awareness	.53
Communication	.60
Sociability	.69
Collaborative Virtual Environment	.71

Table 5.6 - Reliability analysis

5.2.5. Discussion

The results of this study suggest that users have positively evaluated the *SHU3DED* for online learning activities. Analysis of the results revealed that participants achieved high levels of presence during the collaborative experience; reporting good sense of control within the environment, high sensory and realism levels, with relatively low distractions. Presence results denote that users have immersed and achieved the sense of *'being there'* during the experience. In addition, participants' perceptions of being together with others in the same space, communicate and collaborate towards the design of shared goals were also evaluated positively, with positive perceptions towards the ability of the prototype to support sociability and contribute to the development of the feeling of belonging to a group. Participants reported high awareness perceptions of what was happening in the virtual world, who was around them and the roles of others in the environment. In addition, the functionalities of the system to support communication were also positively evaluated. However, concerns regarding the use of gestures as a mean for communication were revealed, indicating that participants had difficulties communicating using gestures. The obtained results suggest that *SHU3DED* supports effective communication and social interaction between users. In addition, participants have also positively evaluated the design of the environment. Participants were satisfied and comfortable with the design of the setting, they were productive during the team building activity and were generally satisfied with their experience in the virtual environment. Moreover, positive relationship was identified between users tendency to get involved with activities and their perceptions of presence, implying that involvement is an important determinant of presence in the virtual world, corroborating Witmer and Singer (1998: 231).

The reliability of the instruments used in this study was also tested. The results confirmed their reliability, revealing acceptable values in all scales but Awareness. Awareness scale revealed low alpha index (α=.53), indicating problematic interrelation of the items comprising the scale, an issue also revealed in De Lucia et al. (2009) study.

During the activities, it was observed that users engaged, equally contributed and effectively collaborated towards the design of shared goals. The chat communication also demonstrated effective communication, collaboration and co-instruction of users during the activity. The logs revealed that the activities were performed in very positive and enthusiastic atmospheres. Participants were initiating both task related and informal conversations, which are considered as evidence of effective socialisation and group cohesion. The teams' final designs also demonstrate that users have learned how to build objects and had effectively put the knowledge gained into practice (Figures 5.1 - 5.3).

This evaluation study was conducted as planned in Chapter 3, and the results were positive. However, a number of limitations were identified, affecting the validity of the results and are discussed in the next Section.

5.2.6. Limitations

One of the most important limitations of this study relates to the activities conducted during this evaluation. It has been observed that the activities concentrated more on the collaborative aspect of the virtual world, and did not expose users to the environment's educational tools and functionalities. It was observed that despite the fact that the activities demonstrated learning outcomes, effective communication and collaboration between users, they did not exploit and utilise the educational aspects of the virtual world to a great extent. During the activities, users were not exposed to the various educational rooms and Sloodle components, and it was identified that the activities conducted are not representative of those learning activities for which virtual worlds are being used such as lectures, presentations, examinations etc. Considering that in the qualitative part of this research project, it was required that users participate in a series of learning activities and then express their opinions based on this experience, it was important that the tasks and activities would expose them to the functionalities of the environment to support online learning. Thus, more appropriate learning activities had to be designed to evaluate the *SHU3DED*.

Another limitation relates to the length of each session of the study. Each session lasted 120 minutes and this may be considered inadequate to establish effective social and collaborative relationships. It would have been ideal to host longer and additional sessions to collect data, however it was impossible to hold the participants for longer and for repeated sessions. In addition, during this limited time participants were only offered a superficial experience of the environment, but evidence of learning and effective collaboration are demonstrated in the final designs of each team. Furthermore, the fact that the environment was evaluated through a single session for each team was another limitation. To establish strong community bonds, more sessions were required for the participants to get more familiar with each other and build relationships between them. An additional limitation was that the sample of this study did not participate as a whole, but in segments during different sessions, and this may have affected the results. However, the results were analysed to identify differences between the perceptions of each group, revealing no significant differences.

The pre-experiment questionnaire used in this study has its own associated limitation. This questionnaire is self-reporting, therefore the responders were responsible to self assess their skills. This raises subjectivity issues, in which participants' rated them selves according to what they believed their skills are, and not according to any objective classification. For example, a participant may rate his skills in computers knowledge as excellent, where in reality he might only be a novice user who uses the computer for prolonged times. This is considered as a major disadvantage of this instrument and its validity is questioned. Therefore, the results of the pre-experiment are questionable, and this instrument was not used in following studies, and other measures to determine the users' characteristics were considered.

Considering the limitations identified in this study, it has been determined that an additional evaluation study was required, featuring improved research design and experimental procedures to address these limitations. Therefore, an additional study was conducted and is presented the following Section.

5.3. Environment Evaluation Through a Virtual Lecture

The purpose of this additional study was to reconsider and redesign the experimental procedures as discussed in Chapter 3, to address the limitations identified in the initial evaluation reported above. Some changes to the experimental design were performed, and more details are reported in this Section.

5.3.1. Changes to the Experimental Design

This study took into account the identified limitations of the previous study, and collected relevant data to re-evaluate the efficacy of *SHU3DED*. The major change to the experimental design of this study was aiming at improving the activities conducted in the virtual world. As discussed in the previous Section, it was observed that the activities conducted during the experiments did not exploit the educational tools of the virtual world to any great extent, such as the use of presentation boards, quiz tools etc. Instead, the activities concentrated on the environment's ability to support synchronous collaboration. For this reason, different learning activities were created and implemented, based on examples of activities conducted within educational virtual worlds. The activities of this study required users to learn the functionality of the system and participate in a number of learning tasks including a virtual lecture, a quick quiz examination and a brainstorming discussion. The activities of this study were situated within *SHU3DED* rooms and not in sandbox areas. The participants' orientation with the environment functionalities were performed in the orientation area, and instructions to undertake activities were issued by the study moderator within the virtual world; therefore the use of a booklet was not required. The experiments of this study took place during a computing class session delivered in Sheffield Hallam University. Three experiments were conducted in three different sessions, because the way the class was structured required students to be divided in three groups. The experiments took place at the end of the first half of each class session. The experiments were conducted in a university computer room, and *Imprudence* viewers were preinstalled in all workstations. To speed up operations and minimise configuration mistakes, user accounts and avatar shapes were set up and assigned to participants beforehand. During each avatar account creation, a unique avatar figure was assigned and tested to identify rendering or other technical issues with it. *Sloodle Toolbar Lite* was then loaded on the top of the viewer of every avatar, to enable classroom gestures.

Another change to the experimental design concerned the pre-experiment questionnaire used in the previous evaluation study. This questionnaire was found inadequate to produce quality results; therefore it was not used in this experiment.

However, it was not feasible to address the limitations identified in the previous study concerning recruiting appropriate sample, sample participation in groups and the short length of the evaluation; and the reasons are explained in the limitations Section (Section 5.3.6).

5.3.2. Participants

At the time this study was conducted, it was still not feasible to recruit participants experiencing situational and institutional barriers impeding accessing education. Therefore, 23 computing undergraduates of Sheffield Hallam University were recruited to conduct this evaluation, comprising three groups of 7, 13 and 3 participants (21 of males and 2 females) aged between 19 and 21 years old (Table 5.7). Similar to the evaluation discussed in the previous Section, it would have been ideal to include all participants in a single session, however this was not feasible because the way the module was structured required students to be in groups.

Session	**Team Names**	**Participants**	
		Male	**Female**
1	Earth	6	1
2	Mars	12	1
3	Venus	3	0
Total N		21	2

Table 5.7 - Participating teams

5.3.3. Procedures

Because participants were co-located in the same physical setting, their informed consent was sought through the form included as Appendix 5.7. This form was also used to collect their names, age and gender. Each student had a computer with similar specifications (Table 5.8) at his/her disposal with *Imprudence* viewer preinstalled, and had to configure the login address manually to access the virtual world. To do this, information was given in an instruction document together with their login information in the document included as Appendix 5.8.

System:	Description:
Operating System	Microsoft Windows 7
Processor	Intel(R) Core(TM) i3-4130 CPU, 3.40 GHz
Installed Memory (RAM)	6.00 GB

Table 5.8 - Users computers specifications

The experiments took place in three different 60-minute sessions. During the sessions, participants logged in the virtual world and spend a few minutes in the orientation area to learn the basic functionalities of the system. This included navigation, textual communication, interaction with objects and the use of gestures. Participants then teleported to the lecture room, and a lecture based on the educational use of virtual worlds was performed (Figure 5.4a). Since the participants and presenter were in the same physical room, the oral aspect of the lecture took place outside the virtual world but the lecture presentation slides appeared in the virtual environment through the use of *Sloodle Presenter*; therefore participants were looking at their screen while listening to the presentation. Participants then navigated to the examination room and completed a quiz through the *Sloodle Quiz Chair* (Figure 5.4b). The purpose of this activity was to demonstrate the online quiz ability of the cyber campus and not to measure participants' performance. Participants then teleported to the meeting room, where a constructive brainstorming discussion on how the virtual worlds can be used in education took place. The chat communication was also recorded for further analysis. At the end of the sessions, Participants were asked to complete the online post experiment questionnaire.

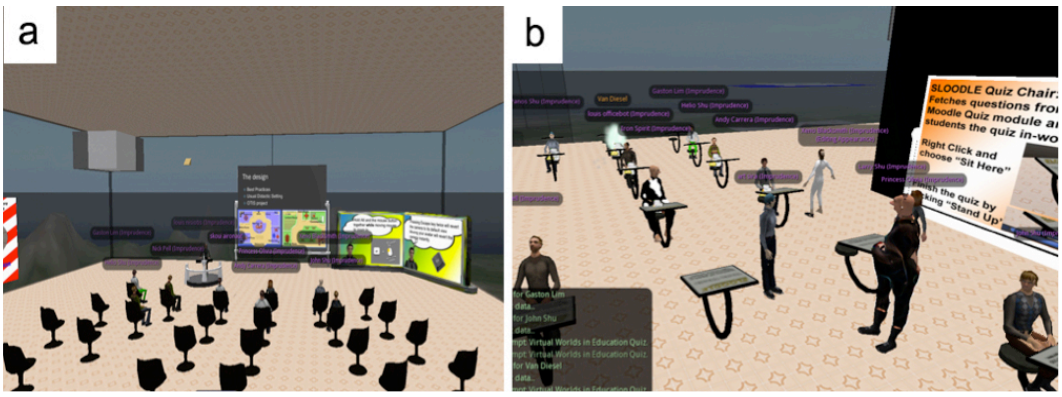

Figure 5.4 - Lecture (a) and examination (b) activities

5.3.4. Results

Because all sessions were conducted under the same experimental procedures, the results were first aggregated and analysed, and then examined individually. The results were verified for normality using a Lilliefors corrected Kolmogorov-Smirnov GoF test, numerical and visual inspection of data. The GoF test revealed that Presence, Awareness and CVE scales were approximately normally distributed. Communication and Sociability scales failed to pass the GoF test, however visual inspection of the data indicated that the distributions were approximately bell-shaped, and numerical tests revealed that both skewness and kurtosis were within the acceptable *Z: ±1.96* criterion (Appendix 5.9). Therefore the scales were considered approximately normally distributed and parametric tests were used.

The PQ was analysed first (Table 5.9). It can be observed that students expressed high perception of presence in the environment (101.6), even when they were all located in the same physical setting. Individual presence factors analysis revealed that users perceived good sense of control (CF) in the environment (Mean=5.31, Sd=0.65). Similar results were obtained for sensory (SF) (Mean=5.45, Sd=0.76), realism (RF) (Mean=5.1, Sd=0.8) and distraction (DF) (Mean=5.55, Sd=0.72) factors, with relatively similar data dispersion.

<table>
<tr><th colspan="2"></th><th>Mean</th><th>Sd</th><th>Minimum</th><th>Maximum</th></tr>
<tr><td rowspan="2">Presence</td><td>Total</td><td>101.6</td><td>11.6</td><td>76</td><td>118</td></tr>
<tr><td>Scaled</td><td>5.35</td><td>.6</td><td>4</td><td>6.2</td></tr>
<tr><td rowspan="4">Presence Factors</td><td>CF</td><td>5.31</td><td>.65</td><td>4.</td><td>6.45</td></tr>
<tr><td>SF</td><td>5.45</td><td>.76</td><td>3.33</td><td>6.83</td></tr>
<tr><td>RF</td><td>5.1</td><td>.8</td><td>3.5</td><td>6.5</td></tr>
<tr><td>DF</td><td>5.55</td><td>.72</td><td>4</td><td>6.67</td></tr>
</table>

Table 5.9 - PQ results

The additional factors that contribute to the evaluation of the efficacy of the virtual world are summarised in Table 5.10. Participants expressed high sociability (Mean=3.95, Sd=0.18) and awareness perceptions (Mean=4.3, Sd=0.41) of the environment, and positively evaluated the communication functionalities of the system (Mean=4.2, Sd=0.28), even when they used only the textual chat and gesture bar to communicate. Similar to the environment evaluation study described in Section 5.2, the item regarding the adequacy of gestures was perceived relatively low (Mean=3.87, Sd=0.34). The total mean value of the factors is very high (4.15) with low data dispersion (Sd=0.29).

Factor:	**Mean**	**Sd**	**Minimum**	**Maximum**
Awareness	4.3	.41	3.67	5
Communication	4.2	.28	3.75	4.75
Sociability	3.95	.18	3.6	4.3

Table 5.10 - Results concerning additional evaluation factors

Table 5.11 summarises the results corresponding to the specific evaluation for the virtual environment and the additional questions related to the productivity and general satisfaction of the experience. The mean of this category is also high (4.25) with low data dispersion (Sd=0.47).

Factor:	**Mean**	**Sd**	**Minimum**	**Maximum**
Collaborative Virtual Environment	4.29	.3	3.9	5
Productivity	4.09	.6	2	5
Satisfaction	4.39	.5	4	5

Table 5.11 - Evaluation of the virtual environment

A one-way-ANOVA test was used to investigate differences between teams (Appendix 5.10), and revealed no significant results, therefore the aggregated data analysis was accepted. The chat communication records were also investigated, and revealed positive opinions towards the use of virtual worlds for learning activities. Students were equally contributing to the brainstorming sessions, and expressed many ideas on how virtual worlds can be used for educational purposes. In addition, enthusiastic and socially warm atmospheres were established throughout the sessions.

> Participant 6: *"Its far more engaging than slideshows or just chatting on forums, highly expandable too"*

> Participant 7: *"It would be useful for teamwork where some wouldn't be able to attend in person"*

> Participant 8: *"It has possibilities for enabling teamwork when you are at home and possibly make lectures more interesting"*.

Reliability test of the scales was also performed during this study to reconfirm the reliability of the results (Table 5.12).

Scale:	**Cronbach's α**
Presence	.88
Awareness	.68
Communication	.62
Sociability	.61
Collaborative Virtual Environment	.67

Table 5.12 - Reliability analysis

5.3.5. Discussion

The results of this evaluation revealed that participants have positively evaluated *SHU3DED* to support online learning activities. During the experience, participants achieved high levels of presence in the virtual world, and reported good sense of control in the environment, high sensory levels and perceived realism with minimum distractions. The presence results indicate that students immersed in the virtual world during the experience, and achieved the feeling of '*being there*'. The students' perceptions of being in a familiar and realistic environment together with their peers was also evaluated positively, with positive perceptions towards the ability of the virtual world to support sociability. Participants reported that they were aware of others around them, their actions and what was going on in the virtual world, and effective communication and social interaction among them was established. In addition, participants have also evaluated the design of the prototype positively, considered the design comfortable, they were productive and satisfied from the experience.

The reliability of the instruments used in this study was also tested. The test revealed scores higher than the coefficients threshold value (α=.60), and confirmed the reliability of the scales. The results of this evaluation are also similar with the evaluation study discussed in the previous Section and other studies in the literature (De Lucia et al., 2009; Griol et al., 2012). This demonstrates high concurrent validity of the evaluation methodology, yelling repeated results.

Observations during the activities indicated that participants were engaging and enthusiastically participating. It was also observed that the atmosphere in all sessions was very friendly and socially warm. The chat records revealed that students have formally and informally communicated, and equally contributed during activities. Participants have also admitted that they enjoyed the experience and they considered the cyber campus as an effective tool to support online learning.

The changes to the experimental study have improved the activities appropriateness, evaluating the environment through a number of tasks that exploit some of the educational capabilities of the virtual world. The activities conducted were representative of those for which virtual worlds are being used. However, a number of limitations in respect to the experimental design were also identified, affecting the results of this study and are discussed in the following Section.

5.3.6. Limitations

The most significant limitation of this study relates to the fact that the sessions took place in a university lab environment, in which students and the moderator were located in the same physical room, and the lecture presentation took place orally in the physical setting rather than within the virtual environment. The concept of this research project was aiming to evaluate the environment through distance, and co-located activities challenged the claims related to online learning support. Since the virtual world can be accessed from anywhere, it is appropriate that users participate in activities from remote locations, and this study did not demonstrate this.

Another limitation of this study relates to the limited length (60 minutes) of each experiment. Because of this limitation, students did not communicate and interact long enough to develop deep social relationships, and also the procedures were shortened. This is most likely to have affected the results but it was not feasible to increase the length of the experiment because it was conducted during a scheduled class. Moreover, the fact that the evaluation took place through a single session is also a limitation. In this limited timeframe, students were only offered a superficial experience of the environment, and the learning experience should have been investigated for a longer period of time. In addition, the sample involved in this study was divided in teams and participated in different sessions. The way the class was structured, required students to be in groups and participate on different days each. For this reason, each experiment was having different numbers of participants and this may have also affected the results.

An important limitation of the previous evaluation study was that the pre-experiment questionnaire was not adequate enough to produce quality data regarding the sample background characteristics. This study did not address this limitation because at the time it was conducted, appropriate questionnaire was not yet devised. In addition, it would have been of great benefit if the users' skills with virtual worlds were measured, to investigate if this was associated with the post experiment results of this study.

Taking into account the limitations discussed in this Section, it was considered necessary to redesign the experiments and conduct an additional study to address them and the benefits were twofold. First, redesigning the experiments would improve the data quality and better support the research claims to evaluate the environment through online learning activities. Second, this would offer the opportunity to establish the sample of the follow up qualitative study as planned in Section 3.5. This study aimed to involve people who have experienced barriers hindering access to education, in which they would have first participated in a online learning activity that demonstrate them the educational affordances of the virtual world, and then discuss their experience. Therefore, conducting an additional experimental study aiming to address the limitations identified in this and the previous study, allowed establishing the sample for the qualitative study to follow.

5.3.7. Chapter Summary

This Chapter presented the results of two experimental studies, initially evaluating the educational efficacy of *SHU3DED*. An initial environment evaluation was conducted through a collaborative online learning activity. During this activity, users have learned how to build and manipulate objects in the virtual world, and collaborated towards the design of shared objects, and the results were positive. However, the environment evaluation as prepared in Chapter 3 (Section 3.4) was not carried out as planned, because at this stage of this research project it was not feasible to recruit appropriate participants. Therefore, the evaluation was conducted using convenience sampling. In addition, a number of limitations were also identified in regards to the experimental design of the study.

An additional study was conducted to address the identified limitations and is also presented in this Chapter. This study redesigned the experimental procedures and evaluated the perceptions of users through a series of learning tasks, comprising of lecture, quiz and brainstorming activities. However, appropriate sample was still not feasible to be established, and limitations in the research design were also identified.

The results of both evaluations indicated that users achieved high levels of presence in the virtual world, with high perceptions of awareness of the existence and actions of others in the environment. Also, communication and the sociability of the environment were positively evaluated. In addition, users have positively evaluated the design of the environment; they were productive and satisfied with the experience. The reliability of the instruments used to collect data was also tested and confirmed.

However, considering the limitations of these studies, their results could only serve as initial evaluations of the environment, providing indications on how to perfect the experimental design of this research project. Taking into consideration these indications, an extended evaluation study to address them was conducted and described in the next Chapter.

Chapter 6 - Extended Evaluation of SHU3DED

6.1. Introduction

In the previous Chapter, two experimental studies initially evaluating the educational efficacy of *SHU3DED* were conducted. The results were positive, however, a number of limitations in respect to the experimental design of both studies were identified, affecting the validity of the results. Also, appropriate sample was not feasible to be recruited. Thus, the need of an additional evaluation study was required to address these limitations, better support the research claims and collect quality data.

This Chapter presents the extended evaluation of *SHU3DED*, aiming to collect participants' perceptions of the environments through an online learning activity in the form of virtual lecture and brainstorm discussion. Section 6.2 presents the changes to the experimental design; the preparation, and lecture material used during this extended evaluation. Section 6.3 presents how participants were recruited, and Section 6.4 describes the procedures followed to conduct this evaluation. Section 6.5 presents the results of this evaluation, and Section 6.6 discusses them. A number of limitations that affect the validity of this study were also identified and are discussed in Section 6.7, and Section 6.8 concludes this Chapter.

6.2. Changes to the Experimental Design

Although the results of the previous evaluation studies were positive, a number of limitations were identified, affecting the validity of the results. To address these limitations, the experimental study presented in this Chapter was aiming to evaluate the environment through a series of online learning activities in which the sample involved participated as a whole, from remote locations, in one virtual online learning session. The ideal situation would have been to involve the sample in several sessions to experience the virtual world to a greater extent; however, this was not feasible. To compensate for this, the length of this experiment was 120 minutes and the educational activities were redesigned, and comprised environment orientation, virtual lecture and brainstorming activities. The step of completing a quiz after the lecture was replaced by longer brainstorming activity, to allow participants communicate and socialise between them for longer period rather than undertaking individual activities. Details of the activities and procedures followed are presented in Section 6.4

Because the sample involved in this experiment participated as a whole and not in groups, the server should have been able to handle multiple user interactions without technical difficulties. Therefore, it was decided to minimise the number of requests to the server to the lowest possible. To achieve this, the teleport function and other scripted objects that posed heavy traffic requests on the server were not used, and participants walked to the rooms instead. Also the information boards within the environment were updated to reflect the needs of the new learning activities.

Another purpose of this study was to establish the sample of the qualitative study that followed, in which the sample involved in this evaluation was invited to participate in a number of virtual focus group sessions. Therefore, the characteristics of the sample had to be investigated using a questionnaire to describe the sample properly. The pre experiment questionnaire used previously (Appendix 3.3) was found inadequate to provide quality data. For this reason, a pre experiment questionnaire was designed and is presented in Appendix 6.1. The purpose of this questionnaire was to collect data based on participants' skills and previous experience with virtual worlds, age, gender, and experiences with barriers impeding access and participation to Higher Education.

6.2.1. Preparation

Because the participants of this study were remotely located, it was necessary to ensure that they would be able to login the system and avoid configuration mistakes. Thus, the preconfigured *Imprudence* installation used in the previous study (Section 5.2) was used, together with creating user accounts and avatar shapes beforehand.

In the preparation of the study, a series of emails were exchanged with the volunteers, to prepare them for participation (Appendix 6.3). Participants were then pre allocated in teams for the needs of the brainstorming activity because of two reasons. The first reason was that the chat-based discussion between people in small groups is more efficient and manageable rather than having many people trying to chat at the same time. The second reason was to prepare the groups to participate in the virtual focus group study that followed. This would allow the participants to meet and familiarise with each other before the virtual focus groups. At this point, participants have completed the pre-experiment questionnaire, and provided details about the barriers they experience hindering access to education. Based on an initial analysis of these responses, a number of situational and institutional barriers were identified and the teams were formed based on a categorisation of similar barriers (Table 6.1).

Team Name	**Barriers**	**N**
Team Puzzle	Disabilities	8
Team Arrow	Distance and financial barriers	9
Team Globe	Family and work related barriers	7

Table 6.1 - Description of the formed teams for the brainstorming activity

6.2.1.1. Lecture Material

To conduct the virtual lecture in this study, a PowerPoint style presentation was designed based on evidence from the literature (Appendix 6.5). The purpose was to demonstrate the capabilities of virtual worlds in education, to generate interest and stimulate discussion based on how this tool can support learning.

Because some participants were not able to listen to the oral presentation because of disabilities, technical or other issues, the *EasySpeak* tool was used. *EasySpeak* is a textual transcribing tool that the presenter attaches to his/her viewer and employs a clicking mechanism to provide line-by-line text in the public text chat. The notes of the presentation were prepared beforehand, and this tool was used to provide textual information of what is been spoken through the public text chat.

6.3. Participants Recruitment

To recruit participants for this study, a call for participation (CFP) webpage was created, describing the purpose of the study, the profile of participation and study procedures. The criteria for participation were the following:

1) Over 18 years old,
2) University student or university graduate,
3) Experience with situational and/or institutional barriers hindering access and participation to education,
4) Relatively modern computer and Internet connection.

The advertisement period was three weeks and took place online. Social networking sites were utilised to issue open invitations for everyone to participate, as well as sending emails to organisations for people with disabilities. Second Life was also used to advertise the CFP to groups with interest in educational virtual worlds. In addition, a presentation to the members of the Virtual Ability Island through Second Life was performed. Virtual Ability Island is an educational and support centre for disabled people community in Second Life (Gilbert et al., 2013).

6.4. Procedures

Participants logged into the virtual world and spend a few minutes in the orientation area to learn and get familiar with the basic functionality of the system such as navigation, chat communication, objects interaction, use of gestures and adjust camera view. Participants who completed the orientation task navigated to the courtyard and socialised while waiting for everyone to connect. When all participants were connected and completed the orientation stage, a voice test was performed. A brief of the activities of the day was performed, followed by a lecture in the outdoor lecture room (Figure 6.1). During the lecture, artefacts were resolved to support the presentation (Figure 6.2a), for example, rendering a temple to demonstrate the ability of virtual worlds to recreate high detailed monuments. At the end of the lecture, a quick break took place and then participants navigated to their team's corresponding meeting room where a tutorial activity was performed. This activity was in the form of a brainstorming session, discussing how virtual worlds can be used in education (Figure 6.2b). Another task of this activity was to mutually decide a convenient day and time to meet in the virtual world for the follow-up virtual focus group sessions. Each team decided and reported their agreed date and time to the study moderator. At the end of the session, participants logged out of the environment and the web-link for the post experiment questionnaire was emailed to them.

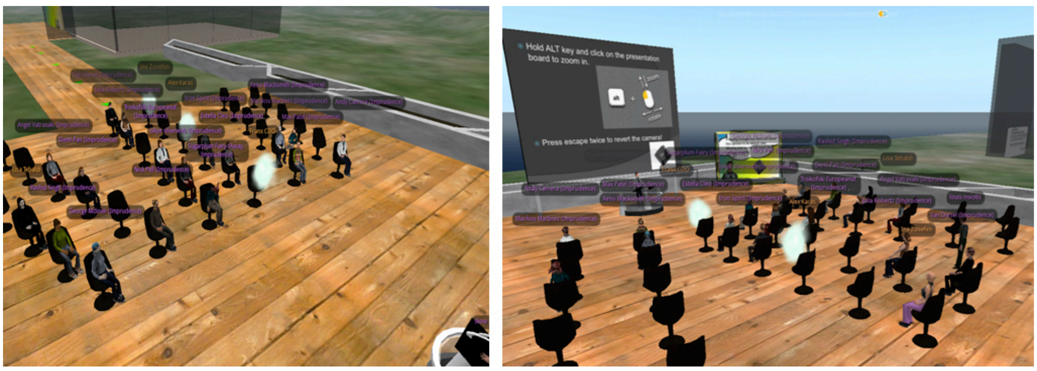

Figure 6.1 - Virtual lecture

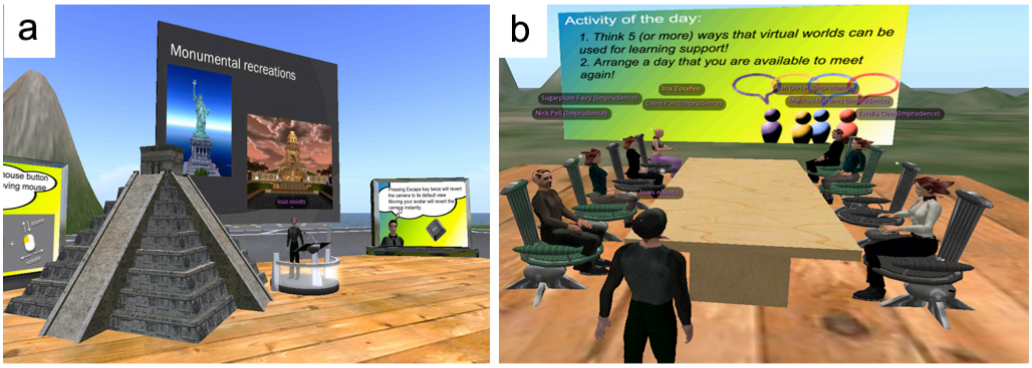

Figure 6.2 - Presentation artefacts (a) and brainstorming activity (b)

6.5. Results

The results of the pre-experiment questionnaire were investigated first. Frequencies were investigated to examine this questionnaire. Participants' responses were categorised in a 7-point skill levels ranging from no experience (1) to expert (7), according to the skills categorisation scheme presented in Appendix 6.2. An additional open-ended question was issued to collect experiences with barriers impeding access and participation to education. The results of this questionnaire are included as Appendix 6.6.

The sample of this study involved 24 people (12 males and 12 females), between 19 and 57 years old. 15 participants were graduates and 9 were Higher Education students. The participants' experiences with virtual worlds is shown in Figure 6.3. According to the responses regarding participants' experiences with barriers hindering access to education, a number of barriers were identified and Figure 6.4 shows their frequencies.

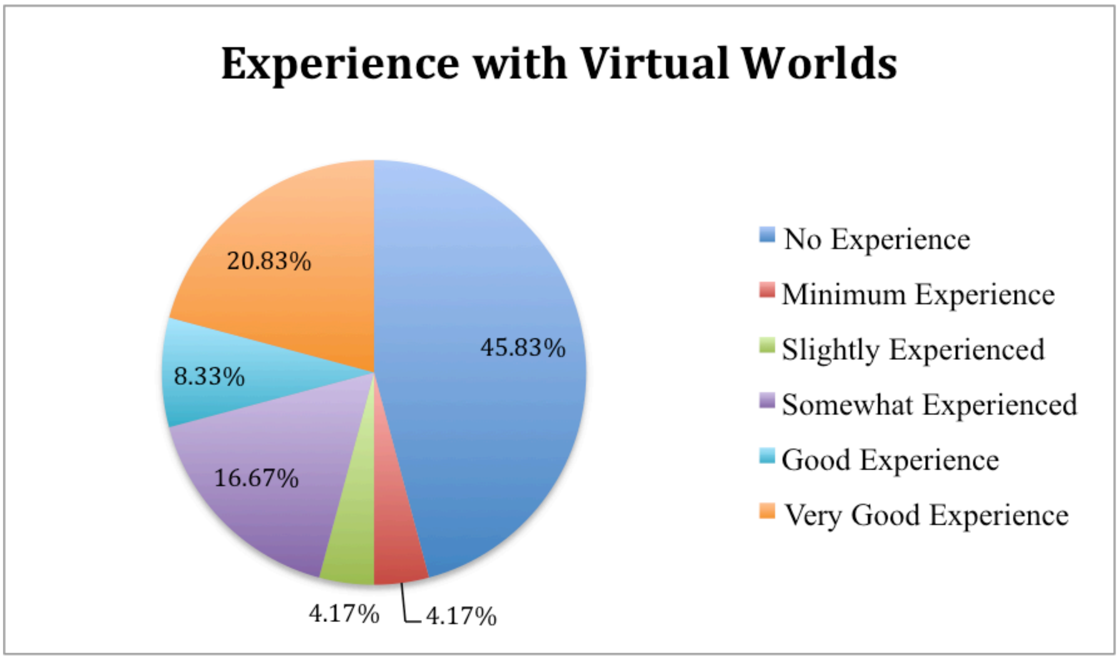

Figure 6.3 - Experience in virtual worlds

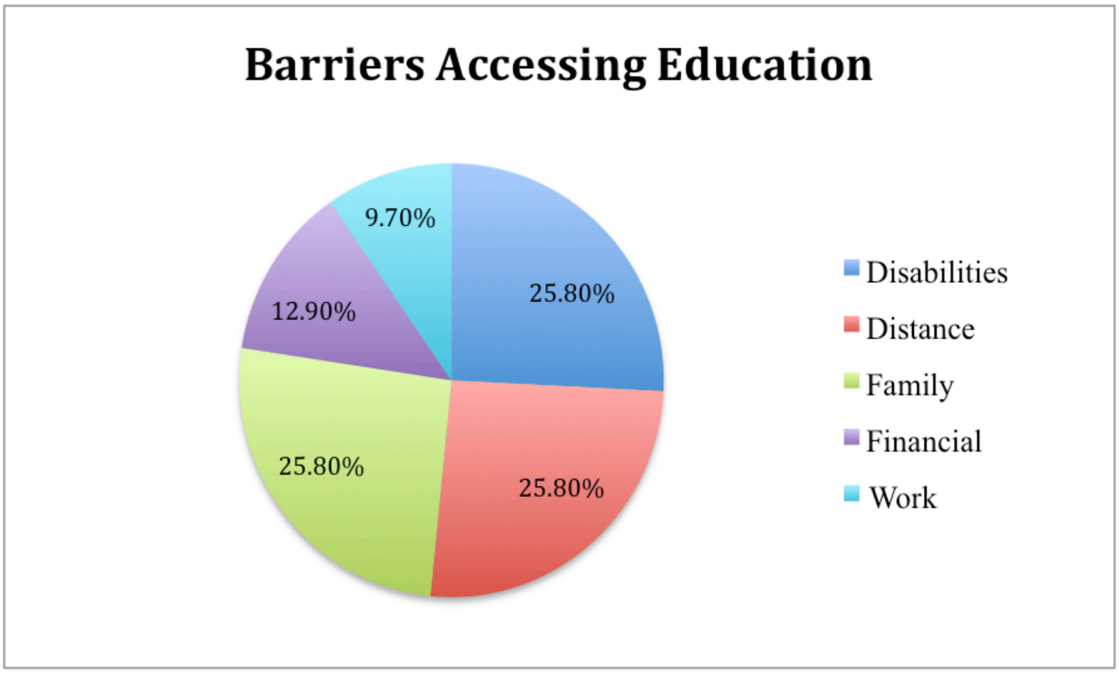

Figure 6.4 - Barriers frequencies

The post experiment questionnaire was then analysed. Before conducting any statistical analyses, the degree of normality of the data distribution was tested. A Lilliefors corrected Kolmogorov-Smirnov GoF test, numerical and visual inspections of the data distribution revealed that Presence, Communication, Sociability and CVE scales were approximately normally distributed (Appendix 6.7). Awareness scale failed to pass the GoF test, revealing a value ($p=.049$) that marginally violates the test threshold ($p<.05$). However, visual inspection of the data indicated that the distribution was approximately bell-shaped and numerical tests revealed that both skewness and kurtosis were within the acceptable *Z: ±1.96* criterion; therefore Awareness scale was also considered approximately normally distributed, and parametric tests were employed for the statistical treatment of all scales.

The PQ was analysed first (Table 6.2), revealing that participants achieved high sense of presence in the environment during the experience (Mean=105.21, Sd=13.6). Individual factors analysis revealed that participants reported good sense of control on the environment (CF)(Mean=5.63, Sd=0.64) with positive perceptions towards the sensory (SF) (Mean=5.51, Sd=0.93) realism (RF)(Mean=5.69, Sd=0.69) and distraction factors (DF)(Mean=5.33, Sd=1.15).

		Mean	Sd	Minimum	Maximum
Presence	Total	105.2	13.6	79	131
	Scaled	5.54	.72	4.16	6.89
Presence Factors	CF	5.63	.64	3.91	6.82
	SF	5.51	.93	3.33	7
	RF	5.69	.69	4	6.5
	DF	5.33	1.15	3.33	7

Table 6.2 - PQ results

Table 6.3 summarises the results of the additional factors. Participants expressed positive perceptions towards Awareness (Mean=4.39, Sd=0.46), Communication (Mean=4.22, Sd=0.74), and Sociability (Mean=4.17, Sd=0.52) in the environment, even when they used only the public text chat and gestures bar to communicate. However, Communication revealed the higher data dispersion (Sd=0.74) of these factors and was investigated further, revealing that perceptions of the use of gestures were mixed. The total mean of the additional factors is high (4.26) with low data dispersion (Sd=0.57).

Factor:	Mean	Sd	Minimum	Maximum
Awareness	4.39	.46	3.33	5
Communication	4.22	.74	2	5
Sociability	4.17	.52	3	5

Table 6.3 - Results concerning additional evaluation factors

Table 6.4 summarises the results of the environment evaluation and the additional items concerning productivity and satisfaction. The mean of this category is also high (Mean=4.31) with low data dispersion (Sd=0.61).

Factor:	**Mean**	**Sd**	**Minimum**	**Maximum**
Collaborative Virtual Environment	4.35	.49	3.29	5
Productivity	4.17	.64	3	5
Satisfaction	4.42	.72	3	5

Table 6.4 - Evaluation of the virtual environment

Further analysis of the obtained results was performed to identify relationships between factors. A Pearson's product-moment correlation coefficient was computed, and revealed significant correlation between all the evaluation factors (Table 6.5). The results were also investigated for potential relationship with the sample experience with virtual worlds as collected through the pre-experiment questionnaire, revealing no significant results (Appendix 6.8). The results were further analysed to identify differences between participants' gender (Appendix 6.9) and academic status (Appendix 6.10) with their perceptions of the environment. A series of one-way-ANOVA tests were conducted revealing no significant differences.

	PQ	**AW**	**COM**	**SOC**	**CVE**	**PRO**	**SAT**
PQ	---						
AW	.54**	---					
COM	.59**	.63**	---				
SOC	.74**	.63**	.72**	---			
CVE	.71**	.65**	.71**	.79**	---		
PRO	.50*	.56**	.70**	.65**	.80**	---	
SAT	.47*	.59**	.70**	.65**	.73**	.70**	---
**. Correlation is significant at the 0.01 level (2-tailed).							
*. Correlation is significant at the 0.05 level (2-tailed).							
Legend: PQ=Presence, AW=Awareness, COM=Communication, SOC=Sociability, CVE=Collaborative Virtual Environment, PRO=Productivity, SAT=Satisfaction							

Table 6.5 - Correlations

The chat communication records were also analysed, revealing positive opinions towards the use of the virtual world for learning activities:

Participant 9: *"Virtual worlds can be used to establish effective and meaningful collaboration between students"*

Participant 10: *"It is amazing how many things you can do in here… Sky is the limit… this easily suits my learning needs"*

Participant 11: *"I think is great to be able to participate in learning through this tool, it is more engaging, richer and more fun than my distance learning course"*

Participants were also communicating and socialising in both formal and informal ways during the activities:

Participant 12: *"I feel that this tool can help me access learning without the problem of distance that I am facing."*
Participant 11: *"Yes it is more engaging and more interesting as well compared to the distance learning course I was enrolled."*
Participant 12: *"So we should note it down for the exercise then? Accessibility and engagement?"*
Participant 13: *"Yes."*
Participant 11: *"Yes!!! "*

Participant 14: *"I live in Greece and it is great that I can meet people from around the world."*
Participant 15: *"Oh you live in Greece? What a lovely place. I visited Athens two years ago."*

Reliability analysis of the scales was also performed to reconfirm the reliability of the instruments, and the results are shown in Table 6.6.

Scale:	Cronbach's α
Presence	.88
Awareness	.47
Communication	.89
Sociability	.90
Collaborative Virtual Environment	.86

Table 6.6 - Reliability analysis

6.6. Discussion

The results of this study imply that participants have positively evaluated the potential of *SHU3DED* to support online learning activities. During the experience, participants immersed and achieved high levels of presence within the cyber campus. Participants perceived good control in the environment, positively evaluated its richness, realism and sensory levels, and reported relatively low distractions that could diminish their sense of presence. The participants' perceptions of being together in the virtual world were also positively perceived, reporting high awareness perceptions of what was happening in the virtual world, the existence, actions and roles of others in the environment. The communication functionalities of the system and sociability of the environment were also positively evaluated. The results suggest that *SHU3DED* can support effective communication and socialisation, and provide the feeling of belonging to a learning community to its users. However, mixed perceptions towards the adequacy of gestures as a mean for communication were identified, indicating that some participants encountered difficulties communicating using gestures. This has repeatedly occurred during the experimental studies of this research project, and this should be investigated further in the future (See Section 9.5). In addition, the design and productivity of the environment was positively evaluated, and participants were satisfied with the experience.

During the virtual experience, participants learned how to use a virtual world and were exposed to some of its educational affordances. Participants enthusiastically participated in activities and the session was conducted in formal, but at the same time socially warm and friendly atmosphere. Participants formally and informally communicated and socialised between them towards both task and non-task related maters, and they also equally contributed in activities. Chat log analysis also revealed that the environment was positively perceived and participants established friendly relationships between them, even when the timeframe of the experience was relatively limited.

The results also indicated significant relationships between the evaluation factors, demonstrating the importance of each factor and its contribution to the experience of users in the virtual world. The results also revealed that users experience and skills with virtual worlds, gender and academic status did not influence their perceptions of the environment.

The reliability of the instruments was also tested, indicating that the scales have high internal consistency, but problematic index was revealed for Awareness scale. This is consistent to the De Lucia's et al. (2009) study and was also identified in the study discussed in Section 5.2, implying that the items comprising the scale are not correlating well with each other. Subsequently, it can be argued that the analysis of Awareness scale may not be as robust and reliable and that the results should be interpreted with caution. A possible solution was to determine if any items of the scale could be discarded to improve reliability (Appendix 6.12). Another solution was to report each item individually and not as part of a scale. However, it was important to consider the possible factors that may have influenced the test results. Appendix 6.12 presents the items comprising Awareness for visual inspection, where homogeneity in the results can be observed. Spiliotopoulou (2009) suggests that data variability is a factor that influence reliability, in which homogeneity in group responses yields lower test results. Sample size and small number of items comprising the scale can also yield lower index (Field, 2009), and Schmitt (1996) suggests that measures with low alpha index can still be useful. Nevertheless, it was beyond the scope of this research project to investigate this, and it could be investigate in the future (See Section 9.5).

Considering the results of this evaluation and observations during the experiment, it can be argued that *SHU3DED* has the potential to effectively support online learning activities. The experiment demonstrated the potential of the environment to handle and support participation in online learning activities for remotely located users, providing effective communication and social interaction between them.

The changes made to the experimental design improved the validity and quality of the results, and addressed the majority of the limitations identified in the previous experiments. In addition, the results of this evaluation are consistent with the literature (De Lucia et al., 2009; Griol et al., 2012), and the previously conducted studies of this research project, implying high concurrent validity. However, a number of limitations in respect to the experimental design of this study were also identified, affecting the quality of the results and are discussed in the following section.

6.7. Limitations

One of the main limitations of this study was that the prototype was not evaluated through a real learning scenario but using an artificially created learning experience, therefore this affected the ecological validity of the study. However, the activities of this study were designed in ways that replicated realistic educational activities. In addition, the length of the activities was also a limitation, together with the fact that the environment was evaluated in one single session. In this timespan, participants were only offered a superficial experience of the learning environment, more related to issues regarding the user interface and social experience than to online learning. Participants should have been be investigated for a longer period of time to obtain data that is relevant for the factors that have been studied, and this was not addressed in this study.

The extent to which the lecture and the presentation slides (Appendix 6.5) used during this activity have influenced the users perceptions of the environment is also an important concern. The lecture was based on the concept and use of virtual worlds for educational purposes, focusing on their capabilities, possibilities and advantages and not presenting the limitations and disadvantages of such environments. Therefore this may have influenced the users perception of the environment and it was an important limitation of this study.

To collect demographic data and describe the sample characteristics, a pre experiment questionnaire was designed and used in this study, investigating the participants' skills and experiences with virtual worlds, and barriers impeding access to education. However, this questionnaire has not been previously used, its reliability and validity are questionable and the results were approached with caution.

Another limitation of this study was that voice functionality of the virtual world was only used during the virtual lecture and this could have affected the results. However, the use of voice was prohibited because one participant was deaf and required textual transcription of verbal messages. Voice was only used during the presentation and was transcribed using *EasySpeak*. Also users were not exposed to IM or group message communication, for the moderator to monitor and manage the conversations.

6.8. Chapter Summary

This Chapter presented the results of the extended evaluation of the efficacy of *SHU3DED* to support online learning activities. A series of learning activities were conducted with the participation of people with experience in situational and institutional barriers hindering access and participation to education, and relevant data was collected. The results suggest that *SHU3DED* has the potential to support online learning activities and be a sound social space, in which students can immerse, socialise and participate together in warm learning activities. This study also demonstrated the potential of the environment to successfully facilitate and support online learning activities. However, a number of limitations were identified relating to the level of confidence and validity of the findings and must be put under deep consideration for any further work to be performed based on this research project.

Following the results of this evaluation, investigation of the ability of *SHU3DED* to support access and participation in learning activities for students experiencing barriers hindering access to education was conducted through a virtual focus group study, and details are discussed in the next Chapter.

Chapter 7 - Virtual Focus Group

7.1. Introduction

In the previous Chapter, the efficacy of *SHU3DED* to support online learning activities was evaluated. A series of online learning tasks were conducted, with the participation of people with experience in situational and institutional barriers hindering access and participation to Higher Education. The results of the environment evaluation implied that *SHU3DED* has the potential to support online learning activities, and be a sound social space that provides effective communication and social interaction. Next, a qualitative study that explored situational and institutional barriers impeding access and participation in education, and the extent to which a cyber campus can support online learning and mitigate the effects of those barriers was conducted, and details are presented in this Chapter. Section 7.2 presents the details of this study, including the procedures followed to collect data, and the sample participated. Section 7.3 presents the results and findings of this study. Section 7.4 discusses the associated limitations of this study, and Section 7.5 concludes this Chapter.

7.2. Experimental Study

In Chapter 3 (Section 3.5), a qualitative study was planned to follow the evaluation of the virtual world for its efficacy to support online learning activities. This study aimed to employ virtual focus group research to understand the barriers hindering access and participation in education, and how a cyber campus can be used to support online learning and alleviate some of those barriers. The participants of the evaluation study discussed in the previous Chapter were invited to participate in a number of virtual focus group sessions, and this Section presents how this study was designed and conducted.

7.2.1. Procedures

To collect data for this study, the teams (Puzzle, Globe, Arrow) that participated in the brainstorming activity of the experiment discussed in the previous Chapter (See Table 6.1) were invited, and a virtual focus group session was conducted for each team. The duration of each session was 120 minutes. The meeting room of the cyber campus was used as the place to facilitate the discussions (Figure 7.1). The questions used to collect data from this study are shown in Appendix 3.11. The plan for the conversation included an introduction, and a discussion about participants' experiences with barriers hindering access and participation to education. The topic then switched to a discussion about participants' experience during the virtual lecture. Following this, a discussion based on the educational characteristics of the virtual world, and how these may support access and participation in online learning activities was conducted. At the end of the sessions, a concluding question was also issued to summarise the most important points of the discussion.

The study was conducted as planned in Chapter 3 (Section 3.5). A few people could not participate in their team's focus group session, and a replacement session was conducted for them. The duration of the replacement session was 50 minutes.

During all sessions, the chat communication was established through the nearby chat and was recorded for analysis, therefore the data was already transcribed. Data was imported to Nvivo 10 qualitative software for analysis. A hybrid thematic analysis utilising both deductive and inductive approaches was employed to identify, analyse and report themes emerging through data.

The results were first analysed to identify barriers hindering access and participation to education. To perform this, the Cross (1981) framework as discussed in Section 3.5.3 was utilised to categorise barriers. Following this, the results concerning the educational characteristics of the virtual world were analysed, to determine the extent to which a cyber campus can alleviate some barriers impeding access and participation to education, and support students experiencing them. The characteristics of presence, awareness, communication and sociability were analysed first, as these are the ones that contribute to the learning experience through cyber campuses. The analysis continued to identify additional characteristics that may contribute to effective learning support through the environment.

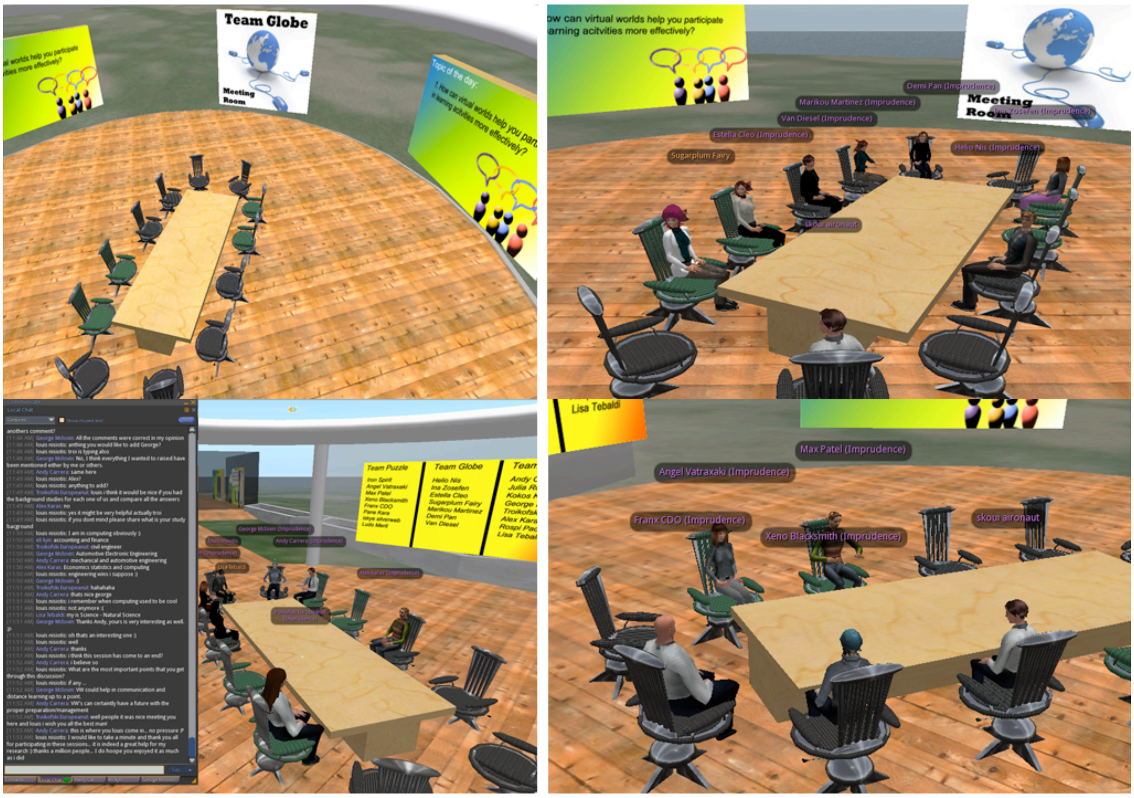

Figure 7.1 - Virtual focus group sessions

7.2.2. Sample

From the overall number of the invited participants of the evaluation study (N=24) discussed in Chapter 6, 19 people participated in this study; 2 of them attended the replacement session. Participants were 9 males and 10 females, between 19 and 57 years old. 6 participants were university students and 13 Higher Education graduates. Participants who could not attend were emailed to complete an open-ended questionnaire with questions similar to the ones used during the focus groups (Appendix 7.1) and two additional responses were collected (28 and 52 years old females, Higher Education graduates, Appendix 7.2). Participants were allocated in teams (Table 7.1) based on the category of barriers they experience in accessing education, according to the information provided in the pre-experiment questionnaire (Appendix 6.1) collected in the previous study (Chapter 6).

Team Name:	Barriers	N
Team Puzzle	Disabilities	4
Team Arrow	Distance and Financial barriers	6
Team Globe	Family and Work related barriers	7
Team Pyramid	Replacement Session	2

Table 7.1 - Virtual focus group teams

7.3. Results

This Section presents the results of this study, which are organised in two main topics:

- Topic 1 - Barriers hindering access and participation to education.

The barriers identified during the virtual focus groups were categorised according to the Cross (1981) framework into situational and institutional barriers, and presented in this order.

- Topic 2 - The characteristics of the cyber campus that support online learning and mitigate barriers hindering access to education.

This topic presents the results related to the characteristics of the environment that contribute to effective online learning support, and help to mitigate some of the barriers impeding access and participation to education. Findings corresponding to presence, awareness, communication and sociability were analysed first; some additional characteristics that contribute to effective online learning support and to alleviate barriers are also presented.

During the presentation of the results, examples from the discussions are used to demonstrate and support the interpretations. The use of square brackets [] indicates comments, corrections or attempts to interpret a hidden meaning. The use of three dots (…) shows that part of the quotation has been purposefully omitted.

7.3.1. Topic 1 - Barriers Hindering Access and Participation to Education

During the virtual focus groups, the participants' experiences with barriers impeding access and participation to education were explored. The results are presented in this Section.

7.3.1.1. Situational barriers

During the data analysis, it became apparent that the situational barriers were the most evident in the participants' educational experience. A number of themes emerged including financial barriers, distance to facilities, family commitments, work responsibilities and health issues. Most frequently, participants discussed financial aspects of education and associated barriers.

> Participant 28: *"Travelling is expensive, buying books is expensive, eating from the university kiosk is expensive."*

Participants pointed out that it is essential to work to manage their financial obligations, and emphasised how this limits their study time, affects their concentration and can even compromise their studies.

> Participant 12: *"*[Financial issues have] *huge impact. Not being able to study. As simple as that. You can still compromise and study but is not what you want to do is it?"*

The financial stress and loss of income were often mentioned, and some participants reported that they have to work longer shifts to support their studies. Participants suggested that this increases their stress levels, lowers energy and affects their concentration and motivation to study.

> Participant 18: *"Due to financial problems, I have a full time and a part time job to cover my financial obligations. I have difficulties attending lectures because I have to work. This is very stressful and tiring."*

The issues of distance to the educational institution and its associated costs, as well as the time and effort of travelling were discussed too. Participants indicated that the costs of transportation have an influencing role in their access and participation in education.

They also explained that travelling to attend lectures is a time and effort-consuming task that affects attendance and participation in learning.

> Participant 17: *"I was staying far from the university campus, so commuting to the university every day to attend lectures was difficult and time consuming. It is also expensive to drive to the campus every day"*

Participants who have to leave home, travel to other areas and find accommodation also revealed that they encounter heavy financial challenges. Some participants explained that the costs of traveling abroad and finding term time accommodation are barriers that pose significant difficulties, and can also be excluding factors.

> Participant 24: *"I think that the major problem will always firstly be financial* [when you study abroad]. *The flights, rentals etc. are major issues. You cannot study abroad without having sufficient money."*

Some of the participants with experience in distance learning pointed out that despite the fact that distance learning courses allow accessing education, there are issues such as lack of real time interaction, loss of communication and ineffective feedback that affects their distance learning experience.

> Participant 11: *"The problem I had during my distance learning experience was that I couldn't communicate with my supervisor effectively... I didn't have a lot of feedback especially in my final thesis"*

Difficulties concerning family commitments and related responsibilities and how these limit time availability were also brought into the discussion. Participants noted that multiple roles, conflicting responsibilities, and the balance between family, work and education pose barriers. Participants explained that these commitments affect the time they have available for learning, and that they are frequently missing classes due to unscheduled events. Some participants also revealed that they skip classes because they get tired and stressed from these responsibilities, and admitted that they tend to concentrate on family and sideline education in most occasions.

> Participant 26: *"[having two kids] is the reason I dropped the chance for further studies… Note that while having this session, I put my oldest daughter to sleep, [and] feed my youngest. Imagine how difficult it is to do this and then go to university."*

> Participant 23: *"Me too Participant 26. I would like to enroll on a masters [degree] but it is impossible. I have three children, I am working and I have the house to look after."*
> Participant 21: *"Yes is very hard when you have family and kids. There is simply not enough time to study."*

Participants often discussed the difficulties of fitting studies in their schedule. Some of them pointed out that childcare in particular pose significant difficulties in accessing education, and focussed attention on how special arrangements are required to find time for learning.

> Participant 25: *"I have two children and attendance at university involves arranging childcare.* [This] *is a massive issue for me.* [I have] *to get up at 5 am!* [to get to the university]*, then travel back another 2 hours, to rescue my kids from whoever have had them :D"*

In addition**,** participants argued that trying to keep a balance between family, work and education, affects time availability, leading to loss of personal time. Participants pointed out that because family is very important and requires extensive attention, they do not concentrate as much as they should in their studies.

> Participant 9: *"Management of time is an issue. Especially the balance between family and studying. I have very little time for myself at the end of the day and because family is very important, I feel that I don't offer my full attention to education."*

In addition, female participants indicated access and participation barriers during pregnancy. Participants explained that it was particularly hard for them to access the educational institutions during that period, and provided examples of occasions in which the doctors had forbidden travelling. Moreover, participants explained that during pregnancy it was very hard to participate and concentrate on learning activities, and also they could not access education for a period after the delivery.

Participant 20: *"During my pregnancy* [it] *was particularly difficult to attend classes! I had to drive to the premises and it was difficult, and the doctor said I should avoid driving. Also exposing to high and low temperatures was difficult. It was also difficult to sit for three hours for my exams… I had to stay in bed for most of my pregnancy "*

Situational barriers concerning physical and health conditions of individuals were also mentioned. Participants with mobility disabilities talked about how these issues hinder their access to education and participation in learning activities. Some participants noted that they experience difficulties attending and participating in certain classes, while others cannot attend university at all, or have to be absent for long periods. Furthermore, a particular participant with hearing impairment (deafness) explained that due to this disability it is hard to follow oral presentations.

Participant 14: *"I have Ankylosing spondylitis, terrible pains on the back, lost as long as one year from my studies."*

7.3.1.2. Institutional Barriers

Institutional barriers were also discussed, relating to tuition fees, physical design of institutions, poor quality of services, and available learning opportunities. Tuition fees were one of the issues mentioned most frequently, mainly concentrating on the increased tuition fees compared to previous years. Participants particularly discussed the fact that tuition fees for UK universities have trebled, and emphasised that this is a factor that difficult access or leads to exclusion from education.

Participant 12: *"Are the Universities willing to lower their fees?"*
Participant 24: *"Yes I was thinking the same as Participant 12. Its £9000 in the UK now."*
Participant 28: *"Per year or the whole degree?... £9000 for university? That's a lot!!!"*

Participants repeatedly pointed out barriers associated to the physical design of institutions and the inability to handle students with disabilities. Furthermore, they provided examples of how physical obstacles and inaccessible facilities difficult their access and participation to education.

Participant 27: *"The first problem is reaching the campus or building, and then access to the room. There is also restricted area in classroom and uncomfortable area for wheelchair parking. Also, unusable deskspace… Problems with heat during summer months... The toilets usually you have to find the one at another floor or the other end of the campus"*

Lack of services and poor quality of services in some institutions were issues that some participants also raised, and they explained that in many situations the educational facilities are not tailored according to their needs.

Participant 14: *"Sometimes if you need something about your health issue (lets say painkillers), there is no one at the university that can give you that (so you can continue your class)."*

During the discussions, some participants pointed out that these difficulties have led to late arrivals to classes, loss of important learning experiences, and caused frustration.

Participant 22: *"You arrive late because the disabled parking is taken, you get wet because it's raining, you arrive late and get frustrated… Arriving frustrated does not help your learning experience."*

Another institutional barrier mentioned was the lack of available learning opportunities. Some participants complained that the educational institutions around their areas do not offer courses of interest, or fail to advertise educational opportunities properly. Participants clarified that this have led in enrolment to courses that were not of their genuine interest or having to register on educational institutions that are far from home.

Participant 12: *"In my area there are no universities that offer the course that I would like to undertake. So I am currently stuck! :P. I cannot undertake the Masters course I am looking for and I don't know what to do. I cannot afford to go to the university that offer this course because it is far away and I work full time."*

7.3.2. Summary of Barriers in Access and Participation to Education

Situational barriers were the most evident in the participants' experiences. The cost of education was one of the most frequently mentioned obstacles to participation in this study. Participants mostly discussed the increased tuition fees and associated costs of Higher Education, concurring with the findings of McDonald (2003 :95) and Terriquez et al. (2013 :3). The study findings revealed that many students need to work to manage their financial obligations, and this is similar to the findings of Yorke and Thomas (2003 :71); implying that these financial concerns influence participation in education.

The issues of the distance to the educational institution and associated costs were also expressed, including the time and effort of travelling. The study findings indicate that transportation costs may be an influencing factor in attendance to education, and this is consistent with the findings of Cullinan et al. (2013a :46), Frenette (2006 :50) and Spiess et al. (2010 :16). It was also expressed that especially students who have to leave home, travel to other areas and find term-time accommodation encounter heavy financial challenges, concurring with the findings of Forsyth and Furlong (2000 :37).

Barriers concerning family commitments were also identified, indicating difficulties in managing family obligations and studying at the same time, stressing the need for special arrangements to make time available for learning. Some female participants also described many difficulties accessing education during pregnancy. Furthermore, it was found that the effort of keeping a balance between family, work and education, significantly affected the participants' available study time. The study findings argue that time management is an important issue, indicating that some people have to make specific schedule adjustments and arrangements in order to access education, agreeing with the view of Gorard (2006 :10). The study findings also revealed that these barriers increase the students' stress levels, lower their energy and affect their concentration in education, concurring with the findings of White (2008 :170) and Chisholm et al. (2004: 68). Moreover, situational barriers concerning the physical condition, health and medical related issues of the individual were identified, and are consistent with the findings of Hall and Healey (2004) and Fuller et al. (2004).

Examples of institutional barriers emerging through the educational institutions and their policies were also identified during this study. The most evident barrier relates to the physical design of institutions and their inability to handle disability, restricting or making access and participation in education difficult. Analysis of the study results revealed many examples of how physical obstacles and inaccessible facilities impede access, navigation and participation to education; these were no different to the barriers already identified in the literature such inaccessible layout, difficulties in mobility around facilities, lack of accessible parking, facilities not tailored according to needs etc. (Borell and Hemmingson, 2002; Hudson, 2005; Welsh et al., 2006; Coster et al., 2013). Furthermore, many concerns were raised regarding the ability of the educational institutions to address students' needs. Situational barriers concerning lack and poor quality of services, as well as lack of available learning opportunities in which the educational institutions fail to offer courses of interest to students were also identified; issues that have been discussed by MacKeracher et al. (2006).

The findings of the virtual focus group indicate that many institutional and situational barriers exist, and not only hinder access and participation to education, but in some occasions might even be excluding factors. The study findings confirm the existence of situational and institutional barriers, corroborating previous research (Cross, 1981; McGivney, 1993, 1999; Gorard et al., 2006; MacKeracher et al., 2006; Shepherd and Nelson, 2012). The findings contribute to understanding the source, nature and impact of these barriers to the student learning experience, and how these affect access and participation to education. The findings of this study also suggest that the Cross (1981) situational and institutional barriers are still relevant in modern days.

7.3.3. Topic 2 - The Characteristics of the Cyber Campus

The second topic of this study explored the participants' perceptions of their experience in the cyber campus during the virtual activities, focussing on the characteristics of the environment that support online learning and help to mitigate some barriers hindering access to education.

7.3.3.1. Presence

Presence was frequently discussed as one of the most important characteristics of the virtual world. Participants in this study acknowledged and emphasised that during their experience with *SHU3DED* they developed the sensation of '*being there'*. Participants pointed out that the opportunity to access learning through a virtual world brought them together in a visually rich shared environment. Participants suggested that the environment created the "*illusion that you are at a university"* (Participant 24), and pointed out that this made them feel present in the virtual world.

> Participant 29: *"I feel that I am in the environment. I am so immersed that I think I'm talking when I'm typing and hearing when reading :D"*

The participants expressed that the feeling of presence allowed them to actively participate in meaningful and purposeful activities, and suggested that this have contributed to their overall learning experience.

> Participant 11: *"I feel that I can be there, and this offer me the opportunity to observe and participate in learning not just review notes and slideshows. It is very important that I can see my 'classmates' and it makes the experience very meaningful... I feel that this can offer, support and improve the learning experience"*

Participants also highlighted the use of the avatar and how it contributed to the development of the feeling of being in the environment.

> Participant 21: *"Avatars make you feel you are there, you walk around in the campus and you see others around you"*

Many participants indicated that the feeling of presence made the experience more engaging, enjoyable, and have influenced them to participate in the activities.

> Participant 9: *"I feel I am there at the time of the class and practically participate. It is very engaging and fun"*

7.3.3.2. Awareness

The environment's characteristic of awareness of the existence and actions of others in the virtual world was also raised many times during the discussions. In particular, participants pointed out that the avatar made the existence of others apparent; made them feel present in the environment, and gave the impression of a team in a natural and realistic way. Participants also highlighted the importance of awareness in understanding the environment and enriching the experience, and implied that this have helped them to participate together in activities.

> Participant 15: *"I like seeing other people. It makes the whole thing more authentic and realistic."*
> Participant 16: *"Yes seeing others around you gives you the impression of the team."*
> Participant 17: *"Yes you see them, what they are doing. The whole thing looks alive. You can also understand where things are and what the buildings are for."*

The participants emphasised that seeing others in the virtual world led to initiation of informal conversations that contributed into the development of the sense of belonging to a community (more on sociability in Section 7.3.2.4). Participants explained that with the use of the avatar they were able to determine who was working with them, and were also able to informally interact between them.

> Participant 11: *"I can see what the person is doing. I think this is very important because we can see all the participants in the area, they also see me, and this makes me feel part of the group"*

Participants also expressed that being able to see the avatars of other users provided realistic experiences (more on environment realism in Section 7.3.2.5). Some participants noted that due to access barriers they do not have the opportunity to meet and work with their colleagues, and the virtual allows performing this.

> Participant 18: *"Well it makes it a more realistic experience being with others on the same place… It makes me more engaged in the activity and it has a very realistic feeling… I can see my colleagues and work with them as if they are here"*

7.3.3.3. Communication

Throughout the virtual learning activities and focus group sessions, the public text chat was used to facilitate communication between participants, and its importance and effectiveness were raised repeatedly. Participants emphasised the importance of the ability to textually communicate between them, and explained that it facilitated synchronous interaction and collaboration in the environment. Additionally, participants highlighted that the ability to synchronously communicate allowed socialisation, exchange of opinions, collaboration and interaction during the virtual activities.

> Participant 11: *"I could communicate with my peers located around the globe in real time, just like if we were together at the university… You were participating at the moment of the learning at the exact time so if I had a question I could ask it at this moment... This could have really helped me on my distance course!!!"*

A particular participant clarified that due to hearing disability, audio to textual transcription and visual representation of information during learning was required. The participant went on to suggest that the ability of providing such information through the virtual world could support her participation in online learning activities and communication with colleagues and teachers.

> Participant 19: *"My main mode of experience in learning is visual. Being deaf, I rely solely on text communications, so anything in voice needs to be transcribed into text, and information need to be accessible through visual means"*

Some participants also insinuated that the ability to textually communicate through the virtual world helped them express their opinions, whereas in real life do not normally contribute to discussions. Furthermore, they argued that the text chat communication helped some of the participants who speak a foreign language, struggle with their accent, or do not feel confident talking in public to contribute to the discussion.

> Participant 16: *"Not all the participants speak fluent English"*
> Participant 15: *"Ah you all write so well that I thought you were all fluent English speakers"*
> Participant 20: *"Merci Participant 15 but my pronunciation wouldn't help in the conversation"*

The ability of the system to keep logs of conversation for later reviewing was also raised. Some participants explained that this helped them catch up with responses they missed, and allowed them to take time and formulate their responses.

> Participant 26: *"It keeps log for all the chats, you don't need to take extra notes… You can be more organised… By accessing other resources concurrently, having the notes on chat history etc… I left* [from the computer], [now] *I am back, and I can follow from where I left it."*

The ability to use gestures in the virtual world was also brought into the discussion. Participants indicated that the use of avatars and gestures made the experience more meaningful and purposeful. Participants also explained that the use of gestures allowed them to convey some emotions, complement textual communication, and made the avatar more interactive and realistic.

> Participant 13: *"I think that the avatar enables more realistic participation and interaction, with gestures… It is very nice that* [the avatar] *moves and waves and can raise hands etc. This brings life to the avatar"*

During the virtual focus groups, participants also identified some disadvantages of the textual chat for communicating. Participants pointed out that prolonged typing was difficult and tiring, and that when many people contributed to the discussion, multiple responses overfilled the chat and caused confusion.

> Participant 12: *"Big disadvantage is typing. In real world when someone talks you stop and hear. Here everyone is typing and there is a bit of confusion and a lot of messages… It is the biggest disadvantage that I found."*
>
> Participant 28: *"That's correct Participant 12"*
>
> Participant 24: *"Good point… Even if we try not to, we all do it. There must be some kind of control on that"*

Participants recommended that this should be controlled by either the use of gestures, or using a tool that allows people to take turns when typing in the public chat.

> Participant 14: *"Generally speaking it would be more preferable for me if there was a tool that gave us an order in which we speak. Or maybe raise hands! :)*

Despite the fact that participants were not communicating through voice but only experienced it during the virtual lecture, they perceived it as a very important functionality of the virtual world that can contribute to the learning experience.

> Participant 9: *"Well virtual worlds provide voice as well"*
>
> Participant 18: *"Voice chat in VW and can be used as real life conversation"*
>
> Participant 12: *"Vocal communication could really help. Totally agree with Participant 9"*

However, a particular participant expressed some concerns on how effective voice would have been.

> Participant 12: *I don't know how background noises could affect…If 5 people have their mics enabled it could as well be a mess…vocal could help, but like now we are a lot of persons so not sure."*
>
> Participant 24: *"Maybe for a person-to-person only"*

7.3.3.4. Sociability

The feeling of belonging to a learning group and how this may support participation was also perceived as an important characteristic of the environment. Participants explained that being together in the same shared space influenced the group communication, allowed them to establish social relationships, and to effectively collaborate in activities. Participants emphasised the ability of the environment to become a space in which effective socialisation can be established. They also suggested that the cyber campus is "*a nice alternative to attending on-campus lectures… without loosing the interaction and belonging*" (Participant 17) when attendance is not an option. Participants elucidated that participation in learning activities through the virtual world allowed socialisation, enabled them to feel members of the group, and they did not felt alone during the experience. They also implied that this allowed the establishment of relationships with their colleagues that contributed to their overall experience.

> Participant 12: *"Being part of the group in virtual worlds can help build personal relationships… You interact with people, earn their trust, learn with them and see their personality."*

Participants also explained how socialisation and collaboration in the virtual world allowed them to reach shared goals, made decisions together and felt as a group. They also indicated that working in groups brought them together, maintained interaction between them, and enabled socialisation during the activities.

> Participant 23*: "In this world we are a group and we can do things together. We can learn, talk, and be friends, without knowing each other personally…"*

Additionally, participants often referred to the use of the virtual world as a place to facilitate informal social interaction on non-task related matters. For instance, the following participant recommended the use of the environment as a socialising space in addition to education:

> Participant 15*: "Well, a cyber campus could organise a meeting place for students just to hang out and get to know one another in addition to working together on a project"*

The ability of the virtual world to bring people together was repeatedly brought into the discussion, focussing attention on how this contributed to reduce loneliness and isolation.

> Participant 9: *"Being together in this campus makes me feeling very comfortable and I enjoy seeing and talking to you people… I feel it is important that I am not alone and we work in groups. It is far more engaging and fun this way"*

During the virtual focus groups, it was observed that participants became more familiar with each other. They commented on each other posts, were engaged in the discussion, contributed into the development of social and friendly atmospheres, and these are considered evidence of group cohesion and sociability.

> Participant 24: *"Nice to 'virtually' meet you people...!"*
> Participant 28: *"It was a productive conversation."*
> Participant 12: *"Pity we can not go all for a Pint though :P"*
> Participant 13: *"Yes very interesting. A group photo :-)?"*
> Participant 12: *"Yeap lets stand near the pyramid sign and I will take a screenshot now."*

7.3.3.5. Environment Realism

In addition to the characteristics of presence, awareness, communication and sociability, some other characteristics that contribute to learning support through the cyber campus were identified. A characteristic that was frequently mentioned was the level of realism of the environment. Participants discussed the ability of the environment to be *"a world without boundaries"* (Participant 13) that can be used to replicate realistic situations, represent or build immersive experiences that are difficult or impossible to do in real life. Participants referred to the ability of the virtual world to graphically represent the real world in great detail, and implied that it provided realistic experiences that engaged them in learning activities. Participants suggested that the realistic feeling of the virtual world and its atmosphere had put them in a *"ready to learn"*(Participant 27) mode, conveyed learning formality, and a feeling that they were actually within a learning environment.

Participant 12: "[I can] *participate practically I would say. A more realistic experience that reminds me of the university and puts me in a learning mode. It feels more natural, you see what is going on, you are there… More realistic participation and distance learning can really help my personal problem."*

The ability to resolve and build high quality graphical content in the virtual world to support learning and how participants experienced it during the virtual lecture was also brought into the discussion. Some participants explained how this can be used in educational context, appreciating that many experiences can be constructed in the virtual world by utilising its ability to design both realistic and unrealistic experiences.

Participant 29*: "The virtual world allows to build something that relates to an experience we want to explore, for example monumental recreations. The ability to set up a learning experience that people can experience any time is very empowering"*

The following participant, for example, pointed out how the ability of the virtual world to provide experiences that deviate from reality can enrich and inspire learning:

Participant 19: *"Richly developed visual environments that are not necessarily rooted in replicating real world settings but that instead promote a fulfilling sense of presence, includedness and connectedness in interactions with others, enriches learning even more and inspires a desire for continued and lifelong learning."*

7.3.3.6. Anonymity

The anonymity of users within the virtual world and how this had contributed to their participation in activities was also raised. However, anonymity was perceived both as an advantage and a disadvantage. Participants expressed that anonymity in the virtual world provided freedom from pressure and allowed better self-expression while preserving their personal details and characteristics. In particular, participants explained that because some of the characteristics that discourage participation were '*hidden'* behind the anonymity offered by the avatar, they socialised and contributed more to the discussions.

> Participant 23: *"When I was at the university I wasn't feeling very confident to participate. I felt embarrassed. Now you don't see me so I can express* [myself] *without feeling uncomfortable about my bad English."*

Some participants also indicated that remaining anonymous in the environment allowed them to be more expressive and encouraged them to participate in activities.

> Participant 25: *"Lots of people don't like to speak in groups but would be more likely to in this scenario. It's less 'scary' than speaking in front of a room full of people."*

Participants also argued that the ability to remain anonymous in the virtual world encouraged quiet users to contribute to the discussions.

> Participant 25: *"It takes away the 'everyone is looking at me' thing... Plus often there are one or two people that dominate discussion, and this might make that less likely by encouraging 'quieter' group members to talk because the embarrassment factor is gone"*

In addition, the following participant suggested that because the physical characteristics of the individual are protected within the virtual environment, this might reduce judgment on appearance.

> Participant 15: *"You can be more yourself rather than people judging you by your appearance."*

Some participants also emphasised that anonymity can allow discussing issues and sensitive matters that are difficult to discuss face to face.

> Participant 28: *"It's also a place where people can be anonymous, allowing them more freedom to discuss things they would not do in RL* [real life]. *It may make someone more prone to engage in such learning activity, participate and feel more comfortable."*

However, participants also pointed out that anonymity in the virtual world can be misused because it is difficult to be sure who is behind the avatar, and implied that this may lead to inappropriate behaviours. Participants noted that anonymity helped them participate effectively in activities, but it also made them cautious.

> Participant 28: *"You can easily lie in virtual world or say a lot of things that they are not real… You can pretend you are someone else or someone can take my avatar and pretend its me"*

7.3.3.7. Synchronicity

Another frequently discussed characteristic was the synchronous participation in learning activities, and synchronicity in users' interaction within the virtual world. Participants indicated that this allowed them to practically participate in activities, and synchronously interact with their peers, in which otherwise would have not be able to because of barriers.

> Participant 11*: "What I really enjoyed during the virtual experience was that there was no video to watch but I was participating at the moment of the learning at the exact time, so if I had a question I could ask it at that moment… I could communicate with my peers located around the globe in real time, just like if we were together at the university."*

Participants referred to the ability to synchronously coexist in the same space, and implied that this allowed them to participate in online learning activities and contributed to the development of the feeling of being together in the environment.

> Participant 18: *"Well it makes it a more realistic experience being with others in the same place at the same time. I can see my colleagues and work with them as if they are here."*

However, some participants also expressed concerns regarding synchronicity in online learning activities. In particular, they raised the issues of catching up with learning when they cannot synchronously participate in an activity in the virtual world, stressing the need to follow the missed lesson on their own time and pace.

> Participant 22: *"Well* [time] *could be* [an issue] *if others are part of the group undertaking an activity and you are not there at that particular time."*
> Participant 27: *"A log is kept for you for reference by the computer."*
> Participant 22: *"Well it all depends if others are waiting for you, or if you will be able to perform/follow* [the activity] *on your own"*

The following participant found synchronicity very helpful but he suggested that it depends on the learning context, explaining that participation in some learning activities should take place individually.

> Participant 28: *"I believe that synchronous learning in some cases is very good but in some others asynchronous* [participation] *might be more useful. I think it depends on what you are studying, for example sometimes you have to do something individually"*

7.3.3.8. Lack of Human Interaction

Another disadvantage that was pointed out during the conversations was the lack of real human interaction in the virtual world. Some participants explained that within the virtual environment they could not see the movement and facial expressions of other users, and this have caused some confusion. Participants focussed on the importance of personal contact and real life interaction, and argued that the loss of facial expressions and emotions during the virtual experience is an important disadvantage of the environment.

> Participant 28: *"I think personal interaction is more like when you have to see someone face to face, to have a conversation, and you can see the others in the eyes. This cannot be done through the virtual world I think"*

Some participants also stressed the importance of real life interaction in education, and implied that the virtual world cannot replicate this to great extent.

> Participant 21: *"Immediate interaction gives you facial expression and voice tone with body language. 1 picture is 1000 words."*
> Participant 26: *"Sure Participant 21. These interactions are very hard to replicate in a virtual environment"*

7.3.4. Summary of the Cyber Campus Characteristics and its Potential to Mitigate Barriers

During this study, users expressed many positive opinions towards the potential of the cyber campus to help managing some situational and institutional barriers hindering access to education, and support participation in online learning. The most frequently discussed attribute of the cyber campus was the ability to offer access in education. Participants often underlined the ability to access immersive learning activities in the cyber campus from effectively anywhere there is an adequate Internet connection. They also frequently argued that such a tool could be an alternative solution to access learning when a student cannot physically attend the educational institution. For instance, the following participant underlined the ability of the virtual world to provide access in learning and facilitate collaboration and socialisation to support students when access to education is challenged:

> Participant 17: *"Virtual worlds are a nice alternative to attending on campus lectures,* [allowing to] *collaborate with fellow students without loosing the interaction and belonging* [to the community] *when access is difficult"*

Some participants also focussed attention on the ability of the environment to offer consistencies between educational experiences in reality and the virtual world, and implied that this can allow them to participate in familiar and realistic learning activities when access to education is challenged.

> Participant 26*: "As far as I am concerned, I see virtual worlds as a really good alternative of real life education. You can do the lectures and the seminars as you can do in a university. The only difference is that you are not participating physically, but the education is still there."*

During this study, participants had repeatedly pointed out that the cyber campus could mitigate several barriers that affect their learning experience. Participants experiencing financial barriers impeding access to education, for example, indicated that remote attendance to online learning activities through the cyber campus could help reducing some of the costs that are associated with traveling to the educational institution.

Participant 21: *"I think that using a virtual world for learning can provide much cheaper education. Less expensive participation, no transportation and other associated expenses…"*

Participants encountering barriers because of family responsibilities had also frequently referred to the ability of the virtual world to allow accessing learning activities from remote locations. They also implied that this can enable them to better manage their family commitments and responsibilities.

Participant 23 *"I think it is more convenient to be at home, you don't need someone to take care the children… You feel that you are there, in a campus, you see the others, you make gestures, you can talk, you can express yourself…"*

For instance, two participants had to go away from their computer in order to manage their family during the discussion, and returned back after few minutes to continue participating. In both occasions, the participants appreciated the ability to review what was said in the public text chat, and continued participating in the discussion.

Participant 17: *"Going to prepare my youngest night milk :) brb in 5 mins"*

Participant 26: *"Note that while having this session, I put my oldest daughter (3 years old) to sleep, feed my youngest (1 and a half years old) and also putting her to sleep."*

Female participants, whom their educational experience was affected during pregnancy, also expressed the potential of the environment to support them. Participants elucidated that the cyber campus could allow accessing and participating education during the late stages and first few months after the pregnancy, in which they could not attend the educational institution.

Participant 16: *"Being able to access education remotely when pregnant and participate in the activities in this way would have definitely helped me."*
Participant 20: *"Oh that would be paradise on earth Participant 16. I remember how difficult it was when I was pregnant. This would have definitely helped."*

Participants experiencing work related difficulties hindering participation to the educational institution and regular attendance to classes highlighted the ability to access information and meet with their colleagues in the virtual world.

> Participant 18: *"Virtual worlds can be a good additional tool to education and allow me to meet with classmates when I cannot go to class… The way lectures and seminars are done through cyber campuses are not much different from the traditional* [classroom]. *This was very interesting"*

Participants also noted that using a cyber campus could help them manage their time more effectively. In particular, participants explained that they could access and participate in educational activities from home; therefore they do not need to make significant arrangements to attend classes. Participants noted that they could fit this method of online learning to their busy schedule. Some participants also explained that as a result of work responsibilities they do not have much available time to study, and suggested that participating in online learning though a cyber campus could allow them to prepare better for the lesson, because this method saves time on travelling.

> Participant 21: *"It helps you participate more effectively in terms of time management. I can fit such style of education easy in my busy schedule. It is important that I don't have to travel to the university, as I am very busy with work, and this can work quite well for me"*

Participants explained that during the virtual lecture, the environment supported effective communication and provided synchronous participation in warm social learning activities, and underlined that this can improve the educational experience of online learners.

> Participant 11: *"During this experience, I felt that I was somewhere familiar,* [I could] *sense people, I could navigate wherever I wanted even if there was a strict schedule to follow. This could have really helped me on my distance course!!!"*

Participants experiencing mostly mobility disabilities suggested that participating in online learning activities through a cyber campus could alleviate some of the physical barriers that impede their transportation from and to the educational institutions and around facilities. Participants highlighted the capacity of the environment to support them attend social learning activities from convenient remote locations. In addition, they indicated that using a cyber campus to access learning may help them save time and effort on preparation and transportation to the educational institution.

> Participant 22: *"I can access education from my own environment without having to fight for a parking spot, traffic and rude people. I can concentrate on following and participating on the lesson at hand."*

The following participant with hearing disability described the ability of the environment to facilitate visual interaction and communication with peers and learning material, suggesting that this supports her needs of visual interaction and participation in learning activities.

> Participant 19: *"I'm deaf, by the way. The freedom to experience learning in a visual medium like this with text communication and the opportunity to work with people and interact with people I'd never meet or get to even talk with in the real world, it's very empowering for someone like me"*

Furthermore, some participants suggested that the cyber campus encouraged them to participate in learning activities by removing language barriers and shyness.

> Participant 23: *"Virtual worlds really helps you participate in learning activities, because you can contribute without the barriers of the foreign language, it gives the chance to attend to a university and we actually interact with each other."*

7.4. Limitations

As in any research project, this study also had its own associated limitations that affect the reliability and trustworthiness of the results. A number of limitations were identified regarding the results of this study and are discussed in this Section.

One of the most important limitations of this study was that the participants' opinions were based on a limited experience they had with the environment, its educational functionalities and learning activities. In order to better support the claim that a cyber campus can support students experiencing barriers impeding access to education, it would have been more appropriate to interview users involved in learning activities carried out for more substantial periods of time. The opinions gathered in the study came from users who participated in one learning experience, and this can serve as an initial indicator of the user preferences, which require further validation. In addition, it can be argued that the approach of demonstrating the educational affordances of the cyber campus during the virtual lecture and learning activities, could have introduced bias in the participants' opinions about the environment.

Another limitation concerned the sample of this study that may have represented a number of experiences but does not cover all barriers in access and participation to education. In addition, this lack of sample diversity limits the transferability of the findings of this study.

The use of the public text chat to communicate during the activities and focus groups instead of a combination of text chat and voice was also a limitation. During this study, participants felt tired after prolonged typing and confused because they were trying to communicate simultaneously through the public text chat. Despite the fact that some participants preferred this method of communication as identified in this study, it would have been more appropriate to allow them to use voice if they wanted to. However, limiting communication through the public text chat allowed better management of the conversations, ensured that technical or other difficulties that are associated with voice communication would not interfere, and was found as an attribute that contributed to participation to the discussion for some people.

The use of virtual focus group method to collect data also has some limitations. This method lacks real group dynamics and misses the important nonverbal input during the discussion. In addition, the Puzzle and Pyramid (replacement session) teams had small numbers of participants, comprising 4 and 2 participants respectively. The rule of thumb for focus group research is 6 to 12 participants and this was considered a limitation, as there was not enough participation to influence bigger discussions. Also, lack of expertise in conducting qualitative research, and the fact that the virtual focus group and the prepared questions were not piloted before conducting this study are also limitations. Furthermore, data collected through focus group research can be interpreted differently across moderators (Calder, 1977). Additionally, the conclusions of this study were mostly based on the reflections and opinions of the participants, but it is arguable that more general conclusions may be drawn from those reflections.

7.5. Chapter Summary

This Chapter presented the findings of the qualitative study set out to explore the situational and institutional barriers hindering access and participation in education, and how a cyber campus can support online learning for students experiencing those barriers. To conduct this study, a virtual focus group method to interview people was employed, and the data was analysed using thematic analysis. The findings of this study revealed a number of barriers hindering access to education and participation in learning activities, affecting the students learning experience. These barriers were categorised to situational and institutional barriers according to Cross (1981) framework and presented in this Chapter. The results were also analysed to identify the characteristics that can support online learning and alleviate some of the barriers hindering access to education. The findings revealed the characteristic of presence, awareness, communication and sociability, together with the level of the environment realism, anonymity of users in the environment and synchronicity in activities. However, disadvantages related to anonymity, synchronicity and lack of human interaction in virtual worlds were also identified.

During the virtual focus group sessions of this study, it was observed that participants communicated effectively and contributed to the development of relaxed, friendly and socially warm atmospheres. Participants equally contributed to the discussions, shared their personal experiences and stories, and respectfully listened and contributed to each other's opinions. Towards the end of the sessions, participants expressed their satisfaction and reported that they had enjoyed participating in the session and the previous experiment.

A number of limitations were identified relating to the level of confidence and validity of the findings, and must be put under deep consideration for any further work to be performed based on this research project.

Having successfully conducted the empirical experimental studies as planned in Chapter 3, the next Chapter discusses the conclusions of this research project, including the research contributions, the associated limitations, and the future work that can be conducted as a result of this investigation.

Chapter 8 - Conclusions, Limitations and Future Work

8.1. Introduction

This Chapter summarises the research carried out and discusses the implications and contributions of this research project. Section 8.2 provides a research summary. Section 8.3 revisits the research objectives and answers the research question set in the beginning of this thesis. This Section also discusses the conclusions and contributions of this research project. Section 8.4 presents the associated limitations of this research project. Section 8.5 discusses the possible directions for future work as a result of this research project, and Section 8.6 concludes this Chapter.

8.2. Research Summary

This research project explored the use of cyber campuses as an online learning tool to support students experiencing situational and institutional barriers accessing education. To investigate this, a four–step research design was planned and conducted as follows:

1. Literature review

Chapter 2 presented a comprehensive review of the literature that helped to develop a sound understanding of the current state of the existing research. Extensive investigation of the literature looking at barriers hindering access and participation to education was performed, together with investigating the use of technology to support online learning. Existing knowledge in the field of virtual worlds was also discussed, as well as the concept of cyber campuses and their educational capabilities, and some examples were presented. Investigation of virtual worlds characteristics of presence, awareness, communication and sociability was performed, as these are the factors that contribute to the efficacy of educational MUVEs. Furthermore, the literature behind the design of cyber campuses, and the associated disadvantages of such environments were also investigated.

From this review, the need to ascertain the extent to which a cyber campus can support students experiencing situational and institutional barriers accessing education was identified, together with the need to find out more on how to design such environments.

2. Research Design

To address the identified research gap, a combination of quantitative and qualitative research was chosen and details are presented in Chapter 3. While formulating the research design, the need of a cyber campus environment to use as a proof of concept and to conduct experiments with had emerged. Thus, the design and development of a prototype, and evaluation of its efficacy to support the characteristics that contribute to online learning activities was planned. Moreover, a qualitative study was also planned to explore perceptions of barriers hindering access and participation to education, and the use of a cyber campus to alleviate those barriers and support participation in online learning activities. This comprised employing virtual focus group method for data collection, and thematic analysis to analyse and report data.

3. The Design and Evaluation of *SHU3DED*

The third stage of this research project focussed on the design and evaluation of the *SHU3DED* cyber campus. The prototype was designed and developed following some of the best practices and examples of educational virtual worlds, and design guidelines from the literature. A technical evaluation was conducted to test the functionality and stability of the system (Chapter 4). Following this, an initial evaluation of the environment's educational efficacy comprising two experimental studies was performed (Chapter 5). During these experiments, a number of limitations were identified in respect to the experimental design as planned and the appropriateness of the sample involved, and changes were required to improve the quality of data. After a series of changes to the experimental design, appropriate sample was identified and an extended evaluation of the environment was performed (Chapter 6).

4. Qualitative Investigation.

After the environment evaluation, a qualitative study was conducted in the form of focus group (Chapter 7). A series of virtual focus group sessions were conducted within the cyber campus, involving the sample that had already participated in the evaluation experiment discussed in Chapter 6. This study investigated people's experiences with barriers in accessing education; explored their opinions regarding the educational characteristics of the environment, and their perceptions on how such environment can mitigate some of the barriers they experience, and support them participate in online learning activities.

8.3. Research Conclusions

Through theoretical and empirical investigation, this thesis contributes to the knowledge base on understanding how a cyber campus environment can support participation in online learning activities for students experiencing situational and institutional barriers hindering access to education. To ascertain this, the following research objectives were set and completed.

> ***O_1: Identify some of the situational and institutional barriers hindering access and participation to Higher Education.***

To address the above objective, the literature behind the barriers hindering access and participation to education was investigated, together with exploration of the opinions of a sample of people experiencing them. The conducted virtual focus group study revealed barriers related to the situation of each student, and issues emerging from educational institutions. The findings of this research project supports the relevance of Cross's (1981) situational and institutional barriers in modern days, confirming their existence and significance to the students' learning experience.

> ***O_2: Determine the extent to which a cyber campus can support online learning activities.***

Developing a cyber campus prototype and using it to conduct a series of online learning activities helped to achieve this objective. The experimental studies of this research project indicate the potential of the cyber campus to facilitate participation of geographically dispersed users in online learning activities. The environment enabled users to co-exist in the same shared space and participate, communicate and collaborate in activities effectively, developing the feeling of 'being there'. The users were able to anticipate the existence and location of other users in the environments and their actions. The environment also supported socialisation and informal interactions between them. Users were interacting with each other and the environment, and were engaging in activities. Furthermore, the design and arrangement of the environment was positively evaluated, users were productive and satisfied from the experience.

O_3: Identify the main characteristics of cyber campuses that can support participation in online learning activities for students experiencing situational and institutional barriers accessing education.

The findings of the evaluation and virtual focus group studies helped to address the above objective. Considering that in a MUVE learning is strongly related to the students perceptions of presence, awareness, communication and sociability, the extent to which these characteristics are supported by the environment were evaluated using the De Lucia et al. (2009) evaluation framework. The evaluation results indicated that the cyber campus provided high sense of presence and awareness of the existence, actions and roles of users in the environment during the learning activities. The communication and sociability of the environment were also positively perceived, suggesting that *SHU3DED* can effectively facilitate social interactions. Opinions regarding these characteristics were also collected and analysed in the virtual focus group study. This allowed identifying and understanding how these characteristics contribute to the students' online learning experience, and how these can help to alleviate some situational and institutional barriers accessing education. Moreover, some additional characteristics were also identified, concentrating on the environment's level of realism, anonymity of users in the environment and synchronicity in learning. Summary of the characteristics and the value to the learning experience are presented in Table 9.3.1.

Completing the above objectives helped to answer the main research question of this research project, which was formulated as follows:

RQ: To what extent can cyber campuses support participation in online learning activities for students experiencing barriers accessing Higher Education?

The findings of this research project revealed many barriers hindering access to education; mostly relating to the personal situation of the student, and issues that emerge from the educational institution. The findings suggest that a cyber campus can potentially support participation in online learning activities for students experiencing situational and institutional barriers accessing Higher Education. The potential of the cyber campus to support these students was analysed using an existing environment evaluation framework and qualitative research, and the identified environment's characteristics contributing to this are summarised in Table 9.3.1. The research findings emphasise the ability of the cyber campus to offer access and participation to realistic and immersive online learning activities, characterised by awareness of the existence of others, effective communication, social interaction and group cohesion. The experiments of this research project have demonstrated the use of a cyber campus to support participation in online learning activities in practice, which are evidence substantiating the hypothesis of this thesis.

Considering the findings of this research project, it can be argued that a cyber campus environment can be used as an alternative online learning support tool to consider when access to the educational institution is challenged. This research project argues that a cyber campus is not to replace traditional learning and real life classroom interaction, but to be used as an efficient tool to support, and enhance online learning activities through a 3D environment. In addition to the findings of this research, a series of suggestions for the design and implementation of effective cyber campuses and relevant educational activities were devised and are included as Appendix 8.

Characteristic	**Description**
Presence	The virtual world provides immersive experiences provide the feeling of being there to its users.
Awareness	The environment supports awareness of the existence and actions of others, contributing to participation and collaboration in activities, enriching the learning experience.
Communication	The environment facilitates synchronous communication that supports participation and collaboration in online learning.
Sociability	The environment supports participation in social learning activities, develops the feeling of belonging to a learning community and contributes to the learning experience.
Environment Realism	The ability to manipulate the level of realism of the virtual world allows participation in realistic and familiar learning activities, and to also design experiences that deviate from reality.
Anonymity	Anonymity in the virtual world encourages students to contribute to the social aspect of learning, by preserving some characteristics of the individual that may discourage participation.
Synchronicity in Learning	The cyber campus provides synchronicity in user interaction and supports collaboration and participation in learning activities.

Table 8.1 - The identified characteristics that contribute to the students online learning experience

8.3.1. Research Contributions

The contributions of this thesis are practical, theoretical and academic. A practical contribution of this thesis concerns the proof of concept and use of a cyber campus in practice to support participation in online learning activities. This research project demonstrated effective use of a cyber campus, making participation in online learning activities engaging, purposeful and meaningful. It was demonstrated that the environment promotes effective socialisation, collaboration and coexistence of online learners. The findings also demonstrated the potential of how a cyber campus could alleviate some situational and institutional barriers impeding access to education.

An additional contribution concerns the design and development of *SHU3DED* cyber campus. This environment is available to be used for learning support as part of a university module and/or other learning activities, and to also conduct additional research to further investigate the educational potentials of virtual worlds. The required files and instructions to deploy the environment can be found in the additional documents disc provided together with this thesis.

The major practical contribution of this research project relates to the proposed suggestions included as Appendix 8 for the design and development of cyber campuses and relevant educational activities to support students. These suggestions were devised from the empirical results and observations during the experiments, examples of best practices, previous theories, guidelines, and personal experiences developed during this research project. The findings of this research project raise awareness on the importance of the environment design and the way the activities are conducted in cyber campuses. The research community, which is very active in the field of educational virtual worlds, could benefit from considering and contributing to the suggestions proposed in this thesis.

This research project theoretically contributes by improving, applying and confirming the De Lucia et al. (2009) evaluation framework. Before applying this framework to evaluate *SHU3DED*, two changes were performed in respect to the versions of the instruments used for data collection to improve their reliability. More specifically, the version of the Presence Questionnaire used in this research project is the updated version of the instrument used by De Lucia et al. (2009), which was revised by its authors (Witmer and Singer, 1998) and features improved reliability and shortens the length of the questionnaire. Also, the Sociability Scale used in this research project was the complete scale as introduced by Kreijns et al. (2007) to preserve its reliability. De

Lucia et al. (2009) used a version comprising 6 out of the 10 items, but the results of the updated scale reliability are not reported. Furthermore, the results of the evaluations conducted in this research project contribute to the concurrent and ecological validity of the evaluation framework. The collected data was also investigated further, identifying unexplored relationships between the evaluation factors.

This research project also confirms the existence of situational and institutional barriers as suggested by Cross (1981). The Cross' (1981) barriers were utilised as a framework to understand the impact and significance of these barriers to the students learning experience, and the findings indicate that situational and institutional barriers are still relevant in modern days.

The work presented in this thesis also contributes to the on going academic research in the field. A number of peer reviewed publications and presentations have emerged from this research project and are listed in Appendix 1. One of the main aims of this thesis was to develop knowledge for others to build upon it, and this research project, its design, and empirical findings can be used by other researchers for further experimentation.

8.4. Research Limitations

The limitations of the research design, methods, experimental studies, data collection and analysis were discussed in detail in the corresponding Chapters of this thesis. This Section provides an overall discussion of the most important limitations that apply to this research project in general.

The most prominent limitation of this research project concerns some aspects of the research design. Firstly, while the design of *SHU3DED* was based on examples, guidelines and influences from the literature, to ensure that it follows a relatively consistent look and feel with other educational virtual worlds that have been successfully used; it can be argued that it did not follow a user-centred design approach in that students' learning needs and requirements where not explored in detail to inform the design of the virtual environment as part of this research. It can thus be argued that the *SHU3DED* design and arrangement is based on subjective interpretations of what is learning efficient, and not necessarily addressing the barriers that some students experience to access Higher Education. However, it can be argued that the guidelines and best practices examples followed are based on success factors, addressing students' needs and requirements.

Following the design of the environment, a series of experiments were conducted to evaluate its efficacy to support online learning. However, the limitations identified in the initial evaluation studies discussed in Chapter 5, led to reconsider and redesign the experimental design as planned in Chapter 3 in order to collect quality data. This was a time consuming task that prolonged the progress of this research project. Nonetheless, conducting these initial evaluation studies enabled to collect and publish important findings about the environment's ability to support learning activities. Furthermore, these studies allowed improving the research designed followed in the extended evaluation study (Chapter 6).

An additional limitation of the evaluation studies was that they were conducted through artificially created learning activities, because it was not feasible to include the cyber campus as part of a module or a real learning activity. Furthermore, the length of the experimental sessions was limited, in which users were offered a superficial experience of the environment, and they should have been investigated for a longer period of time to obtain data that is relevant for the factors that have been studied. Moreover, to better support the claim that a virtual world can help to mitigate barriers in access and participation to education, it would have been ideal to collect data from users involved in learning activities for more substantial periods. However, it was not feasible to hold participants for longer, or regular participation. Due to this limitation, learners did not have the time to gain a complete online learning experience with the virtual world to properly comment on access and participation. Nevertheless, the length of the sessions can be considered appropriate to identify important features of the environment that support online learning activities, user preferences, and to collect users' perceptions regarding the ability of the environment to support them manage some of the barriers they experience.

Another important limitation of this research project concerns the small sample size investigated in the empirical studies. For this reason, the findings of this research project cannot be generalised to the wider population. It was not feasible to draw representative sample to generalise results, therefore the findings presented in this research project are based on proximal similarity of participants. In addition, a larger sample would allow conducting more virtual focus group sessions to achieve theoretical saturation. The data was collected from a group that represents a range of barriers; therefore it is very challenging to attempt drawing generalised conclusions for all barriers hindering access and participation in education. However, the sample involved in the evaluation studies demonstrated the potential of the environment to support participation, collaboration and communication in online learning activities. Furthermore, the sample included in the virtual focus group study provided trustworthy and highly valid insights, revealing important findings.

The conclusions drawn in this research project are mostly based on the reflections of the participants in the virtual focus group study, and it can be argued that if additional sessions were conducted, stronger evidence to support the claims could have been collected. Furthermore, it would have been more appropriate to conduct sessions before and after the users' experience with the virtual world. This would ensure avoiding potential bias in participants' perceptions, and have a more complete view of the barriers they encounter in access to education. It would have been ideal to facilitate an online focus group session through a chat room before users experienced the virtual world, focussing on the barriers in accessing education. Then, the follow up virtual focus group would have allowed concentrating only on the ability of the environment to support online learning and mitigate barriers. However, this was not feasible due to time restrictions and difficulty to hold the participants for more sessions. Moreover, qualitative research is a subjective approach that relies on the researcher's view of what is important, and is criticised that it heavily relies in the relationships as established among the groups during the data collection (Bryman, 2008). In addition, qualitative data can be interpreted differently across moderators (Calder, 1977). Because this is a doctoral research, the coding and analysis of data collected were not cross-examined by other researchers, but were discussed with the research project supervisors.

Lastly, some disadvantages specific to the environment were identified during the virtual focus group study. The lack of effective human interactions in the virtual world was found as an important limitation of the environment, in which the important interpersonal interactions that are established during face to face communication cannot be effectively replicated within the virtual world. Moreover, the issue of inappropriate behaviours as a result of users anonymity in the environment was identified, as well as disadvantages related to synchronicity in learning, in which students are missing learning experiences when cannot synchronously attend a learning activity in the environment.

8.5. Future work

The research project presented in this thesis establishes a starting point for further investigation looking at how cyber campuses can be used to support online learning for students experiencing situational and institutional barriers accessing education. The first direction of future work dictates the investigation of the ability of cyber campuses to mitigate barriers and support online learning over longer periods of user participation, to address the limitations identified in this research project and to extend the findings. In addition, the scope of this research project did not include investigation of the effectiveness of learning in the cyber campus, and this could also be examined in the future. This will allow identifying potential associations between the evaluation factors and students learning performance. Furthermore, more studies can be conducted to apply the suggestions and considerations proposed in this research project (Section 9.3.2), and to improve them using a more user-centered approach.

Another important direction for future work is to further investigate the Awareness factor as introduced in the De Lucia et al. (2009) evaluation methodology, to improve its reliability. It was identified in the De Lucia et al. (2009) study and in this research project that Awareness scale suffers from problematic inter-correlation between the items comprising the scale. Thus, further investigation to improve this methodological limitation can be conducted in future studies. Moreover, communicating using gestures was identified problematic during this research project and previous studies (De Lucia et al., 2009; Griol et al., 2012), and this can also be further investigated. This could also require the development of a tool to provide effective social and classroom gestures that can be used by other virtual world developers, designers and educators.

An important finding of this research project was that the environment realism is a characteristic that contributes to the learning experience. Therefore, another viable future research direction could be to investigate how the environment realism contributes to the overall environment evaluation methodology, and the extent to which it influences any of the evaluation factors. Furthermore, the need of asynchronous participation in online learning activities through the virtual world also emerged in the findings of this research project. However, this issue was not in the scope of this research project and could be investigated in the future to identify ways to support individual and asynchronous participation.

8.6. Chapter Summary

This Chapter provided a summary of this research project, revisited the research objectives and answered the research question set in the beginning of this thesis. Moreover, it presented the contributions of this research project, discussed its limitations, together with viable future work that can be conducted as a result of this research. The research project presented in this thesis provides positive indications that a cyber campus environment has the potential to support students experiencing situational and institutional barriers accessing and participating to education. Prior to this thesis, there was no empirical research addressing this, and little were known on how to design effective cyber campus environments and educational activities. The contributions of this research project are practical, theoretical and academic, developing knowledge for other researchers to use and build upon.

Word Count: 45 324

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A CYBER CAMPUS TO SUPPORT STUDENTS EXPERIENCING BARRIERS ACCESSING EDUCATION

LOUIS NISIOTIS

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF

SHEFFIELD HALLAM UNIVERSITY

FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

VOLUME II - APPENDICES

AUGUST 2015

Table of Contents

Appendix 1 – List of Publications

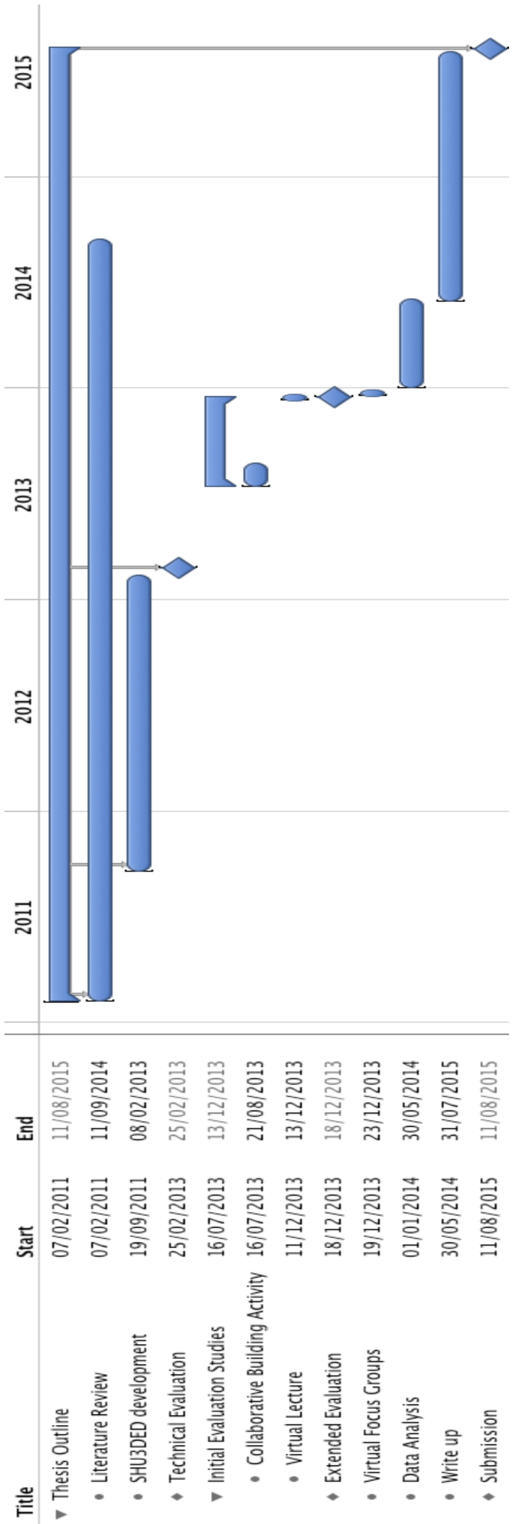
- Nisiotis, L., Beer, M. & Uruchurtu, E. (2015) The Evaluation of a Cyber Campus to Support Distance Learning Activities. In: GARDNER, M., GÜTL, C., PIRKER, J. & RICHTER, J., eds. *Workshop, Short Paper and Poster Proceedings from the inaugural Immersive Learning Research Network Conference, Prague, CZ.*
- Nisiotis, L. (2015) The Use of Cyber Campus Environments to Support Access and Participation to Education. *METHODS Research Students Conference*, April 2015, Sheffield Hallam University.
- Nisiotis, L., Beer, M. & Uruchurtu, E. (2015) Cyber Campus Environments For Effective Learning Support. *Virtual Worlds - Best Practices in Education (VWBPE)*, Crossroads, 18-21 March, 2015, Second Life.
- Kamvisi, M., Kleanthous, S. & Nisiotis, L. (2015) Experiences of Collaborating and Learning through Collab3dworld. In GARDNER, M., GÜTL, C., PIRKER, J. & RICHTER, J., eds. *Workshop, Short Paper and Poster Proceedings from the inaugural Immersive Learning Research Network Conference*, Prague, CZ.
- Nisiotis, L., Beer, M. & Uruchurtu, E. (2014) The Evaluation of SHU3DED Cyber Campus - a Pilot Study. *The 14th International Conference on Advanced Learning Technologies*. 688-690.
- Nisiotis, L., Beer, M. & Uruchurtu, E. (2014) A Cyber Campus For Students Learning Support. *Virtual Worlds - Best Practices in Education (VWBPE),* Connections, 9-12 April, 2014, Second Life.
- Nisiotis, L., Beer, M. & Uruchurtu, E. (2013) A Cyber Campus Assessment Study. *Learning and Teaching Conference*, Sheffield Hallam University, UK
- Nisiotis, L. (2013) Cyber Campuses for Students Learning Support. *BCS Doctoral Consortium*, London, UK
- Nisiotis, L., Beer, M. & Uruchurtu, E. (2011) The SHU3DED Cyber Campus Prototype. *IEEE Learning Technology Newsletter*, 13, (4), 14-17.

Appendix 2 – Terminology

- CSCL – Computer support collaborative learning.
- Emoticons – Pictorial representations of facial expressions.
- FREC – Faculty of Research Ethics Committee.
- Head's Up Display (HUD) – An element that can be attached to the viewer and control behaviour of the avatar or objects in the environment.
- IM – Instant message: A communication functionality of the viewer that allows the user to send private message to a specific user.
- Inventory – A folder that keeps content belonging to an avatar and can be used to store or retrieve various items.
- Lag – A term used to describe when communication, interaction and movements in the virtual world are slowed down.
- Landed – A term used when an avatar arrives in a location.
- LSL – Linden Scripting Language
- Nearby Chat or Local Chat – A communication functionality of the viewer that allows the user to send messages that are visible to other avatars around.
- OSSL – Opensim Scripting Language (LSL extension language).
- Prim –A single part object.
- Region – An area covering 256 x 256 meters.
- Resident – The users of the virtual world.
- Resolving/Rezzing – Unpacking items from the inventory in the virtual world.
- Sandbox – An accessible area without, or minimum restrictions in creating content. and/or flying in the virtual environment
- Teleport – An action that instantly moves an avatar between locations.
- Textures – Graphics that can be used to cover areas of the prims.
- Viewer – The software required for users to view and interact with the virtual world.
- VOIP – Voice Over IP.

Appendix 3 - Research Methods

3.1. Research Outline



3.2. Ethical Clearance

One of the most important issues in ethical research is to obtain informed consent from the participants (Whiteman, 2008). The participant's consent was sought through a form explaining the goals of the study, the use of the findings, and ensuring the privacy and protection of personal data. Moreover, confidentiality was respected and no physical or moral harm or stress was anticipated during or after the studies. In addition, when participants are volunteers, the ethical concerns are reduced (James and Busher, 2006). Due to the nature of online mediated communications, the anonymity of users is preserved because they tend to use nicknames during participation in virtual worlds; however, the confidentiality of what they say was considered. For this reason, it was made explicit to participants that information such as chat logs, emails, usernames etc. will not be available for public view, will not be shared with anyone else apart for the research team, and will be stored safely.

Sheffield
Hallam
University

APPLICATION FOR RESEARCH ETHICS APPROVAL STAFF AND POSTGRADUATE DOCTORAL RESEARCH STUDENTS (SHUREC2A)

SECTION A

Important Note - If you have already written a research proposal (e.g. for a funder) that answers the methodology questions in this section please include a copy of the proposal and leave those questions blank. You **MUST** however complete **ALL** of Section B and C (risk assessment).

1. Name of principal investigator: Louis Nisiotis

Faculty: ACES

Email address: louis.nisiotis@student.shu.ac.uk

2. Title of research: A cyber campus to support learning and overcome barriers of access to the university

3. Supervisor if applicable: Dr Martin Beer - Director of studies, Dr Elizabeth Uruchurtu - Second Supervisor

Email address: m.beer@shu.ac.uk, E.Uruchurtu@shu.ac.uk

4. Proposal Tracking number (applicable for externally funded research):

5. Other investigators (within or outside SHU)

Title	Name	Post	Division	Organisation

6. Proposed duration of project

Start date: 02/11 **End Date: 02/15**

7. Location of research if outside SHU:

8. Main purpose of research:

☒ Educational qualification
☐ Publicly funded research
☐ Staff research project

☐ Other (Please supply details)

9. **Background to the study and scientific rationale** (500 words approx.)

This research aims to analyze the flexibility of cyber campuses to support learning and overcome barriers that restrict students from regularly attend the university. Due to chronic illnesses, impairments, medical conditions, financial constraints or other reasons, some students face barriers that restrict them from physically attending the university, missing important learning experiences. Thus, the ability of cyber campuses to overcome barriers of access and participation shall be empirically investigated, for which a cyber campus has been developed.
To conduct this investigation, the following research aims have been developed:
• Investigation of cyber campuses operation and use for students learning support. Such investigation has enabled a solid understanding of the use of cyber campuses for students learning support and enabled identification on some of the best practices and that have been successfully implemented in academia. This enabled to devise appropriate approaches to adopt for the development of the cyber campus prototype to conduct a series of experiments with.
• Investigate potential groups of users requirements and expectations. This investigation enables the understanding of barriers and limitations that restricts some students from attending the university.
. • Determine possible context in which cyber campuses can support learning and overcome restriction barriers.
The De Lucia et al. (2009) methodological approach to evaluate the efficacy of virtual worlds for synchronous distant learning will be adopted (see below). A series of empirical studies shall be performed using the cyber campus prototype to evaluate its efficacy to support learning and investigate the relationship between the contributing factors and its ability to overcome barriers.

One of the aims of this research is to identify the characteristics of the virtual worlds that may contribute in overcoming barriers of accessibility and participation to university. During the review of the literature, I have decided to adopt the De Lucia et al. (2009) framework that proposes a set of factors that contribute in the development of learning-efficient virtual worlds. This framework suggests that the evaluation of the efficacy of a virtual world is based on the following factors: presence, communication, awareness and the feeling of belonging to a community. Presence relates to the feeling of being part of the virtual world and De Lucia et al. suggests that there is a strong relationship between presence and learning and that presence can enhance and make the learning experience more meaningful. Social awareness relates to the ability to feel the existence of other users and their location in the environment, communication concerns the non verbal communication that virtually complements verbal in the environment and the feeling of belonging relates to the use of a social space to facilitate collaboration, communication and access to information.
By conducting an empirical study through the cyber campus prototype, examination of the relationship among these factors and the ability of cyber campus to overcome restriction barriers shall be performed in order to ascertain the extent to which cyber campuses can support learning and overcome barriers that restricts students from regularly attend the university.

10. **Has the scientific / scholarly basis of this research been approved?** (For example by Research Degrees Subcommittee or an external funding body)

☒ Yes

☐ No - to be submitted
☐ Currently undergoing an approval process
☐ Irrelevant (e.g. there is no relevant committee governing this work)

11. Main research questions
How can cyber campus help student to participate more effectively in learning activities?

12. Summary of methods including proposed data analyses
To conduct this study, subjective evaluation through opinion-based questionnaires and virtual focus groups shall be performed. This will allow the collection of both quantitative and qualitative data that will focus on the perceptions of presence, sociability,communication and awareness, perceived barriers and barriers elimination through the virtual world. Two questionnaires will be provided to participant's prior and after their interaction with the virtual world. The first questionnaire will collect demographic data and the post experiment questionnaire shall measure perceptions of presence, sociability, communication and awareness. (See attached Nisiotis_questionnaires.docx)
A virtual focus group will be conducted after the users experience with the virtual world to collect opinions based on how the virtual worlds can help them participate in learning activities more effectively (see attached Nisiotis_semi-structured_focus_group.doxc).
Data collected through this focus group, will be further examined to identify the relationship between the factors of interest and participants perceptions of how the cyber campus can support them.

SECTION B

1. Describe the arrangements for selecting/sampling and briefing potential participants.
This should include copies of any advertisements for volunteers or letters to individuals/organisations inviting participation. The sample sizes with power calculations if appropriate should be included.
Call for participation (see document attached: NisiotisCFP.docx) will be put online in DRF (disability research forum) and email will be sent to disability organisations in an attempt to recruit people who might be interested. Social media will also be used as a mean of advertisment.

2. What is the potential for participants to benefit from participation in the research?
By participating in this experimental study, participatns will have the chance to virtually gather with other people in a relatively "risk free" environment through the comforts of their home. During this experiment, users will immerse in the virtual world, engage in the eye-catching environment and achieve the feeling of belonging to a community as they will have the oportunity to connect with other people in real time by using their avatars and engage in social interactions.
By participating in this virtual experience, users will understand the concept of learning through a state of the art 3D environment and identify how this tool may be to their benefit in improving learning efficiency.

3. Describe any possible negative consequences of participation in the research along with the ways in which these consequences will be limited.
Due to the nature of the experiment, participants will only meet virtually and communication will be facilitated through a chat room, therefore the only negative concequence that may occur is some sort of missbehavior in the chat by a user (e.g. type swear words on the chat room or cause other textual harassments). In this case,

the user will be immediately banned from the system and he will not be able to login the virtual world again.

4. **Describe the arrangements for obtaining participants' consent.** This should include copies of the information that they will receive & written consent forms where appropriate. If children or vulnerable people are to be participants in the study details of the arrangements for obtaining consent from those acting in *loco parentis* or as advocates should be provided.
Prior any interaction of the participants with the virtual world or any of the study material, they will have to read and accept a consent form that will be administered online. This form will inform participants the purpose of the study, how the data will be handled and their right to withdraw at any time without any concequences. Please see the attached document (Nisiotis_informed_concent_form.docx)

5. **Describe how participants will be made aware of their right to withdraw from the research.** This should also include information about participants' right to withhold information and a reasonable time span for withdrawal should be specified.
As mentioned in previews section (4) participants will made aware that have the right to witdraw from the study at any point. To do so, the participants should only exit the software that they use to connect to the virtual world.

6. **If your data collection requires that you work alone with children or other vulnerable participants have you undergone Criminal Records Bureau screening?** Please supply details.

   N/A

7. **Describe the arrangements for debriefing the participants.** This should include copies of the information that participants will receive where appropriate.
The details of the experimental procedures that will be followed during this experiment will be emailed to the users, few days before the sessions (See attached Nisiotis_Informative_Email .docx). Briefing of the activities that will take place within the virtual world shall take place after the users will login and virtually gather in the meeting point that i have designed. Brief explanation of the activities has been provided in the call for participation advertisment.

8. **Describe the arrangements for ensuring participant confidentiality.** This should include details of:
   - how data will be stored to ensure compliance with data protection legislation
   - how results will be presented
   - exceptional circumstances where confidentiality may not be preserved
   - how and when confidential data will be disposed of

   In accordance to Data Protection Act (1998), all data will be securely stored and will not be shared with third parties. All data collected from this study will be used exclusively by the members of this research and for the needs of my PhD thesis. Users will be identified by their avatar's name (pseudonym) throughout the experiments and results presentation and any identifying features of users real identity will be removed during the transcription and replaced with imaginary features. Conversations established within the virtual world will be recorded and used for data analysis purposes. Excerpts of conversation will be used. Text chat conversations as established within the virtual world cannot be accessed or read by anyone other than the research team, as the system is not accessible to anyone other than the study participants and the researchers. Users can access the data at any time if they ask to. Electronic data will be erased from hardrive and paper data will be shredded at the end of my PhD requirments.

9. **Are there any conflicts of interest in you undertaking this research?** (E.g. are you undertaking research on work colleagues or in an organisation where you are a consultant?) Please supply details of how this will be addressed.
No anticipated confict of interest.

10. **What are the expected outcomes, impacts and benefits of the research?**
During the literature reviewing, a number of opportunities that virtual worlds offer in education and the potential learning benefits that can be achieved have been identified. It has been also identified and determined that the use of virtual worlds to support students who cannot regularly attend their school is very limited and this is what motivates this study. Following the knowledge available, the aim is to perform an empirical study that concentrates on a different setting. Therefore, the original contribution of this research focus on the investigation of cyber campus capabilities to support learing for students who face exclusion barriers in education and overcome barriers to access. The research outcomes will not only extend the existing knowledge but also develop innovative approaches to education. Upon completion of this study, validations on some of the ideas behind this research shall occur and it is expected to fill the gap in the literature, where other researchers can use this empirical study for further investigation.

11. **Please give details of any plans for dissemination of the results of the research**
I intend to submit the results of the research for consideration for journal publication, conferences and my thesis .

SECTION C

RISK ASSESSMENT FOR THE RESEARCHER

1. **Will the proposed data collection take place on campus?**

☐ Yes (Please answer questions 4, 6 and 7)
☒ No (Please complete all questions)

2. **Where will the data collection take place?**
(Tick as many as apply if data collection will take place in multiple venues)

	Location	Please specify
☐	Researcher's Residence	
☐	Participant's Residence	
☐	Education Establishment	
☒	Other e.g. business/voluntary organisation, public venue	**Virtual world - A cyber campus prototype that i have developed. The server is hosted within the University infrastructure.**
☐	Outside UK	

3. **How will you travel to and from the data collection venue?**

☐ On foot ☐ By car ☐ Public Transport
☒ Other (Please specify) **Users will download a specific software and login the virtual world using their login credentials.**

Please outline how you will ensure your personal safety when travelling to and from the data collection venue
N/A

4. **How will you ensure your own personal safety whilst at the research venue?**
N/A - Users will access the system from probably their home and virtually gather so there is no anticipated issue of personal safety.

5. **If you are carrying out research off-campus, you must ensure that each time you go out to collect data you ensure that someone you trust knows where you are going (without breaching the confidentiality of your participants), how you are getting there (preferably including your travel route), when you expect to get back, and what to do should you not return at the specified time.** (See Lone Working Guidelines). Please outline here the procedure you propose using to do this.
N/A

6. **Are there any potential risks to your health and wellbeing associated with either (a) the venue where the research will take place and/or (b) the research topic itself?**

☒ None that I am aware of
☐ Yes (Please outline below)

7. **Does this research project require a health and safety risk analysis for the procedures to be used?**

☐ Yes
☒ No

(If YES the completed Health and Safety Project Safety Plan for Procedures should be attached)

Adherence to SHU policy and procedures

Personal statement	
I confirm that: • this research will conform to the principles outlined in the Sheffield Hallam University Research Ethics policy • this application is accurate to the best of my knowledge	
Principle Investigator	
Signature	
Date	27/11/2013
Supervisor (if applicable)	
Signature	
Date	27/11/2013

Please ensure the following are included with this form if applicable, tick box to indicate:

	Yes	No	N/A
Research proposal if prepared previously	☒	☐	☐

Any recruitment materials (e.g. posters, letters, etc.)	☒	☐	☐
Participant information sheet	☒	☐	☐
Participant consent form	☒	☐	☐
Details of measures to be used (e.g. questionnaires, etc.)	☒	☐	☐
Outline interview schedule / focus group schedule	☒	☐	☐
Debriefing materials	☒	☐	☐
Health and Safety Project Safety Plan for Procedures	☐	☐	☒

3.3. Pre Experiment Questionnaire

Question:	
Avatar Name:	
Age:	
	Factor:
I am expert in the computer usage	*PCK*
I am expert in the Internet usage	*PCK*
I am expert in the usage of Video-games	*3DG*
I am expert in the usage of Virtual Environments	*3DG*
I am expert in the Second Life usage	*3DG*
Sometimes I am so involved in a game that having the impression of being part of the game rather than moving a joystick or watching the screen	*INV*
When working on a task I am easily distracted	*INV*
I often play Video Games (at least one time at day)	*3DG*
I concentrate well also on disagreeable tasks	*INV*
I become so involved in doing something that I lose all track of Time	*INV*
I have been scared by something happening on a TV show or in a Movie	*INV*
Scale:	
7 - Completely Agree *6 - Mostly Agree* *5 - Slightly Agree* *5 – Neither Agree or Disagree* *3 - Slightly Disagree* *2 - Mostly Disagree* *1- Completely Disagree*	
Legend: PCK=Computers Knowledge, 3DG=3D Environments and Gaming, INV=Tendency to get Involved in Activities	

3.4. The initial questionnaire used in De Lucia et al. (2009) study.

Presence Questionnaire	
Question:	***Factors:***
How much were you able to control events?	*CF*
How responsive was the environment to action that you initiated (or performed)?	*CF*
How natural did your interactions with the environment seem?	*CF*
How completely were all of your senses engaged?	*SF*
How much did the visual aspects of the environment involve you?	*SF*
How much did the auditory aspects of the environment involve you?	*SF*
How natural was the mechanism that controlled movement through the environment?	*CF*
*How aware were you of events occurring in the real world around you? **	*DF*
*How aware were you of your display and control devices? **	*DF*
How compelling was your sense of objects moving through space?	*SF*
How inconsistent or disconnected was the information coming from your various senses?	*RF*
How much did your experiences in the virtual environment seem consistent with your real-world experiences?	*RF, CF*
Were you able to anticipate what would happen in response to the actions that you performed?	*CF*
How completely were you able to actively survey or search the environment using vision?	*RF, CF, SF*
How well could you identify sounds?	*RF, SF*
How well could you localize sounds?	*RF, SF*
How well could you actively survey or search the virtual environment using speech?	*RF, SF*
How compelling was your sense of moving around inside the virtual environment?	*SF*
How closely were you able to examine objects?	*SF*
How well could you examine objects from multiple viewpoints?	*SF*

How well could you create or manipulate objects in the virtual environment?	*CF*
To what degree did you feel confused or disoriented at the beginning or at the end of the experimental session?	*RF*
How involved were you in the virtual environment experience?	*INV*
How distracting was the control mechanism?	
How much delay did you experience between your actions and expected outcomes?	*CF*
How quickly did you adjust to the virtual environment experience?	*CF*
*How proficient in moving and interacting with the virtual environment did you feel at the end of the experience? **	*CF*
How much did the visual display quality interfere or distract you from performing assigned tasks or required activities?	*DF*
*How much did the control devices interfere with the performance of assigned tasks or with other activities? **	*DF, CF*
*How well could you concentrate on the assigned tasks rather than on the mechanisms used to perform them? **	*DF*
Did you learn new techniques that enabled you to improve your performance?	*CF*
Were you involved in the experimental task to the extent that you lost track of time?	*INV*
*Legend: CF = control factors, SF = sensory factors, DF = distraction factors, RF = realism factor, * = reverse coded*	

Awareness
I have been immediately aware of the existence of the other participants
I was aware of what was going on
I was aware of the participant roles (teacher, tutor, student)

Communication
Communicating with the other participants was easy
The system increased the opportunity of discussing with the others
Conversation has been properly managed
Non-verbal communication (gesture) was adequate

Sociability
This environment enabled me to easily contact my teammates
I did not feel lonely in this environment
This environment enabled me to get a good impression of my teammates
This environment allows spontaneous informal conversations
This environment allowed for non-task-related conversations
This environment enabled me to make close friendships with my teammates

Collaborative Virtual Environment
The environment design was stimulating
The object metaphors were intuitive
Objects reacted in an inconsistent/consistent way to selection and manipulation,
The User Interface components, needed to participate, were easy to locate
Amount of information that was displayed on the screen was adequate
Arrangement of information on the screen was logical
The design of the didactical environments was logical

3.5. Presence Questionnaire (PQ)

Item:	***Description:***	***Factor:***
PQ1	*How much were you able to control events?*	*CF*
PQ2	*How responsive was the environment to action that you initiated (or performed)?*	*CF*
PQ3	*How natural did your interactions with the environment seem?*	*CF*
PQ4	*How much did the visual aspects of the environment involve you?*	*SF*
PQ5	*How natural was the mechanism that controlled movement through the environment?*	*CF*
PQ6	*How compelling was your sense of objects moving through space?*	*SF*
PQ7	*How much did your experiences in the virtual environment seem consistent with your real-world experiences?*	*RF, CF*
PQ8	*Were you able to anticipate what would happen in response to the actions that you performed?*	*CF*
PQ9	*How completely were you able to actively survey or search the environment using vision?*	*RF, CF, SF*
PQ10	*How compelling was your sense of moving around inside the virtual environment?*	*SF*
PQ11	*How closely were you able to examine objects?*	*SF*
PQ12	*How well could you examine objects from multiple viewpoints?*	*SF*
PQ13	*How involved were you in the virtual environment experience?*	
PQ14	*How much delay did you experience between your actions and expected outcomes? **	*CF*
PQ15	*How quickly did you adjust to the virtual environment experience?*	*CF*
PQ16	*How proficient in moving and interacting with the virtual environment did you feel at the end of the experience?*	*CF*
PQ17	*How much did the visual display quality interfere or distract you from performing assigned tasks or required activities?**	*DF*
PQ18	*How much did the control devices interfere with the performance of assigned tasks or with other activities? **	*DF, CF*
PQ19	*How well could you concentrate on the assigned tasks rather than on the mechanisms used to perform them?*	*DF*
Legend: CF = control factors, SF = sensory factors, DF = distraction factors, RF =		

realism factor, * = reverse coded

3.6. Awareness Scale

Item:	***Description:***
AW1	*I have been immediately aware of the existence of the other participants*
AW2	*I was aware of what was going on*
AW3	*I was aware of the participant roles (teacher, tutor, student)*

3.7. Communication Scale

Item:	***Description:***
COM1	*Communicating with the other participants was easy*
COM2	*The system increased the opportunity of discussing with the others*
COM3	*Conversation has been properly managed*
COM4	*Non-verbal communication (gesture) was adequate*

3.8. Sociability Scale

Item:	***Description:***
SOC1	*This environment enabled me to easily contact my teammates*
SOC2	*I did not feel lonely in this environment*
SOC3	*This environment enabled me to get a good impression of my teammates*
SOC4	*This environment allows spontaneous informal conversations*
SOC5	*This environment allowed for non-task-related conversations*
SOC6	*This environment enabled me to make close friendships with my teammates*
SOC7	*This virtual environment enables us to develop into a well performing team*
SOC8	*This virtual environment enables me to develop good work relationships with my team mates*
SOC9	*This virtual environment enables me to identify myself with the team.*
SOC10	*I feel comfortable with this virtual environment*

3.9. Collaborative Virtual Environment Scale

Item:	***Description:***
CVE1	*The environment design was stimulating*
CVE2	*The object metaphors were intuitive*
CVE3	*Objects reacted in an inconsistent/consistent way to selection and manipulation*
CVE4	*The User Interface components, needed to participate, were easy to locate*
CVE5	*Amount of information that was displayed on the screen was adequate*
CVE6	*Arrangement of information on the screen was logical*
CVE7	*The design of the didactical environments was logical*
CVE8	*This environment enabled me to learn*
CVE9	*I am satisfied with the experience*

3.10. Questionnaire Responses

Presence Questionnaire - (Witmer and Singer, 1998)
1. How much were you able to control events?
NOT AT ALL
ALMOST NEVER
SOME CONTROL
MODERATE CONTROL
FREQUENTLY
MOST OF THE TIME
COMPLETELY
2. How responsive was the environment to action that you initiated (or performed)?
NOT RESPONSIVE
VERY SLIGHT RESPONSIVENESS
SLIGHTLY RESPONSIVE
MODERATELY RESPONSIVE
VERY RESPONSIVE
VERY GOOD RESPONSIVENESS
COMPLETELY RESPONSIVE
3. How natural did your interactions with the environment seem?
EXTREMELY UNATURAL
MOSTLY UNATURAL
SLIGHTLY UNATURAL
MODERATELY NATURAL
MOSTLY NATURAL
VERY NATURAL
COMPLETELY NATURAL
4. How much did the visual aspects of the environment involve you?
NOT AT ALL
VERY SLIGHT INVOLVEMENT
SLIGHTLY INVOLVED
SOMEWHAT INVOLVED
VERY INVOLVED
VERY MUCH INVOLVED

COMPLETELY INVOLVED
5. How natural was the mechanism that controlled movement through the environment?
EXTREMELY UNATURAL
MOSTLY UNATURAL
SLIGHTLY UNATURAL
MODERATELY NATURAL
SLIGHTLY NATURAL
MOSTLY NATURAL
COMPLETELY NATURAL
6. How compelling was your sense of objects moving through space?
NOT AT ALL
NOT VERY COMPELLING
SLIGHTLY COMPELLING
MODERATELY COMPELLING
COMPELLING
VERY COMPELLING
EXTREMELY COMPELLING
7. How much did your experiences in the virtual environment seem consistent with your real-world experiences?
NOT CONSISTENT
VERY SLIGHT CONSISTENCY
SLIGHT CONSISTENCY
MODERATE CONSISTENCY
GOOD CONSISTENCY
VERY CONSISTENT
EXTREMELY CONSISTENT
8. Were you able to anticipate what would happen in response to the actions that you performed?
NOT AT ALL
VERY SLIGHT ANTICIPATION
SLIGHT ANTICIPATION
SOME ANTICIPATION
GOOD ANTICIPATION

VERY GOOD ANTICIPATION
COMPLETELY ANTICIPATED
9. How completely were you able to actively survey or search the environment using vision?
NOT AT ALL
VERY SLIGHLTY
SLIGHTLY
SOMEWHAT
MUCH
VERY MUCH
COMPLETELY
10. How compelling was your sense of moving around inside the virtual environment?
NOT AT ALL
NOT VERY COMPELLING
SLIGHTLY COMPELLING
SOMEWHAT COMPELLING
COMPELLING
VERY COMPELLING
COMPLETELY COMPELLING
11. How closely were you able to examine objects?
NOT AT ALL
NOT VERY CLOSELY
SLIGHTLY CLOSE
SOMEWHAT CLOSELY
CLOSELY
VERY CLOSELY
EXTREMELY CLOSELY
12. How well could you examine objects from multiple viewpoints?
NOT AT ALL
NOT WELL
NOT VERY WELL
SOMEWHAT WELL
SLIGHTLY WELL

VERY WELL
EXTENSIVELY
13. How involved were you in the virtual environment experience?
NOT INVOLVED
NOT VERY INVOLVED
SLIGHTLY INVOLVED
MILDLY INVOLVED
INVOLVED
VERY INVOLVED
COMPLETELY INVOLVED
14. How much delay did you experience between your actions and expected outcomes? *
NEVER
RARE DELAYS
OCCASIONAL DELAYS
SOME DELAYS
FREQUENT DELAYS
VERY FREQUENT DELAYS
UNUSABLE EXPERIENCE
15. How quickly did you adjust to the virtual environment experience?
NOT AT ALL
EXTREMELY SLOWLY
VERY SLOWLY
SLOWLY
FAST
VERY FAST
LESS THAN A MINUTE
16. How proficient in moving and interacting with the virtual environment did you feel at the end of the experience?
NOT PROFICIENT
VERY SLIGHTLY PROFICIENT
SLIGHTLY PROFFICIENT
REASONABLY PROFICIENT
PROFICIENT

VERY PROFICIENT
EXTREMELY PROFICIENT
17. How much did the visual display quality interfere or distract you from performing assigned tasks or required activities?*
NOT AT ALL
VERY SLIGHT INTERFERENCE
SLIGHT INTERFERENCE
INTERFERED SOMEWHAT
MUCH INTERFERENCE
VERY MUCH INTERFERENCE
PREVENTED TASK PERFORMANCE
18. How much did the control devices interfere with the performance of assigned tasks or with other activities? *
NOT AT ALL
VERY SLIGHT INTERFERENCE
SLIGHT INTERFERENCE
INTERFERED SOMEWHAT
MUCH INTERFERE
VERY MUCH INTERFERE
INTERFERED GREATLY
19. How well could you concentrate on the assigned tasks or required activities rather than on the mechanisms used to perform those tasks or activities?
NOT AT ALL
ALMOST NO CONCENTRATION
SLIGHT CONCENTRATION
SOMEWHAT CONCENTRATED
MUCH CONCENTRATION
VERY MUCH CONCENTRATION
COMPLETELY CONCENTRATED

Awareness Scale (De Lucia et al, 2009)
1. I have been immediately aware of the existence of the other participants
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
2. I was aware of what was going on
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
3. I was aware of the participant roles (teacher, tutor, student)
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE

Communication Scale (De Lucia et al., 2009)
1. Communicating with the other participants was easy
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
2. The system increased the opportunity of discussing with the others
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
3. Conversation has been properly managed

STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
4. Non-verbal communication (gesture) was adequate
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE

Sociability Scale (Kreijns et al., 2007)
1. This environment enabled me to easily contact my teammates
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
2. I did not feel lonely in this environment
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
3. This environment enabled me to get a good impression of my teammates
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
4. This environment allows spontaneous informal conversations
STRONGLY DISAGREE
DISAGREE

UNDECIDED
AGREE
STRONGLY AGREE
5. This environment allowed for non-task-related conversations
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
6. This environment enabled me to make close friendships with my teammates
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
7. This virtual environment enables us to develop into a well performing team
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
8. This virtual environment enables me to develop good work relationships with my team mates
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
9. This virtual environment enables me to identify myself with the team.
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE

10. I feel comfortable with this virtual environment
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE

Collaborative Virtual Environment (CVE) Scale – (De Lucia et al., 2009)
1. The environment design was stimulating
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
2. The object metaphors were intuitive
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
3. Objects reacted in an inconsistent/consistent way to selection and manipulation
VERY INCONSISTENT
SLIGHTLY INCONSISTENT
UNDECIDED
SLIGHTLY CONSISTENT
VERY CONSISTENT
4. The User Interface components, needed to participate, were easy to locate
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
5. Amount of information that was displayed on the screen was adequate
STRONGLY DISAGREE

DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
6. Arrangement of information on the screen was logical
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
7. The design of the didactical environments was logical
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
8. This environment enabled me to learn
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
9. I am satisfied with the experience
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE

3.11. Virtual Focus Group Questions

Q1: What are the barriers you experience impeding access and participation to education and learning activities?

Q2: How these barriers affect or affected your learning experience?

Q3: What are the most important educational characteristics of the cyber campus based on your experience in the previous session?

Q4: How can these characteristics help you participate in online learning activities?

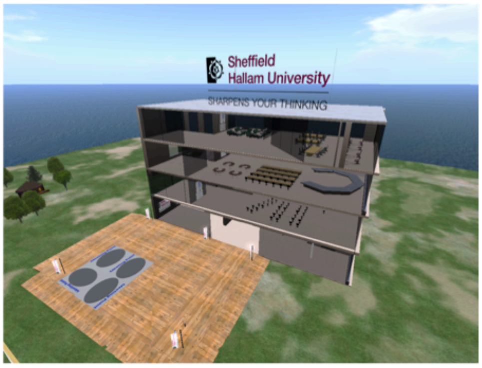
Q5: What are the most important points you get through this discussion?

Appendix 4 - The Cyber Campus Prototype

4.1. Tutorial Booklet

SHU3DED Cyber Campus Assessment Study

Instructions Booklet
Date: 25/02/2013
Cantor 9309



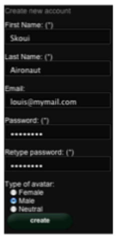
Part 1. Configuration
1.1 Create your Account

These steps should be performed **only the first time you log in the system**.
On Imprudence Viewer, click **Create Account** from the **Main Menu** on the right.

You will be redirected to the **Create New Account** page, where you should fill in the fields marked with an asterisk (*****).

Please use a **FICTIONAL First and Last name** for your Avatar. Only letters, numbers, and underscores are accepted characters for account names.

- First Name – Please enter a **fictional** first name
- Last Name – Please enter a **fictional** last name
- Email – Not mandatory
- Password – Type a secure password.
- Type of Avatar – Choose your avatar genre.

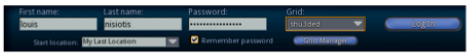


First Name, **Last** Name and your **password** are your system **login credentials!**

1.2 Log in the system

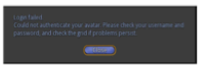
To **login** the system:

1. First enter your Avatar **First / Last** name and **Password.**
2. Then from the **Grid drop-down list** choose **shu3ded** if not selected.
3. Click the "**Log In**" button.

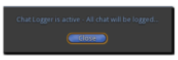


NOTE: If a "Login Failed" box appears, please check your username and re-enter your password

When you log in, the system will pop up some notification boxes.



You will be notified that **all chat** will be logged. Click **Close**.



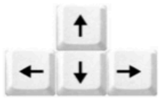
Important Notice

At this point, you might experience the "**cloud avatar**" issue. This make you or the other users look like a white smoke or cloud. This occurs because the system is trying to load the shape and the clothes of your avatar. The loading times depends on the computer and network speed. This is more likely to be resolved in the next few minutes.
Continue to Part 2 and if the avatar is not loaded in few minutes, notice an administrator.

Part 2. Basic interaction

2.1 Basic Navigation

- **Walking**
  - You can move your avatar with the arrow keys on your keyboard.
  - The **up arrow moves you forward**, and **the down arrow moves you backward**.
  - The left and right arrows rotate you to the left or right.
- **Run**
  - To move faster, you can also **RUN** by **hitting and holding** the UP Arrow twice on your keyboard



2.2 Communication – Local Chat

Use **local chat** to speak with avatars **near you** in the virtual environment. Anything you say over local chat is available for anyone **within close range** to read. Local chat is best used for chat amongst multiple avatars.

To use local chat:

- Clicking the **local chat** button at the bottom of your screen will open a small white bar just above it so that you may chat.

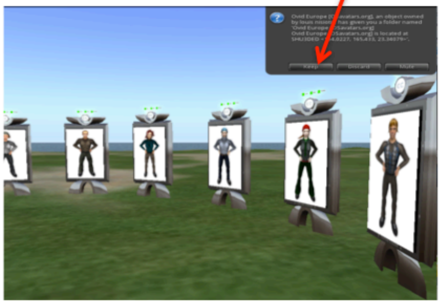
NOTE: If the chatting text box is hidden click the **Show Chat** button.

- **Task**: Everybody say "Hello World!" to the local chat.

2.4 Avatar

Locate and go to the Avatar area. In this area, you should choose from a range of predesigned shapes and looks.
To select the avatar of your choice, **click** on the Default Avatar **board** of your choice and **choose "KEEP"** on the notifications window that will pop up on your right.

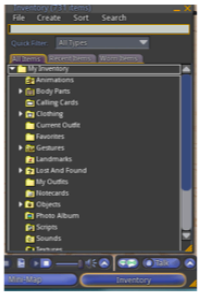
Task: Choose your Avatar.



Note the name of the Avatar folder. You will be asked to locate it in the next stage!
To find the name of the Avatar folder, check the local chat.

2.5 Inventory

Your Inventory is the collection of all the stored items that you own or have access to.
It does not include items actively placed within the 3D world, but it does include items attached to your avatar.



- Find the folder named after the avatar you have chosen in previews stage.
(If you cant remember the folder name, click local chat and find it from the chat history.)
- **Right click** the folder and choose **"Replace Outfit"**
- **Task**: Everybody **locate and "replace"** the outfit of your Avatar.

At this point, if you were experiencing the **"Cloud Avatar Issue"**, replacing your avatar's outfit should fix it. If not, please notice an administrator.

2.6 Teleport

To move around the cyber campus, you can **Teleport.**

A *Teleport* is an instant change of locations. If you are near a Teleport Area, **Right Click** on the location you want to visit and click **Teleport.**

By now, the facilitator has allocated you on a team.

Task: Teleport to your assigned team sandbox area.

Part 3. Basic Object Manipulation

So far you have learned how to navigate around and communicate with other users in the virtual environment. The next task is to learn how to build and manipulate your own objects in the virtual world.

Imprudence Viewer software has built in tools to create and modify objects. Objects are made of one or more "primitive shapes", or "**prims**". Each prim has one or more images called "**textures**" applied to its surfaces, and can contain an unlimited number of items inside it, including other objects.

Part 3 will guide you on how to create a basic prim, position, rotate and resize as well as how to apply textures and duplicate them for further use.

By the end of this part, you will be in a position to build and manipulate a basic object.

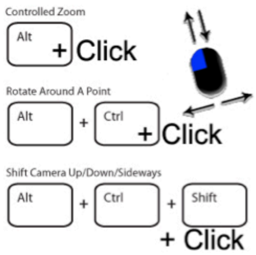
3.1 Camera Controls

To control your camera view is important when you are building and want to have a close look of the objects.

Try the following using your mouse and keyboard:

1. Holding down **ALT** Key – **click and moving** the mouse up and down zooms the camera in and out.
2. Holding down **ALT** Key – **click and moving** the mouse left or right, orbits the camera to left or right.
3. Holding down **ALT** Key and **CTRL** Key – **click and moving** the mouse orbits the camera - this time both horizontally and vertically, or in combinations if you move the mouse at an angle.

Pressing **Escape key** (twice for most users, once to close the chat bar, once to revert the camera) will revert the camera to its default, over-the-shoulder view or close to it. Moving your avatar will revert the camera instantly.



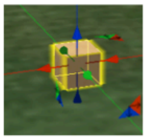
3.2 Creating a basic prim

Step 1
Right click anywhere on the ground.
Click **Build or Create** to open the Tools window.

Step 2
In the Tools window you will see list of shapes.
Select the shape you want to create, e.g. square, sphere, pyramid.

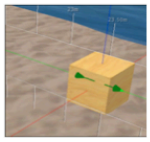
Step 3
The cursor will appear as a **magic wand**.
Click the ground to create (**Rez**) the prim you have selected.

3.3 Positioning



Step 1 (If the Tools window is not open, **right click** on a prim and select **Edit**.)
On the selected prim, choose the **Position** option at the top of the **Tools** window.

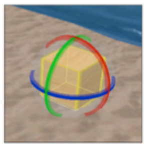
Three lines will appear on the prim showing:
X (red),
Y (green) and
Z (blue) axes.



Step 2
Hover over an arrow on an axis **until it becomes highlighted**.

Click and drag to move the prim along the axis.

3.4 Rotating



Step 1 – (If the Tools window is not open, **right click** on a prim and select **Edit**.)
With the selected prim, choose the **Rotate** option at the top of the **Tools** window.
Three rings will appear on the prim showing the:
X (red),
Y (green) and
Z (blue) rotation axes.
Hover over a ring until it becomes highlighted.
Click, hold and move your mouse from side to side to rotate the prim along the selected axis.
Holding CTRL key on your keyboard can also do this!

3.5 Resizing

Step 1 - (If the Tools window is not open, **right click** on a prim and select **Edit**.)

With the selected prim, choose the **Stretch** option and **UN-TICK** Stretch Both Sides checkbox from the top of the Tools window.
Red, blue and green cubes will appear on the prim.
Step 2
Hover over a cube until it becomes highlighted.
Click and drag to resize the prim along the selected axis.

Step 3 - Tick the Stretch Both Sides checkbox at the top of the Tools window.
Click and drag to resize the prim along the selected axis.
Holding CTRL+SHIFT keys on your keyboard can also do this!

Step 4
Click and drag one of the **grey** cubes on the corners of the prim to change the whole prim size with its proportions constrained

3.6 Colour

Step 1 - (If the Tools window is not open, **right click** on a prim and select **Edit**.)
With the selected prim, select the Texture tab.
This shows information about your prim colors and textures.

Step 2
Click the Color thumbnail.
The **Color Picker** window will now open.
Select a desired colour for your prim and click Select.

Step 3
Your prim will now have changed colour
IF NOT, (probably the prim is still on the default wood grain texture).
Click the Texture thumbnail in the Tools window.
The Texture window will open.
In the Texture window select **Blank** and close the window.

Step 4
Choose the Select Texture option from the top of the Tools window.

Click on one of the **faces** (surfaces) of your shape.

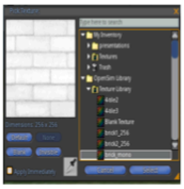
After you click, **a white target** will appear on the selected face to confirm selection.

Step 5
Click the Color thumbnail in the Tools window.
Select a colour from the Color Picker window and then click Select.
The face of the prim that you selected **will change colour** but the rest will stay the same.
Note that if you haven't chosen **Select Texture**, the whole prim will change colour.

3.7 Texture

Step 1 (If the Tools window is not open, **right click** on a prim and select **Edit**.)
With the selected prim, select the Texture tab.

Step 2
Note: If you have previously changed the colour of your prim, change it back to white.
Click Color, select white from the Color Picker window and click Select.



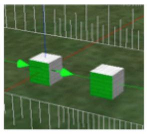
Step 3
Click the Texture thumbnail to open the Texture window.

Step 4
Navigate to Opensim Library
Select a texture from your Opensim Library/Textures Library folder.
A preview of it will appear on the left. Click Select to apply it to your prim.
There is a range of textures in this library to use. Feel free to use them on your prim.

Step 5
Choose the **Select Texture** option from the top of the Tools window.
Click on **one of the faces** of your shape.
A **white target** will appear on it to confirm selection.

Step 6
Click the **Texture** thumbnail in the Tools window.
Select a texture in the Texture window and click Select.
The face of the prim that you selected will change texture but the rest will stay the same.
Note: If you haven't chosen Select Texture the whole prim will change.

3.7 Duplicating Prims



Step 1
To **duplicate** a prim, make sure the desired prim is on **position option.**
Then hold SHIFT key and drag the highlighted arrows until it is duplicated

To **Delete** a prim – Right click the prim and choose **Delete**

Part 4 - Team Building

So far, you have learned how to navigate in the virtual world and communicate using the local chat. Furthermore, you have learned how to create and manipulate basic prim shapes, apply colours and textures. Now it is time to put all this learning in practice!

With your team members, you should collaboratively decide and build a virtual design together.

The design concept should be one of the following:

- A small house or a building.
- A car.
- Statue, totem.
- Maze.
- Pyramids.
- Planets, solar system.

NOTE: At the end of the session, close the Imprudence window by pressing the x button on the top right of the window.

Please **DO NOT** log off or shut down the computer.

4.2. Informed Consent Form

Participant Information Form

The purpose of this study is to test the SHU3DED cyber campus prototype. This will require your participation using a virtual character (Avatar), to navigate in the virtual environment and perform a series of tasks.

During this study you will learn how to navigate, communicate and collaborate in the virtual environment in order to complete a team building activity.

Relevant data will be recorded through chat logging. In all cases, all participants shall remain anonymous and shall be identified with their Avatar name. All collected data will be used for the writing of Louis Nisiotis PhD thesis.

This study only concentrates on the cyber campus functionality and does not intend to measure user performance.

Participant Consent

I confirm that I am aware of the aims and objectives of this study, the activities involved and how the collected data will be used. I can contact the researcher at any time during the study. I can also withdraw from the study at any time.

I understand that:

- *I can withdraw from the study any time.*
- *It is not mandatory to complete questionnaires and surveys.*
- *I can obtain copy of the findings of the research after the completion of the study by contacting the researcher.*

Name of Participant:

____

I am over 18 years of age and competent to give consent (please circle): YES / NO

Participant's Signature:

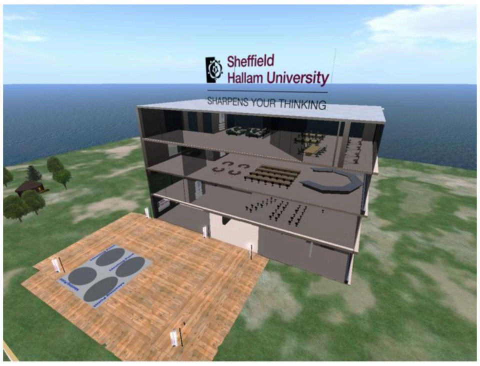
____*Date:* _________________

*Researcher's Signature:*____

Appendix 5 – Initial Evaluation of SHU3DED

5.1. Refined Instructions Booklet

Instructions Booklet



For live support, go to: http://learninvw.com/chat.
Administrator's Email: louis.nisiotis@student.shu.ac.uk

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Table of Contents

1. CONFIGURATION

1.1. Viewer Installation

Download and Install Imprudence Viewer

1. Go to http://learninvw.com/downloads/installation.zip
2. Unzip the folder: Installation.zip

The folder contains three files:
1) SETUP.bat
2) viewer.exe
3) additional

3. RUN the file called: SETUP.bat.
4. Follow the installation instructions.
5. Run Imprudence Viewer.

1.2. Log in the system

Your login credentials including your Avatar Name and password have been emailed to you. If not, contact the administrator.

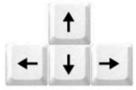
To **login** the system:

1. First enter your Avatar **First / Last** name and **Password.**
2. Click the "**Log In"** button.

2. BASIC INTERACTION

2.1. Basic Navigation

- **Walking**
  - You can move your avatar with the arrow keys on your keyboard.
  - The **up arrow moves you forward**, and **the down arrow moves you backward**.
  - The left and right arrows rotate you to the left or right.

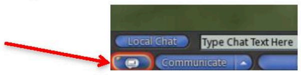


2.2. Communication – Local Chat

Use **local chat** to speak with avatars **near you**. Anything you say over local chat is available for anyone **within close range** to read.

To use local chat:
- Clicking the **local chat** button at the bottom of your screen will open a small white bar just above it so that you may chat.

NOTE: If the chatting text box is hidden click the **Show Chat** button



2.3. Gestures

Gestures trigger your avatar to animate and for practical use.
On the top of your screen, locate and try out the various gestures.

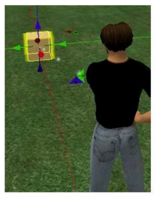
3. BASIC OBJECT MANIPULATION

So far you have learned how to navigate around and communicate with other users in the virtual environment. The next task is to learn how to build and manipulate your own objects in the virtual world.

Imprudence Viewer software has built in tools to create and modify objects. Objects are made of one or more "primitive shapes", or "**prims**". Each prim has one or more images called "**textures**" applied to its surfaces, and can contain an unlimited number of items inside it, including other objects.

Part 3 will guide you on how to create a basic prim, position, rotate and resize as well as how to apply textures and duplicate them for further use.

By the end of this part, you will be in a position to build and manipulate a basic object.



3.1. Camera Controls

To control your camera view is important when you are building and want to have a close look of the objects.

Try the following using your mouse and keyboard:

1. Holding down **ALT** Key – **click and moving** the mouse up and down zooms the camera in and out.

2. Holding down **ALT** Key – **click and moving** the mouse left or right, orbits the camera to left or right.

Pressing Escape key (twice for most users, once to close the chat bar, once to revert the camera) will revert the camera to its default, over-the-shoulder view or close to it. Moving your avatar will revert the camera instantly.

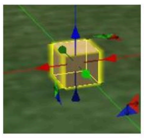
3.2. Creating a basic prim

Step 1
Right click anywhere on the ground.
Click **Build or Create** to open the Tools window.

Step 2
In the Tools window you will see list of shapes.
Select the shape you want to create, e.g. square, sphere, pyramid.

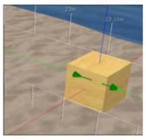
Step 3
The cursor will appear as a **magic wand**.
Click the ground to create (**Rez**) the prim you have selected.

3.3. Positioning



step 1 (If the Tools window is not open, **right click** on a prim and select **Edit**.)
On the selected prim, choose the **Position** option at the top of the **Tools** window.

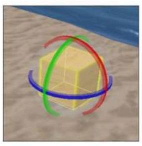
Three lines will appear on the prim showing:
X (red),
Y (green) and Z (blue) axes.



Step 2
Hover over an arrow on an axis **until it becomes highlighted**.

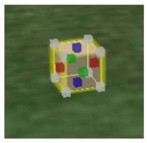
Click and drag to move the prim along the axis.

3.4. Rotating



Step 1 – (If the Tools window is not open, **right click** on a prim and select **Edit**.)
With the selected prim, choose the **Rotate** option at the top of the **Tools** window.
Three rings will appear on the prim showing the:
X (red),
Y (green) and Z (blue) rotation axes.
Hover over a ring until it becomes highlighted.
Click, hold and move your mouse from side to side to rotate the prim along the selected axis.
Holding CTRL key on your keyboard can also do this!

3.5. Resizing



Step 1 - (If the Tools window is not open, **right click** on a prim and select **Edit**.)

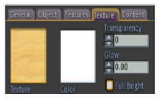
With the selected prim, choose the **Stretch** option and **UN-TICK** Stretch Both Sides checkbox from the top of the Tools window.
Red, blue and green cubes will appear on the prim.

Step 2
Hover over a cube until it becomes highlighted.
Click and drag to resize the prim along the selected axis.

Step 3 - Tick the Stretch Both Sides checkbox at the top of the Tools window.
Click and drag to resize the prim along the selected axis.
Holding CTRL+SHIFT keys on your keyboard can also do this!

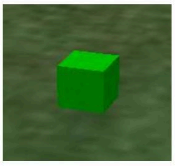
Step 4
Click and drag one of the **grey** cubes on the corners of the prim to change the whole prim size with its proportions constrained.

3.6. Colour

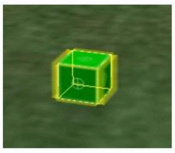


Step 1 - (If the Tools window is not open, **right click** on a prim and select **Edit**.)
With the selected prim, select the Texture tab. **This shows information about your prim colors and textures.**

Step 2
Click the Color thumbnail.
The **Color Picker** window will now open.
Select a desired colour for your prim and click Select.



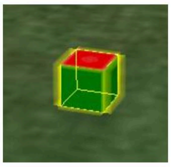
Step 3
Your prim will now have changed colour
IF NOT, **(probably** the prim is still on the default wood grain texture).
Click the Texture thumbnail in the Tools window.
The Texture window will open.
In the Texture window select **Blank** and close the window.



Step 4
Choose the Select Texture option from the top of the Tools window.

Click on one of the **faces** (surfaces) of your shape.

After you click, **a white target** will appear on the selected face to confirm selection.



Step 5
Click the Color thumbnail in the Tools window.
Select a colour from the Color Picker window and then click Select.
The face of the prim that you selected **will change colour** but the rest will stay the same.

Note that if you haven't chosen **Select Texture**, the whole prim will change colour.

3.7. Texture

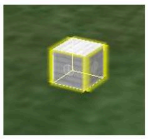
Step 1 (If the Tools window is not open, **right click** on a prim and select **Edit**.)
With the selected prim, select the Texture tab.

Step 2
Note: If you have previously changed the colour of your prim, change it back to white.
Click Color, select white from the Color Picker window and click Select.

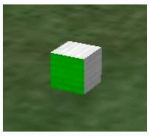
Step 3
Click the Texture thumbnail to open the Texture window.

Step 4
Navigate to Opensim Library
Select a texture from your Opensim Library/Textures Library folder.
A preview of it will appear on the left.
Click Select to apply it to your prim.

There is a range of textures in this library to use. Feel free to use them on your prim.



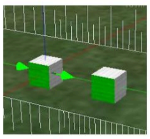
Step 5
Choose the **Select Texture** option from the top of the Tools window.
Click on **one of the faces** of your shape.
A **white target** will appear on it to confirm selection.



Step 6
Click the **Texture** thumbnail in the Tools window.
Select a texture in the Texture window and click Select.
The face of the prim that you selected will change texture but the rest will stay the same.

Note: If you haven't chosen Select Texture the whole prim will change.

3.8. Duplicating Prims



Step 1
To **duplicate** a prim, make sure the desired prim is on **position option**.
Then hold SHIFT key and drag the highlighted arrows until it is duplicated

To **Delete** a prim – Right click the prim and choose **Delete**

4. TEAM BUILDING

So far, you have learned how to navigate in the virtual world and communicate using the local chat. Furthermore, you have learned how to create and manipulate basic prim shapes, apply colors and textures. Now it is time to put all this learning in practice!

With your team members, you should collaboratively decide and build a virtual object together.

The design concept could be one of the following:
- A small house or a building.
- A car.
- Statue, totem.
- Maze.
- Pyramids.
- Planets, solar system.

5.2. Informed Consent Form

Participant Information Form

The purpose of this study is to analyse the flexibility of cyber campuses to support students. To investigate this, your perceptions of presence, awareness, communication and sociability of the environment will be analysed.

This will require your participation using a virtual character (Avatar), to navigate in the virtual environment and perform a series of tasks.

During this study you will learn how to navigate, communicate and collaborate in the virtual environment in order to complete a team building activity. Relevant data will be recorded using surveys and chat logging. In all cases, all participants shall remain anonymous and shall be identified with their Avatar name.

All collected data will be used for the writing of Louis Nisiotis PhD thesis.

This study only concentrates on the cyber campus functionality and does not intend to measure user performance.

Participant Consent

I confirm that I am aware of the aims and objectives of this study, the activities involved and how the collected data will be used. I can contact the researcher at any time during the study. I can also withdraw from the study at any time.

I understand that:

- *I can withdraw from the study any time.*
- *It is not mandatory to complete questionnaires and surveys.*
- *I can obtain copy of the findings of the research after the completion of the study by contacting the researcher.*

Name of Participant:

____

I am over 18 years of age and competent to give consent (please circle): YES / NO

Participant's Signature:

____ *Date:* __________________

Researcher's Signature:

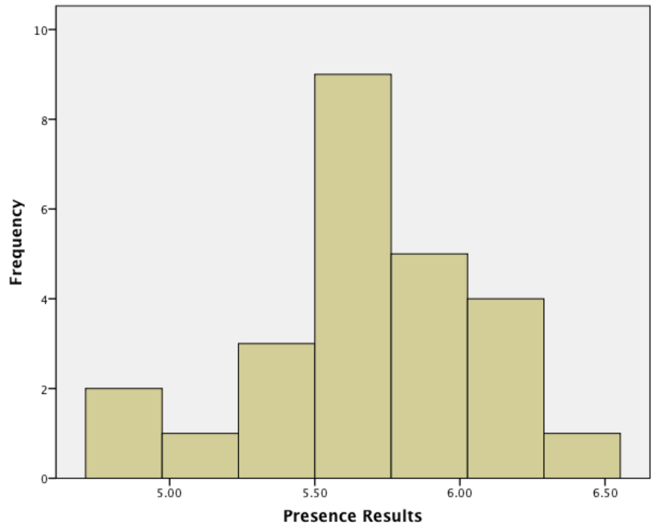
____

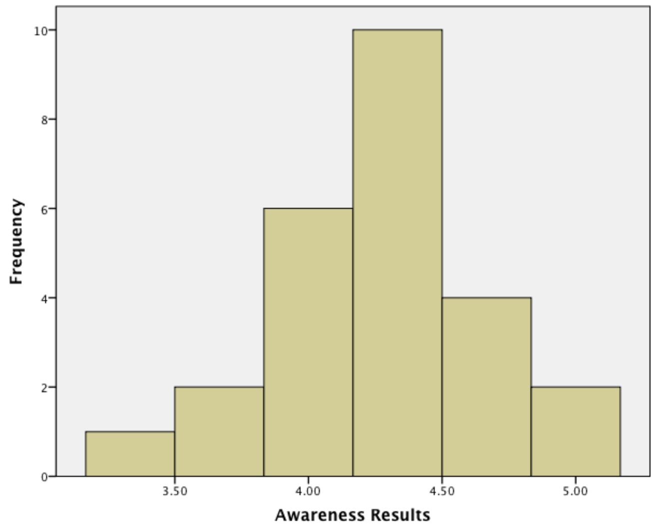
5.3. Data Distribution Tests

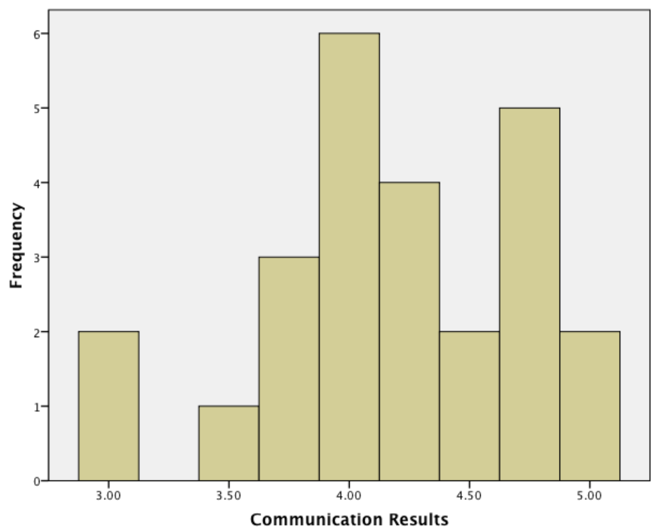
5.3.1. Numerical and GoF tests

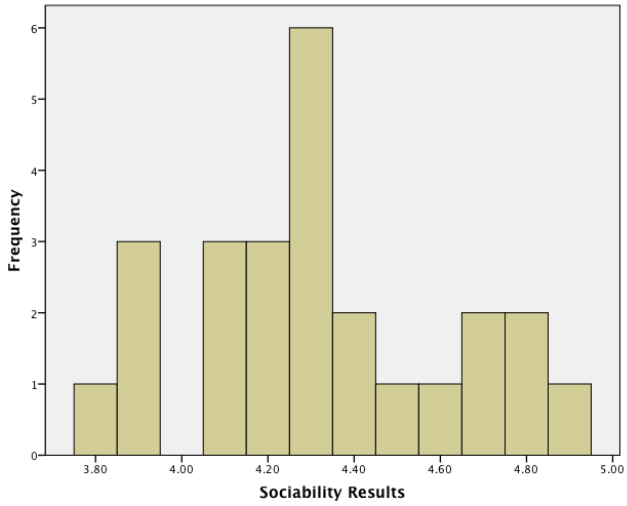
	PQ	*COM*	*AW*	*SOC*	*CVE*
Skewness	*-0.188*	*-0.491*	*-0.226*	*0.253*	*-.344*
SE Skewness	*0.464*	*0.464*	*0.464*	*0.464*	*0.464*
Z Skewness	*-0.405*	*-1.058*	*-0.487*	*0.545*	*0.741*
Kurtosis	*0.15*	*-0.44*	*0.321*	*-0.597*	*-0.472*
SE Kurtosis	*0.902*	*0.902*	*0.902*	*0.902*	*0.902*
Z Kurtosis	*0.166*	*-0.487*	*0.355*	*-0.604*	*-0.523*
Kolmogorov – Smirnov GoF with Lilliefors Correction Test					
Statistics	*0.143*	*0.131*	*0.207*	*0.166*	*0.126*
Df	*25*	*25*	*25*	*25*	*25*
P Value	*0.200*	*0.200*	*0.007*	*0.73*	*0.200*
Legend: PQ=Presence Questionnaire, AW=Awareness Scale, COM=Communication Scale, SOC=Sociability Scale, CVE=Collaborative Virtual Environment Scale, SE =Standard Error, Df=Degree of freedom, deviation, Z= ±1.96 criterion					

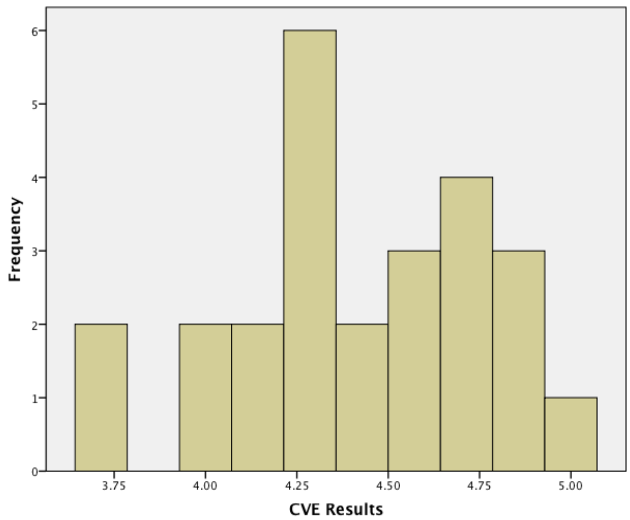
5.3.2. Data distribution visual inspection tests








Frequency
0
1
2
3
4
5
6
3.80
4.00
4.20
4.40
4.60
4.80
5.00
Sociability Results


Frequency
0
1
2
3
4
5
6
3.75
4.00
4.25
4.50
4.75
5.00
CVE Results

5.4. ANOVA of Teams and their Environment Perceptions

		Sum of Squares	*df*	*Mean Square*	*F*	*Sig.*
PQ	*Between Groups*	*1.009*	*4*	*.252*	*1.678*	*.194*
	Within Groups	*3.006*	*20*	*.150*		
	Total	*4.015*	*24*			
AW	*Between Groups*	*1.191*	*4*	*.298*	*2.301*	*.094*
	Within Groups	*2.587*	*20*	*.129*		
	Total	*3.778*	*24*			
COM	*Between Groups*	*.166*	*4*	*.042*	*.118*	*.974*
	Within Groups	*7.024*	*20*	*.351*		
	Total	*7.190*	*24*			
SOC	*Between Groups*	*.174*	*4*	*.043*	*.428*	*.787*
	Within Groups	*2.027*	*20*	*.101*		
	Total	*2.200*	*24*			
CVE	*Between Groups*	*.201*	*4*	*.050*	*.368*	*.829*
	Within Groups	*2.734*	*20*	*.137*		
	Total	*2.936*	*24*			
PRO	*Between Groups*	*.627*	*4*	*.157*	*.329*	*.855*
	Within Groups	*9.533*	*20*	*.477*		
	Total	*10.160*	*24*			
SAT	*Between Groups*	*1.467*	*4*	*.367*	*.859*	*.505*
	Within Groups	*8.533*	*20*	*.427*		
	Total	*10.000*	*24*			
Legend: PQ=Presence, AW=Awareness, COM=Communication, SOC=Sociability, CVE=Collaborative Virtual Environment, PRO=Productivity, SAT=Satisfaction						

5.5. Correlations

	PCK	***3DG***	***INV***	***PQ***	***AW***	***COM***	***SOC***	***CVE***	***PRO***	***SAT***
PCK	---									
3DG	*.31*	---								
	.13									
INV	*-.08*	*.08*	---							
	.7	*.75*								
PQ	*-.29*	*.06*	*.52***	---						
	.16	*.777*	*.008*							
AW	*.03*	*-.07*	*.41**	*.35*	---					
	.90	*.722*	*.041*	*.082*						
COM	*.31*	*.18*	*.34*	*.3*	*.57***	---				
	.14	*.388*	*.097*	*.146*	*.003*					
PS	*.1*	*.12*	*.22*	*.17*	*.49**	*.54***	---			
	.62	*.579*	*.289*	*.410*	*.014*	*.006*				
CVE	*-.15*	*-.38*	*.25*	*.26*	*.28*	*-.04*	*.01*	---		
	.47	*.057*	*.226*	*.210*	*.175*	*.837*	*.949*			
PRO	*-.09*	*-.38*	*.11*	*.13*	*.17*	*-.08*	*-.09*	*.86***	---	
	.66	*.062*	*.59*	*.543*	*.411*	*.685*	*.673*	*.000*		
SAT	*-.15*	*-.43**	*.15*	*.19*	*.38*	*.05*	*.15*	*.71***	*.75***	---
	.48	*.033*	*.48*	*.365*	*.061*	*.801*	*.476*	*.000*	*.00*	

**. Correlation is significant at the 0.05 level (2-tailed).*

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

Legend: PCK=Computers Knowledge, 3DG= 3D Environments and Gaming Experience, INV=Involvement, PQ=Presence, AW=Awareness, COM=Communication, SOC=Sociability, CVE=Collaborative Virtual Environment PRO=Productivity, SAT=Satisfaction

5.6. Environment Evaluation Through a Collaborative Team Building Activity - Raw Data

Presence Results			
Item:	***Question:***	***Mean***	***Sd***
PQ1	*How much were you able to control events?*	*5.76*	*.83*
PQ2	*How responsive was the environment to action that you initiated (or performed)?*	*5.76*	*.83*
PQ3	*How natural did your interactions with the environment seem?*	*5.28*	*.84*
PQ4	*How much did the visual aspects of the environment involve you?*	*5.52*	*.77*
PQ5	*How natural was the mechanism that controlled movement through the environment?*	*5.76*	*.78*
PQ6	*How compelling was your sense of objects moving through space?*	*5.96*	*.79*
PQ7	*How much did your experiences in the virtual environment seem consistent with your real-world experiences?*	*4.88*	*.93*
PQ8	*Were you able to anticipate what would happen in response to the actions that you performed?*	*5.32*	*.63*
PQ9	*How completely were you able to actively survey or search the environment using vision?*	*5.72*	*.79*
PQ10	*How compelling was your sense of moving around inside the virtual environment?*	*5.84*	*.85*
PQ11	*How closely were you able to examine objects?*	*6.04*	*.98*
PQ12	*How well could you examine objects from multiple viewpoints?*	*6.04*	*.68*
PQ13	*How involved were you in the virtual environment experience?*	*5.84*	*1.1*
PQ14	*How much delay did you experience between your actions and expected outcomes?*	*6.32*	*.63*
PQ15	*How quickly did you adjust to the virtual environment experience?*	*5.76*	*.78*

PQ16	*How proficient in moving and interacting with the virtual environment did you feel at the end of the experience?*	*5.76*	*.93*
PQ17	*How much did the visual display quality interfere or distract you from performing assigned tasks or required activities?*	*5.80*	*1.4*
PQ18	*How much did the control devices interfere with the performance of assigned tasks or with other activities?*	*5.40*	*1.4*
PQ19	*How well could you concentrate on the assigned tasks or required activities rather than on the mechanisms used to perform those tasks or activities?*	*5.56*	*.92*
	Awareness Results		
Item:	***Question:***	***Mean***	***Sd***
AW1	*I have been immediately aware of the existence of the other participants.*	*4.40*	*.58*
AW2	*I was aware of what was going on.*	*4.36*	*.49*
AW3	*I was aware of the participant roles (administrator, colleague)*	*4.12*	*.60*
	Communication Results		
Item:	***Question:***	***Mean***	***Sd***
COM1	*Communicating with the other participants was easy.*	*4.56*	*.51*
COM2	*The system increased the opportunity of discussing with the others.*	*4.36*	*.86*
COM3	*Conversation has been properly managed.*	*4.32*	*.62*
COM4	*Non-verbal communication (gesture) was adequate.*	*3.48*	*1.1*
	Sociability Results		
Item:	***Question:***	***Mean***	***Sd***
SOC1	*This environment enabled me to easily contact my teammates.*	*4.28*	*.54*
SOC2	*I did not feel lonely in this environment.*	*4.76*	*.44*
SOC3	*This environment enabled me to get a good impression of my teammates.*	*4.28*	*.69*
SOC4	*This environment allows spontaneous informal conversations.*	*4.48*	*.59*
SOC5	*This environment allowed for non-task-related*	*4.32*	*.56*

	conversations.		
SOC6	*This environment enabled me to make close friendships with my teammates.*	*4.04*	*.68*
SOC7	*This virtual environment enables us to develop into a well performing team.*	*4.40*	*.65*
SOC8	*This virtual environment enables me to develop good work relationships with my teammates.*	*4.12*	*.60*
SOC9	*This virtual environment enables me to identify myself with the team.*	*4.12*	*.60*
SOC10	*I feel comfortable with this virtual environment.*	*4.40*	*.50*
	CVE Results		
Item:	***Question:***	***Mean***	***Sd***
CVE1	*The environment design was stimulating.*	*4.56*	*.58*
CVE2	*The object metaphors were intuitive.*	*4.48*	*.51*
CVE3	*Objects reacted in an inconsistent/consistent way to selection and manipulation*	*4.56*	*.51*
CVE4	*The User Interface components, needed to participate, were easy to locate.*	*4.32*	*.63*
CVE5	*Amount of information that was displayed on the screen was adequate.*	*4.24*	*.72*
CVE6	*Arrangement of information on the screen was logical.*	*4.32*	*.56*
CVE7	*The design of the didactical environments was logical.*	*4.44*	*.51*
CVE8	*This environment enabled me to learn*	*4.44*	*.65*
CVE9	*I am satisfied with the experience*	*4.40*	*.64*

5.7. Informed Consent Form

Participant Information Form

The purpose of this study is to analyse how can virtual worlds support participation in learning activities. To investigate this, your perceptions of presence, sociability, communication and awareness in the virtual world will be collected and analysed.

This will require your participation using a virtual character (Avatar), to navigate in the virtual environment and attend a virtual session. During this session you will learn how to navigate, communicate and collaborate in the virtual environment in order to simulate a real life learning scenario within the virtual world.

Relevant data will be recorded using a survey and chat logging. In all cases, all participants shall remain anonymous and shall be identified with their Avatar name. All collected data will be used for the writing of Louis Nisiotis PhD thesis.

This study only concentrates on the virtual world flexibility and does not intend to measure user performance.

Participant Consent

I confirm that I am aware of the aims and objectives of this study, the activities involved and how the collected data will be used. I can contact the researcher at any time during the study. I can also withdraw from the study at any time.

I understand that:

- *I can withdraw from the study any time.*
- *It is not mandatory to complete questionnaires and surveys.*
- *I can obtain copy of the findings of the research after the completion of the study by contacting the researcher.*

Name of Participant:

Age: Gender:

I am over 18 years of age and competent to give consent (please circle) YES / NO

Participant's Signature:

____*Date:* ________________

Researcher's Signature:

____

5.8. Viewer Setup Instructions

Instructions to Login

Please follow the following steps to login the virtual world

First you need to download the required configuration files and put them in your %APPDATA% folder

1. *Go to http://tinyurl.com/shuconfig. The folder* ***config.zip*** *will be automatically start downloading.*

   When downloaded, **unzip config.zip**.

The zip file contains a folder named: ***Imprudence***

   Copy this folder to your %APPDATA% folder by: Hit the Windows Start button:

   START/RUN…/ type %APPDATA% and hit OK

(If Imprudence folder exists in %APPDATA%, delete it and then paste the new downloaded folder)

2. ***Move*** *the folder* ***Imprudence*** *in the* ***%APPDATA%*** *folder.*

3. *Launch Imprudence Viewer by searching for "Imprudence Viewer". Hit the Windows Start button and use the "search for programs or files" field*

   IF a notification regarding the system graphics card appears click **Close**

4. *To login, use the following login credentials:*

First Name:

Last Name:

Password: ********

NOTE: *When you log in the system, Windows will be blocking SLVOICE.exe. That's OK - Click Cancel*

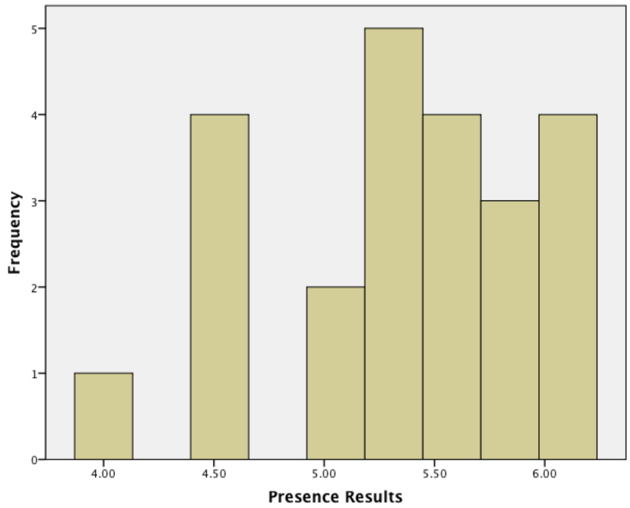
NOTE 2: *You might experience the "CLOUD ISSUE" when you login. That is if you see other around you as clouds. This is normal and is because the computer is downloading your Avatar. If the problem remains please notice the administrator.*

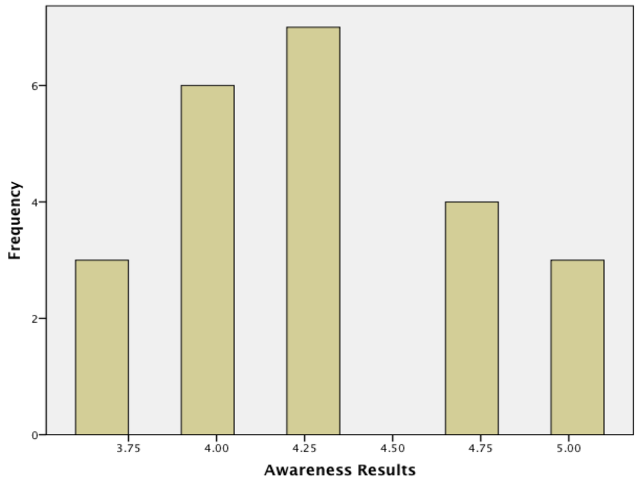
5.9. Data Distribution Tests

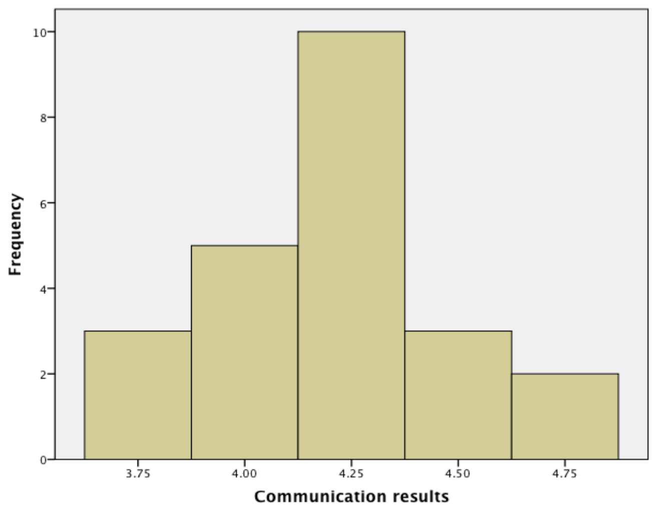
5.9.1. Numerical and GoF tests

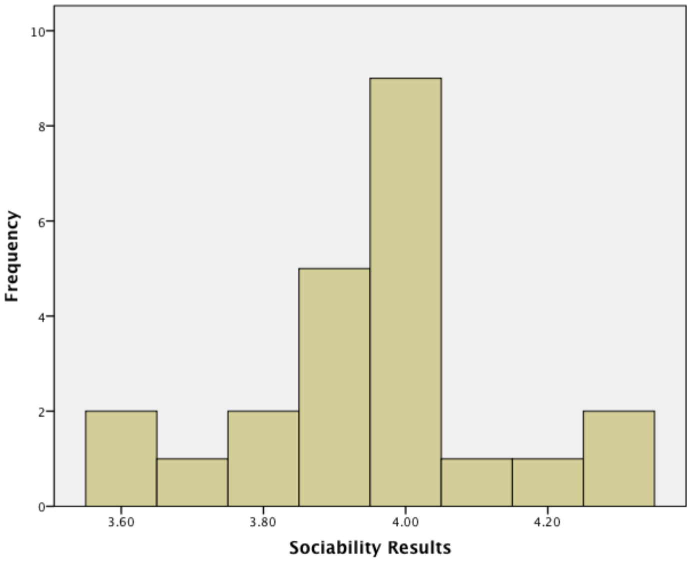
	PQ	*COM*	*AW*	*SOC*	*CVE*
Skewness	*-0.590*	*0.157*	*0.183*	*-0.064*	*0.541*
SE Skewness	*0.481*	*0.481*	*0.481*	*0.481*	*0.481*
Z Skewness	*-122*	*0.326*	*0.380*	*-0.133*	*1.124*
Kurtosis	*-0.395*	*-0.119*	*-0.757*	*0.447*	*-0.082*
SE Kurtosis	*0.935*	*0.935*	*0.935*	*0.935*	*0.935*
Z Kurtosis	*-0.422*	*-0.127*	*-0.809*	*0.478*	*-0.087*
Kolmogorov – Smirnov GoF with Lilliefors Correction Test					
Statistics	*0.124*	*0.221*	*0.168*	*0.222*	*0.149*
Df	*23*	*23*	*23*	*23*	*23*
P Value	*0.200*	*0.005*	*0.93*	*0.005*	*0.200*
Legend: PQ=Presence Questionnaire, AW=Awareness Scale, COM=Communication Scale, SOC=Sociability Scale, CVE=Collaborative Virtual Environment Scale, SE =Standard Error, Df=Degree of freedom, deviation, Z= ±1.96 criterion					

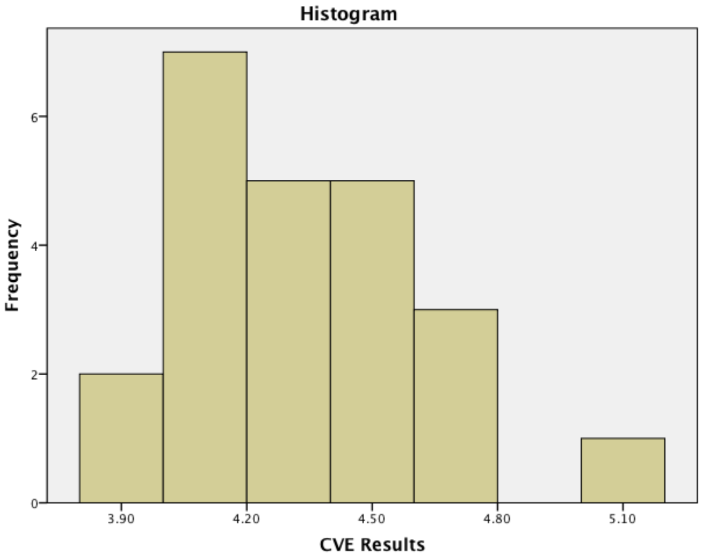
5.9.2. Data distribution visual inspection tests








Frequency
Sociability Results
3.60
3.80
4.00
4.20


Histogram
Frequency
CVE Results
3.90
4.20
4.50
4.80
5.10

5.10. ANOVA of Teams and their Environment Perceptions

		Sum of Squares	df	Mean Square	F	Sig.
PQ	Between Groups	.000	1	.000	.000	.985
	Within Groups	8.225	21	.392		
	Total	8.225	22			
AW	Between Groups	.189	1	.189	2.610	.121
	Within Groups	1.518	21	.072		
	Total	1.707	22			
COM	Between Groups	.005	1	.005	.148	.705
	Within Groups	.712	21	.034		
	Total	.717	22			
SOC	Between Groups	.084	1	.084	.481	.496
	Within Groups	3.670	21	.175		
	Total	3.754	22			
CVE	Between Groups	.013	1	.013	.140	.712
	Within Groups	1.960	21	.093		
	Total	1.973	22			
PRO	Between Groups	.661	1	.331	.923	.414
	Within Groups	7.165	21	.358		
	Total	7.826	22			
SAT	Between Groups	.152	1	.076	.286	.754
	Within Groups	5.326	21	.266		
	Total	5.478	22			

Legend: PQ=Presence, AW=Awareness, COM=Communication, SOC=Sociability, CVE=Collaborative Virtual Environment PRO=Productivity, SAT=Satisfaction

5.11. Environment Evaluation Through a Virtual Lecture Study - Raw Data

Presence Results			
Item:	***Question:***	***Mean***	***Sd***
PQ1	*How much were you able to control events?*	*5.87*	*1.22*
PQ2	*How responsive was the environment to action that you initiated (or performed)?*	*5.17*	*1.23*
PQ3	*How natural did your interactions with the environment seem?*	*4.52*	*1.27*
PQ4	*How much did the visual aspects of the environment involve you?*	*5.57*	*.94*
PQ5	*How natural was the mechanism that controlled movement through the environment?*	*5.00*	*1.31*
PQ6	*How compelling was your sense of objects moving through space?*	*5.04*	*1.15*
PQ7	*How much did your experiences in the virtual environment seem consistent with your real-world experiences?*	*4.70*	*.93*
PQ8	*Were you able to anticipate what would happen in response to the actions that you performed?*	*5.13*	*1.06*
PQ9	*How completely were you able to actively survey or search the environment using vision?*	*5.52*	*.95*
PQ10	*How compelling was your sense of moving around inside the virtual environment?*	*5.26*	*.86*
PQ11	*How closely were you able to examine objects?*	*5.65*	*1.11*
PQ12	*How well could you examine objects from multiple viewpoints?*	*5.70*	*.93*
PQ13	*How involved were you in the virtual environment experience?*	*5.52*	*.99*
PQ14	*How much delay did you experience between your actions and expected outcomes?*	*5.70*	*1.46*
PQ15	*How quickly did you adjust to the virtual environment experience?*	*5.57*	*.84*

PQ16	*How proficient in moving and interacting with the virtual environment did you feel at the end of the experience?*	*5.09*	*.90*
PQ17	*How much did the visual display quality interfere or distract you from performing assigned tasks or required activities?*	*5.57*	*1.04*
PQ18	*How much did the control devices interfere with the performance of assigned tasks or with other activities?*	*6.17*	*.834*
PQ19	*How well could you concentrate on the assigned tasks or required activities rather than on the mechanisms used to perform those tasks or activities?*	*4.91*	*1.31*
	Awareness Results		
Item:	***Question:***	***Mean***	***Sd***
AW1	*I have been immediately aware of the existence of the other participants.*	*4.52*	*.51*
AW2	*I was aware of what was going on.*	*4.30*	*.47*
AW3	*I was aware of the participant roles (administrator, colleague)*	*4.09*	*.6*
	Communication Results		
Item:	***Question:***	***Mean***	***Sd***
COM1	*Communicating with the other participants was easy.*	*4.22*	*.42*
COM2	*The system increased the opportunity of discussing with the others.*	*4.61*	*.5*
COM3	*Conversation has been properly managed.*	*4.13*	*.34*
COM4	*Non-verbal communication (gesture) was adequate.*	*3.87*	*.34*
	Sociability Results		
Item:	***Question:***	***Mean***	***Sd***
SOC1	*This environment enabled me to easily contact my teammates.*	*4.09*	*.42*
SOC2	*I did not feel lonely in this environment.*	*4.04*	*.21*
SOC3	*This environment enabled me to get a good impression of my teammates.*	*3.78*	*.42*
SOC4	*This environment allows spontaneous informal conversations.*	*4.09*	*.29*
SOC5	*This environment allowed for non-task-related*	*4.00*	*.43*

	conversations.		
SOC6	*This environment enabled me to make close friendships with my teammates.*	*3.70*	*.47*
SOC7	*This virtual environment enables us to develop into a well performing team.*	*3.83*	*.39*
SOC8	*This virtual environment enables me to develop good work relationships with my teammates.*	*3.96*	*.37*
SOC9	*This virtual environment enables me to identify myself with the team.*	*3.91*	*.29*
SOC10	*I feel comfortable with this virtual environment.*	*4.13*	*.46*
CVE Results			
Item:	***Question:***	***Mean***	***Sd***
CVE1	*The environment design was stimulating.*	*4.13*	*.46*
CVE2	*The object metaphors were intuitive.*	*4.04*	*.37*
CVE3	*Objects reacted in an inconsistent/consistent way to selection and manipulation*	*4.22*	*.74*
CVE4	*The User Interface components, needed to participate, were easy to locate.*	*4.30*	*.47*
CVE5	*Amount of information that was displayed on the screen was adequate.*	*4.39*	*.5*
CVE6	*Arrangement of information on the screen was logical.*	*4.43*	*.51*
CVE7	*The design of the didactical environments was logical.*	*4.52*	*.51*
CVE8	*This environment enabled me to learn*	*4.09*	*.6*
CVE9	*I am satisfied with the experience*	*4.39*	*.5*

Appendix 6 - Extended Evaluation of SHU3DED

6.1. Pre Experiment Questionnaire

Q1: Name: ***Q2: Age:*** ***Q3: Gender:*** ***Q4: What barriers you experience hindering access to higher education?*** ***Q5: Your virtual worlds experience skills include:***
(Please Tick ✓ where appropriate – you can choose multiple answers) ☐ *Never used virtual worlds before* ☐ *Login the virtual world* ☐ *Navigate in the virtual world* ☐ *Communicate using nearby chat* ☐ *Communicate using voice* ☐ *Use gestures* ☐ *Create your own gestures* ☐ *Interact with objects that lay around* ☐ *Edit avatar appearance* ☐ *Teleport between regions* ☐ *Offer, accept friendship requests* ☐ *Use map/minimap* ☐ *Search for locations* ☐ *Join groups* ☐ *Locate inventory items* ☐ *Attach items to avatars* ☐ *Transfer inventory items to other avatars* ☐ *Build/edit and manipulate prims* ☐ *Apply textures* ☐ *Upload textures*

☐ *Implement scripts in objects*

☐ *Create scripts*

☐ *Host Sims*

6.2. Pre Experiment Questionnaire Categorisation Scheme

Categorisation Scheme – Not visible to participants *If a user doesn't meet the minimum requirements of a particular category, is immediately classified in the previous category.*	
1 - NO EXPERIENCE	*Never used virtual worlds before.*
2 - MINIMUM EXPERIENCE	*Login the virtual world.* *Navigate in the virtual world.*
3 - SLIGHTLY EXPERIENCED *Requires all minimum experience skills and at least two of the following:*	*Interact with objects that lay around.* *Communicate using nearby chat.* *Communicate using voice.* *Use map/minimap.*
4 - SOMEWHAT EXPERIENCED *Requires all minimum experience skills, at least two slightly experienced skills and at least three of the following:*	*Teleport between regions.* *Locate inventory items.* *Use gestures.* *Join groups.* *Search for locations.* *Edit avatar appearance.* *Offer, accept friendship requests.*
5 - GOOD EXPERIENCE *Requires all minimum/slightly experienced skills, at least three somewhat experienced skills and at least one of the following:*	*Transfer inventory items to other avatars.* *Create your own gestures.* *Attach items to avatars.*
6 - VERY GOOD EXPERIENCE *Requires all minimum/slightly/somewhat experienced skills, at least two good experienced skills and at least one of the following:*	*Build/edit and manipulate prims.* *Apply textures.* *Upload textures.*
7 - EXPERT *Requires all previous experience categories and at least one of the following:*	*Implement scripts in objects.* *Create scripts.* *Host Sims.*

6.3. Emails to Participants

6.3.1. Email 1 - Avatar name

The first email requested participants to choose their avatar name. The purpose was to create their user account, assign avatar shape and ensure the anonymity of the participant during the study. The avatar name was also used as the part of the participant's login credentials (username). A random password was generated and provided at a later stage (Email 3).

Hello [Participant's Name]. *To ensure that your personal details will not be identified during the virtual experience, you should choose a pseudonym for your Avatar.* *For example, I (Louis Nisiotis) use the name "Skoui Aironaut" for my avatar name.* *Please email me an imaginary first and last name you would like to use during the virtual experience that WILL NOT reveal your real identity and you would like people addressing you as.* *This pseudonym will also be your login username to login the virtual world.* *Thanks for your help.*

6.3.2. Email 2 - Informed consent form and online survey

This email sought participants' informed consent. The form below was administered through the web prior to any interaction with the study materials, and requested participant's acknowledgment to proceed. When consent was sought, participants were redirected to the pre experiment questionnaire web page. At the completion of the questionnaire, participants were informed through the website to wait for further email instructions.

Hello [Participant's Name] *The date and time for the session has been set of Wednesday 18th of December at 19:00 UK time. This session will take 120 minutes. The preparation for the session includes the following two steps:* *1) The first step is to read and accept the informed consent form that explains the purpose of the research, your right to withdraw at any point and how the results will be used.*

2) Following this, you will be asked to complete a short survey based on your virtual worlds experience if any. Also you will be kindly asked say few words about your experience with barriers that affect your access and participation to higher education.

The informed consent form followed by the survey are in the following link: http://goo.gl/NrCNpt

Further instructions will be emailed after you have completed the survey.

For any help or questions you may have, don't hesitate to contact me.

Thanks for your invaluable help.

6.3.3. Email 3 - Install Imprudence and test logins

The next email provided instructions on how to download and install *Imprudence*. The login credentials of each participant were also included. In addition, participants were requested to test their connection with the virtual world to ensure that their system could run *Imprudence* and could successfully connect to the environment. Upon successful login, participants were landed in an empty space with limited interaction with the rest of the environment. An information board instructed them to close their viewer and wait for further email instructions. A script was logging access to the virtual world, allowing to determine who has successfully connected. Three participants had problems connecting and were contacted via email to resolve this.

Hello [Participant's Name]

The next stage in the preparation for the experiment requires the installation of the Imprudence software in your computer.

The source to download the software and the installation instructions can be found in the following link:

http://learninvw.com/cc/downloads

After installing and running Imprudence, use the following credentials to login the virtual world:

First Name: [Avatar Name]

Last Name: [Avatar Last Name]

Password: [Random Password]

Please install and login the virtual world to make sure that the software is working

properly on your computer (which it should) and let me know.
If during the installation or login stage you experience and problems, please email me immediately.
Thanks again for your invaluable help.

6.3.4. Email 4 - Dates and additional information

This email announced the date of the session and provided information regarding the procedures to follow in the event of technical difficulties.

Hello [Participant's Name]
This is to remind you that the session that will take place tomorrow Wednesday 18/12 at 7pm UK time. During the virtual experience, I will use the voice functionality of the virtual world to give an oral presentation, therefore make sure you have your speakers connected to your computer.
If you do not have speakers, face problems with the sound or have hearing difficulties, all the lecture notes will be given through the chat simultaneously.
I encourage you to log in the virtual world 10 or 15 minutes before just to make sure everything is ok with your system.
As I hope everything goes smoothly, it is always possible for there to be technical difficulties during the virtual experience. If this happens, I appreciate your patience and understanding while I work to resolve the issue.
In the Event of Technical Difficulties:
Scenario 1: If Imprudence or your computer crashes, or you lose power or Internet connection, relaunch the Imprudence and login the virtual world as normal.
Scenario 2: In the unlikely scenario that the virtual world crash and you cant log in, join the chartroom in http://learninvw.com/chat and wait for my instructions.
For any problems, you can email me directly or join the chartroom in http://learninvw.com/chat
Thank you for your cooperation and help.
Lets make this a unique and fun experience. See you in the virtual world!!!
If during the installation or login stage you experience and problems, please email me immediately.
Thanks again for your precious help.

6.3.5. Email 5 - Reminder and schedule

This was a reminder of the login date and time, and a brief of the schedule of activities during the session.

Hello [Participant's Name]

The schedule of the session is like this (times are UK local):

19:00 Logins and Orientation (we shall wait for everyone to login)

19:25 Briefing (the activities of the session)

19:30 Lecture (virtual presentation)

19:55 Short Break (relax and meet some new people)

20:15 Group activity (brainstorming session in groups)

21:00 End of the session

I encourage you to login few minutes before to ensure that everything is ok with your system.

See you in the virtual world :) Thanks again for your precious help.

6.4. Informed Consent Form

Participant Information Form

The purpose of this study is to analyse the flexibility of cyber campuses to support students experiencing barriers hindering access to education. To investigate this, your perceptions of presence, awareness, communication and sociability will be analysed.

This will require your participation using a virtual character (Avatar), to navigate in the virtual environment and perform a series of tasks.

During this study you will learn how to navigate, communicate and collaborate in the virtual environment, participating in a learning scenario. Relevant data will be recorded using surveys and chat logging. In all cases, all participants shall remain anonymous and shall be identified with their Avatar name.

All collected data will be used for the writing of Louis Nisiotis PhD thesis.

This study only concentrates on the cyber campus functionality and does not intend to measure user performance.

Participant Consent

I confirm that I am aware of the aims and objectives of this study, the activities involved and how the collected data will be used. I can contact the researcher at any time during the study. I can also withdraw from the study at any time.

I understand that:

- *I can withdraw from the study any time.*
- *It is not mandatory to complete questionnaires and surveys.*
- *I can obtain copy of the findings of the research after the completion of the study by contacting the researcher.*

Name of Participant:

____

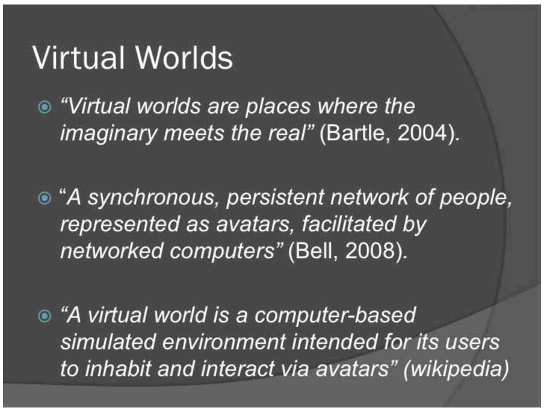
I am over 18 years of age and competent to give consent (please circle): YES / NO

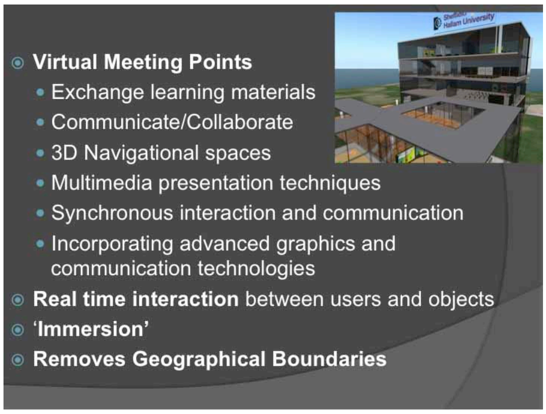
Participant's Signature:

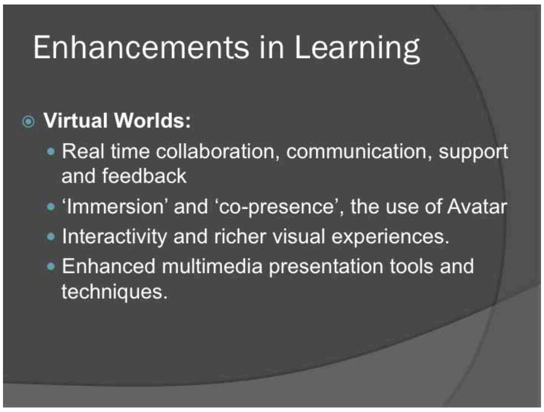
____*Date:*_________________

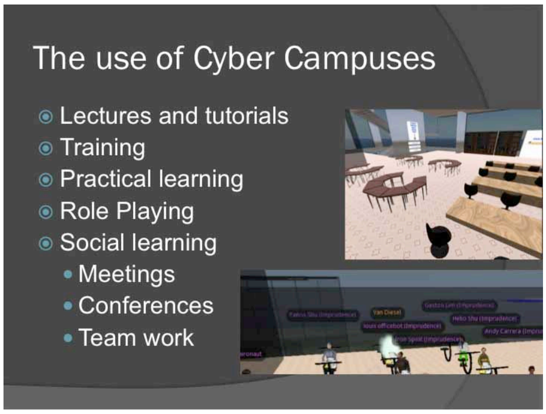
*Researcher's Signature:*____

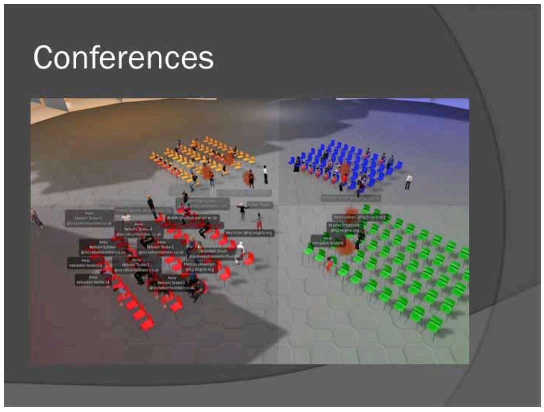
6.5. Virtual Lecture Presentation





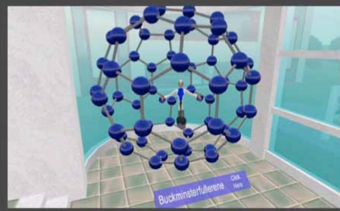






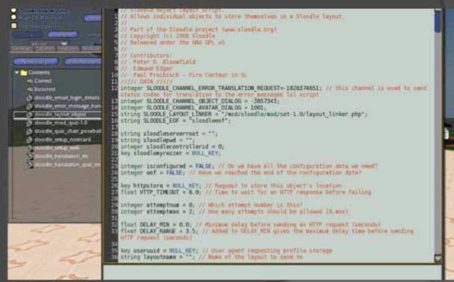
Blended Reality

Modeling

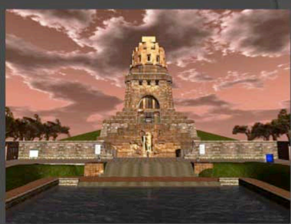


Team building

Programming



Monumental recreations



Meetings

Group Activity!

- 3 Groups
- Brainstorming activity!
  - Think 5 (or more) ways to use virtual worlds for learning.
    - Meet each other.
    - Decide a day that you can meet for a discussion based on:
      - How the virtual worlds can help you participate more effectively in learning activities?
- Have Fun!

Thank You!

Any Questions?

6.6. Pre Experiment Questionnaire Results

Virtual Worlds Experience		***N***
Never used virtual worlds		*13*
Login the virtual world		*12*
Navigate in the virtual world		*12*
Communicate using voice		*12*
Edit avatar appearance		*12*
Communicate using nearby chat		*11*
Use gestures		*11*
Interact with objects around		*10*
Use map/minimap		*10*
Search for locations		*10*
Offer, accept friendship		*9*
Teleport between regions		*9*
Join groups		*8*
Attach items to avatars		*8*
Apply textures		*8*
Locate inventory items		*7*
Create scripts		*7*
Create your own gestures		*6*
Implement scripts in objects		*6*
Upload textures		*6*
Build/edit and manipulate prims		*6*
Transfer inventory items		*5*
Host Sims		*5*
Open Ended Question Results		
Participant	***Answer:***	
Participant 27	*a) Restricted access to building or teaching area.* *b) Restricted area within classroom. Uncomfortable area reserved for wheelchair parking, unusable desk space for wheelchair user.* *c) High temperature in class area in the summer.* *d) Access to suitable toilet.* *e) Cost of participating as a fulltime student*	

Participant 21	*1) Slow home internet connection* *2) Have a family (wife + child)* *3) Full time job* *4) Have loans (need full time job + extras)*
Participant 22	*As a paraplegic I found it difficult to participate in certain classes, given that the university failed to install a lift to get to classes on the second floor.*
Participant 23	*I want to* [start a] *master degree but it is impossible because I have three children and I am working.*
Participant 13	*I would have access to courses but some courses are in other country so for me is impossible.*
Participant 29	*I joined SL when I became housebound by incontinence and back problems. I'm sicker now and have trouble sitting up long enough to do anything on SL. It's been my only social and creative outlet for 7.5 years.*
Participant 11	*I study Computer Science in ****** and I was e-learning student in ***** University. As e-learning student I had some difficulties. I didn't have a lot of feedback especially in my final thesis. They didn't answer me after the second chapter of my thesis. Something else was even if I got answers from the 2 first chapters the feedback wasn't so clear. This problem was only for my thesis as in our modules we had 3 hour meetings every week in ******* as the two universities were cooperating, and all my problems in my reading was clear by the lectures from ******.*
Participant 19	*My main mode of experience in virtual worlds is visual. Being deaf, I rely solely on text communications, so anything in voice needs to be transcribed into text, and information need to be accessible through visual means. It also means I seek out very richly developed visual environments that are not necessarily rooted in replicating real world settings but that instead promote a fulfilling sense of presence, includedness (NOT that buzzword "inclusiveness" which gives me a rash when I see it) and connectedness in interactions with others in the settings which enriches learning even more, and inspires a desire for continued and lifelong learning.*

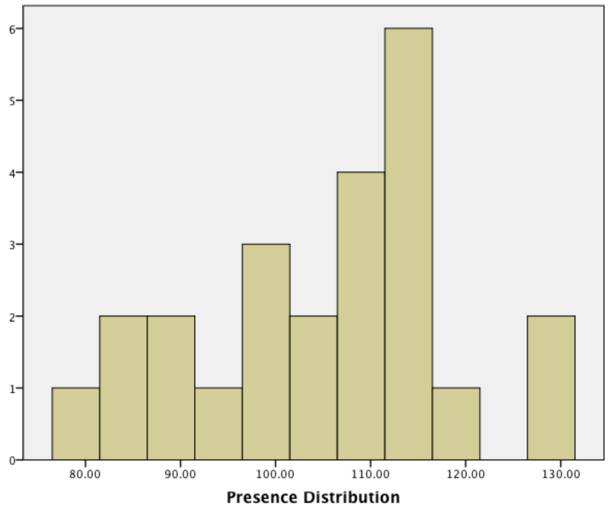
Participant 30	*My issues are that I need 24/7 care because I am quadriplegic with some side effects. I feel more comfortable in my own place.*
Participant 20	*During my pregnancy period it was particularly hard to attend university classes. First of all I had to drive to go to the premises, which was hard. In addition, if I would found parking place, I needed to walk to the rooms. Secondly it was hard for me to be exposed to the high temperatures during summer time and the low during the winter. Last but not least it was difficult to sit for three hours in order to take my exams.*
Participant 25	*I am a part time PhD student and live in Liverpool. Other than for supervision sessions, I think there should be more use of on line teaching. I would be able to attend seminars virtually at a time that suited me, at a fraction of the cost. I have two children and attendance at university also involves arranging childcare. On line teaching would offer me greater flexibility in managing my competing demands.*
Participant 12	*Full time employed. This stands as a barrier to attending the University and Course of my choice. I would be currently forced to choose a part time course in a nearby University not offering my desired course.*
Participant 14	*Have Ankylosing spondylitis, terrible pains on the back, lost as long as one year from my studies.*
Participant 17	*1) I was staying far from the university campus (2 hours away), so commuting to the university every day to attend lectures was difficult and time consuming.* *2) I was pregnant and later had a newborn at home, so I could not travel to the university daily.*
Participant 18	*In the past I did not participate in an academic course due to financial problems, I had a full time job and no extra money to pay the high tuition fees.*
Participant 16	*I have been pregnant during my master degree and it was very difficult to me to attend courses before and after delivery.*

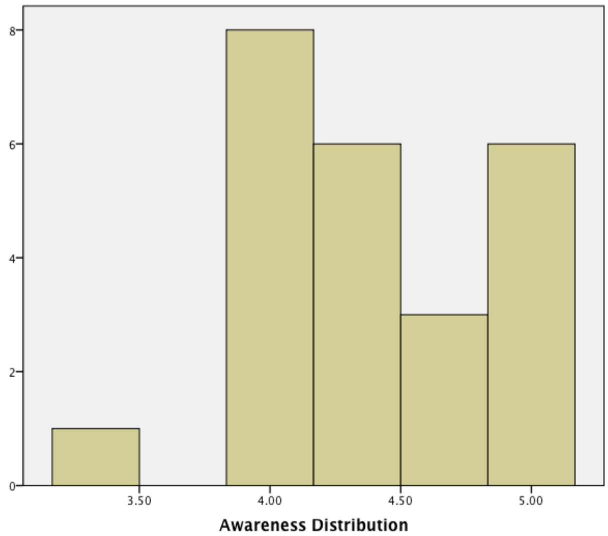
6.7. Data Distribution Tests

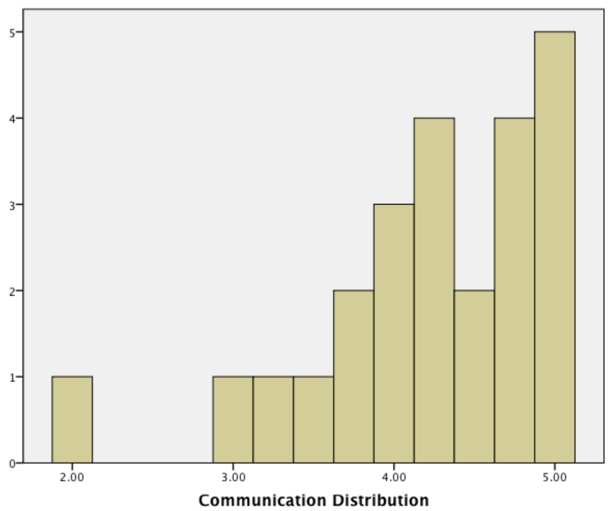
6.7.1. Numerical and GoF tests

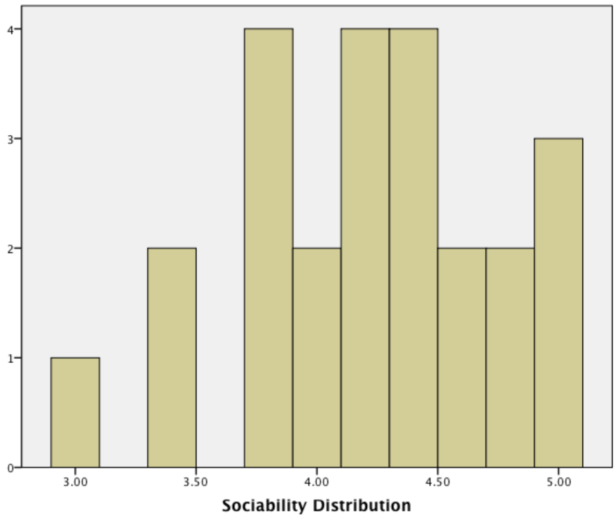
	PQ	***COM***	***AW***	***SOC***	***CVE***
Skewness	-.216	-1.284	-.106	-.324	-.555
SE Skewness	0.472	0.472	0.472	0.472	0.472
Z Skewness	-0.457	-2.720	-0.224	0.686	-1.175
Kurtosis	-0.486	2.023	-.498	-0.299	-.010
SE Kurtosis	0.918	0.918	0.918	0.918	0.918
Z Kurtosis	-0.529	2.203	-0.542	-0.325	-0.01
Kolmogorov – Smirnov GoF With Lilliefors Correction Test					
Statistics	0.11	0.147	0.177	0.079	0.174
Df	24	24	24	24	24
P Value	0.200	0.192	0.049	0.200	0.059
Legend: PQ=Presence Questionnaire, AW=Awareness Scale, COM=Communication Scale, SOC=Sociability Scale, CVE=Collaborative Virtual Environment Scale, SE =Standard Error, Df=Degree of freedom, deviation, Z= ±1.96 criterion					

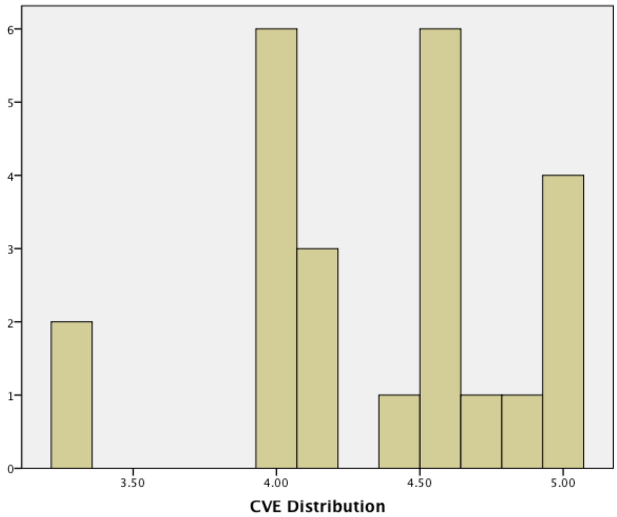
6.7.2. Data distribution visual inspection tests








0
1
2
3
4
3.00
3.50
4.00
4.50
5.00
Sociability Distribution


0
1
2
3
4
5
6
3.50
4.00
4.50
5.00
CVE Distribution

6.8. Correlations

	VW	PQ	CF	SF	RF	DF	AW	COM	SOC	CVE	PRO	SAT
VW	---											
PQ	.20	---										
CF	.15	.88	---									
SF	.26	.86	.54	---								
RF	-.13	.57	.7	.37	---							
DF	-.07	.82	.75	.58	.52	---						
AW	.01	.54	.44	.49	.45	.36	---					
COM	.17	.59	.25	.74	.07	.44	.63	---				
SOC	.32	.74	.6	.69	.31	.57	.63	.72	---			
CVE	.14	.71	.48	.74	.29	.54	.65	.71	.79	---		
PRO	.005	.50	.27	.58	.22	.42	.56	.7	.65	.80	---	
SAT	-.15	.47	.31	.42	.1	.40	.59	.7	.65	.73	.7	---

Legend: VW=Virtual Worlds Experience, PQ=Presence, CF=Control Factors, SF=Sensory Factors, RF=Realism Factors, DF=Distraction Factors AW=Awareness, COM=Communication, SOC=Sociability, CVE=Collaborative Virtual Environment PRO=Productivity, SAT=Satisfaction

6.9. ANOVA of Gender and Environment Perceptions

		Sum of Squares	*df*	*Mean Square*	*F*	*Sig.*
PQ	*Between Groups*	*.072*	*1*	*.072*	*.13*	*.72*
	Within Groups	*11.723*	*22*	*.533*		
	Total	*11.795*	*23*			
AW	*Between Groups*	*.167*	*1*	*.167*	*.79*	*.38*
	Within Groups	*4.648*	*22*	*.211*		
	Total	*4.815*	*23*			
COM	*Between Groups*	*1.628*	*1*	*1.628*	*3.2*	*.09*
	Within Groups	*11.161*	*22*	*.507*		
	Total	*12.789*	*23*			
SOC	*Between Groups*	*.844*	*1*	*.844*	*3.5*	*.08*
	Within Groups	*5.366*	*22*	*.244*		
	Total	*6.210*	*23*			
CVE	*Between Groups*	*.375*	*1*	*.375*	*1.6*	*.22*
	Within Groups	*5.134*	*22*	*.233*		
	Total	*5.509*	*23*			
PRO	*Between Groups*	*.167*	*1*	*.167*	*.4*	*.53*
	Within Groups	*9.167*	*22*	*.417*		
	Total	*9.333*	*23*			
SAT	*Between Groups*	*.167*	*1*	*.167*	*.31*	*.58*
	Within Groups	*11.667*	*22*	*.530*		
	Total	*11.833*	*23*			

Legend: PQ=Presence, AW=Awareness, COM=Communication, SOC=Sociability, CVE=Collaborative Virtual Environment PRO=Productivity, SAT=Satisfaction

6.10. ANOVA of Academic Status and Environment Perceptions

		Sum of Squares	df	Mean Square	F	Sig.
PQ	*Between Groups*	.263	1	.263	.50	.49
	Within Groups	11.532	22	.524		
	Total	11.795	23			
AW	*Between Groups*	.005	1	.005	.02	.88
	Within Groups	4.810	22	.219		
	Total	4.815	23			
COM	*Between Groups*	.292	1	.292	.51	.48
	Within Groups	12.497	22	.568		
	Total	12.789	23			
SOC	*Between Groups*	.005	1	.005	.02	.9
	Within Groups	6.205	22	.282		
	Total	6.210	23			
CVE	*Between Groups*	.086	1	.086	.35	.50
	Within Groups	5.423	22	.247		
	Total	5.509	23			
PRO	*Between Groups*	.044	1	.044	.10	.75
	Within Groups	9.289	22	.422		
	Total	9.333	23			
SAT	*Between Groups*	.011	1	.011	.02	.89
	Within Groups	11.822	22	.537		
	Total	11.833	23			

Legend: PQ=Presence, AW=Awareness, COM=Communication, SOC=Sociability, CVE=Collaborative Virtual Environment PRO=Productivity, SAT=Satisfaction

6.11. Extended Evaluation of SHU3DED Results - Raw Data

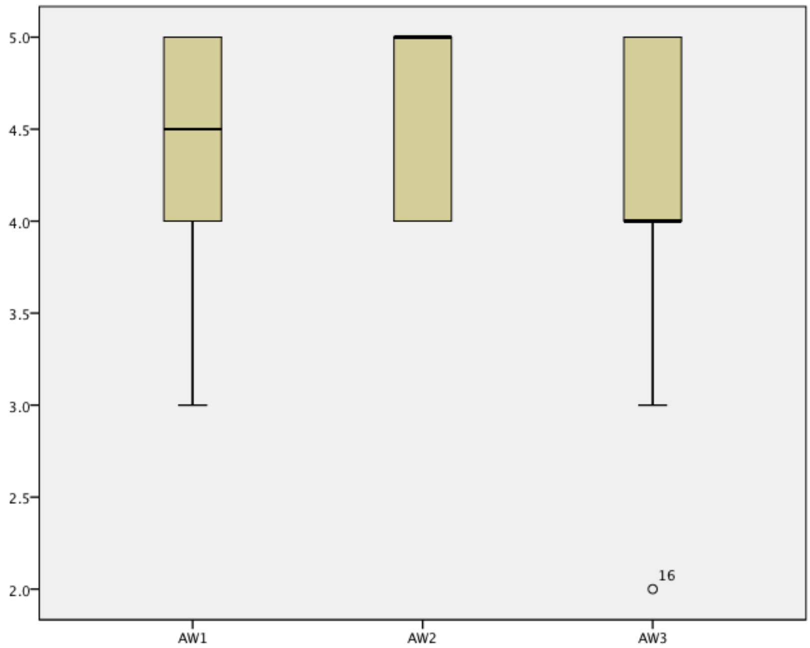
Presence Results			
Item:	***Question:***	***Mean***	***Sd***
PQ1	*How much were you able to control events?*	*5.54*	*1.41*
PQ2	*How responsive was the environment to action that you initiated (or performed)?*	*5.75*	*1.07*
PQ3	*How natural did your interactions with the environment seem?*	*5.33*	*1.37*
PQ4	*How much did the visual aspects of the environment involve you?*	*5.50*	*1.32*
PQ5	*How natural was the mechanism that controlled movement through the environment?*	*5.50*	*.98*
PQ6	*How compelling was your sense of objects moving through space?*	*5.42*	*1.47*
PQ7	*How much did your experiences in the virtual environment seem consistent with your real-world experiences?*	*5.42*	*.88*
PQ8	*Were you able to anticipate what would happen in response to the actions that you performed?*	*5.83*	*.92*
PQ9	*How completely were you able to actively survey or search the environment using vision?*	*5.96*	*.86*
PQ10	*How compelling was your sense of moving around inside the virtual environment?*	*5.50*	*1.18*
PQ11	*How closely were you able to examine objects?*	*5.33*	*1.58*
PQ12	*How well could you examine objects from multiple viewpoints?*	*5.38*	*1.53*
PQ13	*How involved were you in the virtual environment experience?*	*5.54*	*1.47*
PQ14	*How much delay did you experience between your actions and expected outcomes?*	*6.08*	*.77*
PQ15	*How quickly did you adjust to the virtual environment experience?*	*5.71*	*1.08*

PQ16	*How proficient in moving and interacting with the virtual environment did you feel at the end of the experience?*	*5.42*	*1.25*
PQ17	*How much did the visual display quality interfere or distract you from performing assigned tasks or required activities?*	*5.42*	*1.53*
PQ18	*How much did the control devices interfere with the performance of assigned tasks or with other activities?*	*5.38*	*1.47*
PQ19	*How well could you concentrate on the assigned tasks or required activities rather than on the mechanisms used to perform those tasks or activities?*	*5.21*	*1.44*
	Awareness Results		
Item:	***Question:***	***Mean***	***Sd***
AW1	*I have been immediately aware of the existence of the other participants.*	*4.42*	*.65*
AW2	*I was aware of what was going on.*	*4.54*	*.51*
AW3	*I was aware of the participant roles (administrator, colleague)*	*4.21*	*.78*
	Communication Results		
Item:	***Question:***	***Mean***	***Sd***
COM1	*Communicating with the other participants was easy.*	*4.42*	*.72*
COM2	*The system increased the opportunity of discussing with the others.*	*4.33*	*.82*
COM3	*Conversation has been properly managed.*	*4.42*	*.72*
COM4	*Non-verbal communication (gesture) was adequate.*	*3.71*	*1.1*
	Sociability Results		
Item:	***Question:***	***Mean***	***Sd***
SOC1	*This environment enabled me to easily contact my teammates.*	*4.42*	*.50*
SOC2	*I did not feel lonely in this environment.*	*4.46*	*.59*
SOC3	*This environment enabled me to get a good impression of my teammates.*	*3.96*	*.81*
SOC4	*This environment allows spontaneous informal conversations.*	*4.38*	*.65*
SOC5	*This environment allowed for non-task-related*	*4.13*	*.80*

	conversations.		
SOC6	*This environment enabled me to make close friendships with my teammates.*	*3.54*	*.98*
SOC7	*This virtual environment enables us to develop into a well performing team.*	*4.04*	*.75*
SOC8	*This virtual environment enables me to develop good work relationships with my teammates.*	*4.08*	*.72*
SOC9	*This virtual environment enables me to identify myself with the team.*	*4.25*	*.68*
SOC10	*I feel comfortable with this virtual environment.*	*4.46*	*.59*
	CVE Results		
Item:	***Question:***	***Mean***	***Sd***
CVE1	*The environment design was stimulating.*	*4.21*	*.72*
CVE2	*The object metaphors were intuitive.*	*4.21*	*.72*
CVE3	*Objects reacted in an inconsistent/consistent way to selection and manipulation*	*4.46*	*.72*
CVE4	*The User Interface components, needed to participate, were easy to locate.*	*4.46*	*.66*
CVE5	*Amount of information that was displayed on the screen was adequate.*	*4.54*	*.59*
CVE6	*Arrangement of information on the screen was logical.*	*4.29*	*.55*
CVE7	*The design of the didactical environments was logical.*	*4.29*	*.62*
CVE8	*This environment enabled me to learn*	*4.17*	*.64*
CVE9	*I am satisfied with the experience*	*4.42*	*.72*

6.12. Awareness Scale Reliability Test

Awareness Scale α Index:			**.470**
Item:		**Scaled Mean if Item Deleted:**	**Index if Item Deleted:**
AW1	*I have been immediately aware of the existence of the other participants.*	*8.75*	*.602*
AW2	*I was aware of what was going on.*	*8.63*	*.278*
AW3	*I was aware of the participant roles (administrator, colleagues)*	*8.96*	*.138*



Items comprising Awareness Scale

Appendix 7 - Virtual Focus Group Study

7.1. Questions to People who Missed the Virtual Focus Group

Hello [Name]

Because you could not participate in the focus group session, I kindly request you to answer few questions based on your experience with barriers hindering access and participation in education, and your thoughts on how the virtual world may support mitigate these barriers and support online learning.

1. Please explain some of the barriers you experience/d and how these affected your access and participation to the learning activities?

2. Which are the most important characteristics of the virtual world based on the experience you had during the virtual session?

3. How can the virtual world mitigate some of the barriers you experience/d and support you to participate in online learning activities?

Thank you for all you help and support.

Regards,

Moderator

7.2. Additional Responses

Participant 11:

I have been a distant learner in ****** university. The problem i had during my distant learning experience was that i couldn't communicate with my supervisor effectively. I was sending him a chapter per month and i only heard back from him twice in the first two chapters. The head of the department replied after many reminders that i had sent to them without any constructive feedback which had led to loosing my distinction.

I have also took 6 free courses of ***** university, where there was good feedback and explanatory videos to download but the disadvantage of these courses was that there were around 40 000 students enrolled therefore the teacher couldn't answer to all the questions. The good part of this solution was that the teachers were actively monitoring the course forum where all the questions were raised through it.

What i really enjoyed during the virtual experience is that there was no video to watch but you were participating at the moment of the learning at the exact time so if i had a question i could ask it at this moment.

Another aspect i really liked was that i could communicate with my peers located around the globe in real time, just like if we were together at the university.

For example the brainstorming activity had the advantage of getting immediate answers to your questions rather than waiting 2 hours or more for a reply.

Also, through the virtual world everyone is equal and could speak and express him/her self, providing freedom of speech compared to the real life university where the teacher could not give you the word because he has to proceed with the lesson.

During this experience i felt that i was somewhere familiar, i could navigate wherever i wanted even if there was a strict schedule to follow. This could have really helped me on my distant learning course.

Participant 25:

Which are the most important characteristics of the virtual world based on the experience you had during the virtual session?

The way people can learn in many different ways. Voice is important, text is important, slide shows and powerpoint presentations are important, Instant interaction rather than waiting for posts or email is important. The ability to model things by building in SL is important. The ability to interact with things using the Linden Scripting Language is important. For some classes, teaching the students to build and script can be part of what the class is trying to teach. LSL is a good introduction to programming, for example. Another example is *******, who uses SL building as an art therapy tool, inviting us to build something that in some way relates to an experience we want to explore. The ability to set up a learning experience that people can experience any time is important. Having class meetings is also important but sometimes difficult in a global world like SL. Some people will identify strongly with their avatars in SL, immersing themselves in the experience. Others won't but they can still learn, as long as they realize that the other students are people.

How can the virtual world mitigate some of the barriers you experience/d and support you to participate in online learning activities?

Voice conveys the emotion, but sometimes it stutters or the speaker has an accent, or the student is deaf. I use a notecard reader and speak into the mic as well. I have set up a learning experience that describes a hero's journey, and anyone can visit it any time. I also take people through it in voice-text. I have a class called *****, on conflict resolution, that I've set up so people can take it any time, but people aren't taking it as far as I know. I think I need to redesign it so that to see the slides that go with the class people don't have to click on a prim. A university campus in SL should be set up so there is lots of information and no question about how to get it. SL has enough tools - the problem is using them effectively with people who don't really need to learn to use all the tools themselves. If you want to learn about how to set up a good learning experience consider Virtual Ability, Inc. It is a rl organization that helps the disabled use SL. They know how to run a presentation, how to set up a study, how to design a sim for good experiences. They have to deal with people who can't see or can't hear or can't type well.

Appendix 8 - The Design and Development of Effective Cyber Campuses

From the findings of this investigation, observations during the experiments, and from the experience developed during this research project, a series of suggestions and considerations for the design and development of effective cyber campuses were devised. These suggestions aims to assist virtual worlds developers, designers and educators to design and implement cyber campus environments and relevant educational activities to accommodate for the characteristics that contribute to the learning experience and mitigate barriers as discussed in this Chapter.

8.1. Environment Design and Development

To deploy an effective cyber campus, the developer first needs to consider and decide which platform to adopt. Second Life and Opensim are the most widely used virtual worlds for the implementation of educational virtual environments. In order to decide, it is suggested that the developer considers the discussion in Section 4.2.1. If the developer decides to adopt Second Life, there is no development or configuration required to connect in the virtual world, apart from renting a virtual land to design the environment.

However, if Opensim is the platform of choice, a series of actions need to take place to configure the server and deploy the system. The environment deployment and configuration suggestions presented in Section 8.4.1.1 below refer to using Opensim, and are based on the experience developed in this research project.

8.1.1. The Server

Opensim is a platform independent server; therefore it can be deployed in any major operating system that meets the requirements reported in the system website[1]. The operating system is not of great importance, but the processing power and network connection speed of the workstation is. Many things affect the performance of the

[1] http://opensimulator.org/wiki/Dependencies

environment and it is recommended that the more processing power, memory and Internet speed, the better the performance[2]. Held and Durlach (1992) suggests that noticeable delays between actions and outcomes can diminish the sense of presence. Therefore, it is recommended that the server have sufficient processing resources and ample network infrastructure to support effective multi-user and user-environment interaction, minimising lag occurrences that can affect the user control on the environment. The specifications of the server used in this research project are shown in Table 4.1.

Running Opensim for the first time provides a number of questions to assist in setting up the region[3]. To allow remote access to the system, the developer needs to complete some additional configuration. First of all, the internal and external IP address should be provided to the Opensim.ini file located in the Opensim server file system. Then to allow access to users, specific network configuration is required[4]. However, if Opensim is deployed within networks with advanced firewall security, additional configuration may need to take place.

At this point, it is important to configure the communication in the virtual world. First of all, the voice component of Opensim is not supported by default. Few voice components are available[5], and the Vivox voice service[6], which was implemented and used successfully during this research project, is recommended. On the contrary, Second Life is accessed by installing the *Second Life viewer*, supporting voice by default; therefore no additional configuration is needed. In Second Life and the other virtual worlds, the chat range for a public message is by default set to 20 meters, 10 meters when whispering and 100 meters when the avatar shouts (Linden, 2014a). In Opensim however, the chat range can be changed through the configuration files by editing the simulator chat settings[7] to increase the chat distance. It was identified during the experimental studies that the public chat messages range of 20 meters distance was not very effective, as it did not allow users in relatively close proximity to communicate efficiently. For this reason it is suggested that the public chat distance is increased to 50 meters.

The developer may also want to consider how to manage user accounts to provide access in the environment. In Second Life, user accounts can be created through the

[2] http://opensimulator.org/wiki/Performance
[3] http://opensimulator.org/wiki/Configuration
[4] http://opensimulator.org/wiki/Network_Settings
[5] http://opensimulator.org/wiki/Category:Voice
[6] http://support.vivox.com/opensim/
[7] http://opensimulator.org/wiki/Configuring_Simulator_Parameters

official website[8]. In Opensim, the accounts should be created through the server console and there are two ways of doing this. The first way requires the administrator to programmatically create avatar name, surname and password through the system console. The second way (that is the one used in this research project and is recommended) is through the use of *Wifi* user management component described in Chapter 4 (Section 4.2.1). To deploy *Wifi*, the developer needs to perform the configuration described in the component's website[9].

The use of automated bots to test the environment's stability and performance prior populating it with real users is suggested, to ensure that the environment is capable to handle multi user and user environment interactions. Thus, the use of pCampBot bot management framework as discussed in Section 4.3 is recommended. Instruction on how to setup this tool can be found in the framework's website[10].

8.1.2. Environment Privacy

Once Opensim is deployed, the environment provides an empty island to begin and the designer can adjust its size through a series of server commands[11]. However, in Second Life the privacy of the land should be considered because there may be other islands around populated with people with no relation to the educational activity. For instance, if random people can visit the cyber campus, or if the cyber campus has neighbours, it can distract students. Additionally, increased traffic or complex objects and buildings on the neighbours' land can cause the students' viewer to slow down in an attempt to draw these objects and avatars. For this reason, it is recommended that the cyber campus operates on isolated islands, or having minimum numbers of neighbours to avoid distractions. This is consisted with the Savin-Baden's (2010 :168) suggestions to use isolated islands to avoid intrusions.

8.1.3. The Design of the environment

First and foremost, it is recommended that the designer considers the discipline and adapts the environment according to the educational context and requirements of the learning activity. Because the information from the virtual world are mainly visually received, Witmer and Singer (1998) suggests that visual information may strongly influence presence. Thus, it is recommended to exploit the ability of the virtual world to

[8] http://www.secondlife.com
[9] http://opensimulator.org/wiki/Wifi
[10] http://opensimulator.org/wiki/PCampBot
[11] http://opensimulator.org/wiki/Server_Commands

provide rich 3D visual information to influence presence in the design of the environment. According to Held and Durlach (1992), providing consistency between real and virtual world experiences should contribute to the users presence experience. The findings of this research project indicate that the environment realism contributes to the meaningfulness of the experience and in the development of the feeling of being in the virtual world, supporting the claims of Witmer and Singer (1998 :230). The findings also concur with Slater's (2003 :3) suggestion that increasing the realism of the setting, influences presence. Therefore, this research project recommends the design of the setting to be realistic, representing the layout and atmosphere of a real campus, and this is consistent with the design guidelines of Prasolova-Førland's (2008) and Fominykh et al. (2011). It was identified during the experiments of this research project that the use of intuitive and realistic objects, such as chairs, tables, doors, presentation boards etc. allowed users to understand the environment, and their use is recommended to make it clear and understandable. Considering the layout of the cyber campus, the design of collaborative zones, common student campus, and lecture rooms, as proposed by Redfern and Naughton (2002) are suggested. Collaborative areas and lecture rooms may vary in size to accommodate small or large groups of students depending on the requirements of the learning activities. Moreover, the De Lucia et al. (2009) suggestion for designing recreational areas is also recommended. Furthermore, this research project proposes the design of some additional areas to serve a number of purposes. An orientation area is recommended to allow users familiarise with the viewer and its functionalities, because users have to learn the features and tools of the viewer in order to behave '*normally*' in the environment (Johnson, 2006; Baker et al., 2009; Sutcliffe and Alrayes, 2012). The design of a courtyard area, that can for example, be established as the meeting point for students to group before setting off to perform activities is suggested. The design of a quiet room in which users who are away from keyboard but not disconnected, or do not want to be disturbed, can navigate to, may also be considered. An additional recommendation concerns the design of dedicated sandbox areas, in which the content design functionality of the environment is not restricted. Furthermore, the design of a fantasy area may be considered to allow developing experiences that significantly deviate from reality but contribute to the learning and recreational activities. However, it is very important to avoid overdesigning the environment, because many objects and buildings can obstruct participation. This is in line with Schmeil's (2012 :140) suggestion of avoid placing many objects in small spaces that can jam participation and cause frustration. Avoiding the use of complex and high object counts in the design of buildings and other content in the environment is also recommended, as this can cause the user viewer to slow down and experience lag. Furthermore, avoiding over-scripting objects in the environment is also important, an issue already discussed by Dillenbourg (2002).

To support awareness of the existence and actions of others in the environment, it is suggested that the way the layout is arranged allows users to clearly see each other. The graphics drawing distance of the majority of viewers is set between 96 and 126 meters by default, meaning that the viewer will only render objects within that distance from the avatar's viewpoint. Therefore, concentrating the design of the setting on relatively small spaces will ensure that nearby avatars and surroundings will be rendered to support awareness. Designing recognisable buildings, surroundings and facilities as suggested can cater for the users' need to understand what is going on in the environment and not get lost in space.

Anticipation and immediacy of actions during the virtual experience is an important aspect of presence in a virtual environment. Witmer and Singer (1998 :229) suggests that presence is influenced by the user anticipation of what will happen as a result of an action, and it may be useful to consider this when designing the environment. Thus, ensuring immediacy of actions, apparent outcomes and outcomes prediction when designing objects and environment behaviours is recommended. To accommodate for this, the designer needs to ensure that the objects in the environment are interacted in expected ways, similar to real life; for example, the avatar will immediately sit on a chair when the chair is clicked.

Communication facilities in the environment are subject to distance limitations and only users in close proximity within the virtual world are able to perceive them visually or acoustically. The proximity restrictions for public text chat are by default set in 20 meters unless changed in the configuration files as suggested in Section 8.4.1.1. When using voice, lip synchronisation and volume intensity indicators allow identifying the speaker. These visual indications are noticeable to avatars around the speaker and the audible distance is 60 meters (Linden, 2014b). The gestures visibility depends on the surroundings of the avatar and how these may hide them, and also to the rendering distance of the viewer. Therefore, it is recommended that the design and arrangement of the setting cater for these visual, acoustical and textual communication proximity restrictions. This can be achieved by designing areas in ways that users are gathered in spaces in which communication proximity is perceived. In addition, avoiding designing objects and buildings that can affect visibility can cater for this.

It is also important to exploit the ability of the virtual world to bring people together, and provide the opportunities of facilitating vivid discussions to create warm social learning atmospheres. Avoiding the design of large collaborative spaces where users can get lost in space, loose visual contact and depart from communication proximity zones can contribute to this. In addition, it is recommended to avoid concentrating areas into very small spaces, as this is overcrowding areas.

8.2. Suggestions for Educators

Educators and the way they manage the environment, students and learning activities, can pose an important role in effective online learning support in the virtual world. However, it is very important that the educator is familiar with the virtual world and its functionalities in order to be able to design and facilitate learning activities in the environment. It is suggested that the educator has experience and skills in building, manipulating and scripting objects, using the communication functionalities of the system, creating and using gestures and animations, editing avatars, storing, retrieving and sharing content; these suggestions are concurring with the educators required expertise suggestions of Moschini (2010). Instructions [12] and video tutorials [13] are available to help the educator familiarise and develop the required skills to efficiently use the environment.

8.2.1. Learning Tools

Having deployed the virtual world, designed and arranged the layout of the environment, the cyber campus then needs to be equipped with tools that provide educational functionalities. To equip the environment, the use of intuitive and interactive learning tools that present information in multimedia ways such as presentation boards, website loaders, video players and audio players, interactive quiz tools etc. are recommended to support learning activities, and for the user to understand their use and purpose. The use of a backend LMS is also recommended to support content management and delivery. The example of Moodle LMS and Sloodle components as discussed in Section 4.2.4, which were successfully used in this research project, are recommended. Moodle can be deployed through a set of installation instructions [14] and the educator can create courses and manage material through the web

[12] http://wiki.secondlife.com/wiki/User%27s_Manual
[13] http://wiki.secondlife.com/wiki/Video_Tutorials
[14] https://docs.moodle.org/23/en/Installing_Moodle

interface of the system. To link Moodle with the virtual world, the Sloodle components need to be obtained and configured[15]. As shown in Table 4.2**,** Sloodle provides many intuitive objects that can be utilised to offer educational functionalities and support a range of learning activities. The objects to be used depend on the context and requirements of the activity. The objects used to equip *SHU3DED* are discussed in Section 4.2.4. However, a particular object that is recommended to implement regardless is the *Sloodle Web Intercom*. This tool records the conversations in the virtual world and allows students to revisit them later through Moodle when they need to, ensuring workspace awareness of '*how did it happen*', as suggested by De Lucia et al. (2009). However, the need to have textual transcripts of oral presentations is required for the component to capture what has been said. For example, textual transcription of what the presenter says should take place, but this is as a difficult task to do in real time. Therefore, the use of a tool to provide textual information of what has been verbally said is recommended. In this research project, the *EasySpeak* tool was used to provide line-by-line text in the nearby chat and is recommended. This is very useful when students missed an activity; experience technical problems with audio or have hearing impairments. During the extended evaluation experiment, this tool was found particularly useful to accommodate the needs of a deaf participant. Therefore, using *EasySpeak* to pre-transcribe verbal notes allows textual information of what the presenter has prepared to say and logging for later revisiting, contributing to the development of workspace awareness. The use of the *Sloodle Web Intercom* and *EasySpeak* can also contribute to support asynchronous participation in activities.

8.2.2. Environment Management

The educator may want to consider how to manage some of the environment functionalities and determine how these contribute to the learning experience. During this research project, it was observed that distractions may occur from within the environment, mostly due to the users ability to build objects and fly around the virtual world, and because of unnecessary objects or functionalities that do not apply or contribute to the educational experience. Therefore, the educator may want to consider the needs of the learning activity when enabling environment functionalities. It is recommended that flying and content creation functionalities are limited to specific areas and are only used as part of activities when needed. Other functionalities such as teleporting, media streaming, editing terrain, creating landmarks, running scripts etc.

[15] http://www.sloodle.org

may also be considered according to the activities requirements. In addition, it may be useful to consider granting access to the virtual world only to registered students, in order to avoid random visitors especially in open virtual worlds. This is something Perera et al. (2010) also insist. In Second Life, this can be achieved by configuring the land properties to allow access to specific avatars. In Opensim, the educator can give the server login address only to registered students, and also configure access through the land properties.

The findings of the virtual focus group suggests that anonymity of users in the virtual world had influenced better self-expression and participation in activities, supporting the arguments of Lee (2013 :260). For this reason, encouraging students to use pseudonyms to preserve their real life identity is recommended. However, the study findings also indicated that anonymity of users in the environment is both an advantage and disadvantage of the virtual world, concurring with many authors in the literature (Castelfranchi and Tan, 2001; Junglas et al., 2007; Bente et al., 2008; Warburton, 2009; Prasolova-Førland et al., 2010). For example, the study findings indicated that anonymity in the virtual world can be misused and lead to possible misbehaviour or hostile behaviour, an issue also discussed by Kohler et al. (2009 :404). To partly address the issues of anonymity, it is suggested that the educator knows which avatar belongs to each student in real life, a point also discussed by Perera et al. (2010 :2), and this can be managed through Moodle and Sloodle. To support this, the example of *Sloodle Reg Booth* tool can be considered. With this tool, Sloodle links the avatar that is present in the virtual world with the student registered in Moodle, and the educator can monitor attendance.

8.2.3. The Design of Educational Activities

The first recommendation regarding the design of educational activities is to ensure that students are comfortable enough with the environment and its controls in order to be able to participate effectively. As discussed in Section 8.4.1.3, the need of an orientation area is important to allow users learn the functionalities of the system. Therefore, providing training time for students to familiarise with the environment and its controls through the use of the orientation area is recommended.

The richness of the environment and the way information is presented to students can be improved through the way educational activities are presented and performed. In conjunction with the previous suggestion of using visually rich and interactive teaching tools to support learning, resolving artefacts to support the learning experience is also recommended. Utilising a fantasy area in the cyber campus can also contribute to the richness of the environment. In this area, the educator can exploit the 3D design capabilities of the virtual world to offer experiences that are difficult to construct or perform in real life, but according to Prasolova-Førland et al. (2010 :6) contribute to the learning experience.

An important observation during the evaluation experiments was that when activities were recognisable and interacted in expected ways similar to real life, users were initiating, undertaking and successfully completing them without problems or noticeable delays. This supports Witmer and Singer's (1998 :229) argument of the importance of the natural movement control and interactions with the environment to influence presence. During the experimental study described in Chapter 5 (Section 5.3), for example, it was observed that when users had to complete a quiz through the *Sloodle Quiz Chair*, they understood that they had to walk in the room, sit on the chair in order to start the test, and stand up when they had finished. Conversely, when an activity required users to try it several times to familiarise with the procedures, it caused difficulties, confusion, delays and in some occasions unsuccessful outcomes. Difficulties were also observed when activities required complex interaction between the user and the environment, the use of the viewer's contextual menu, combination of actions or complex procedures. Held and Durlach (1992) explains that if the mode of control is artificial, presence is diminished until the interactions become well learned. To address this, it is recommended that the environment interactions during activities are performed in natural and recognisable ways that the user can undertake without the need to practice them, at least not extensively. It is also recommended that the design of activities and required interactions with the environment to undertake them is simple and easy to carry out. This is in line with Schmeil's (2012 :139) suggestion that making activities easy enable users to adapt faster in the environment. It was further observed that users engaged in activities when they had to navigate around in the environment to acquire or share information. For this reason, it is recommended to design activities that require students to actively search the environment for information. Moreover, the ability to modify the avatar's viewpoint may also be exploited to allow students to closely examine artefacts, focus on presentation boards, listen to speakers etc. Therefore it is suggested that activities require students to modify their viewpoint and change what they see and/or hear, as according to Witmer and Singer (1998 :230) these are also actions that influence presence.

An important finding of the virtual focus group was that participation in meaningful and interactive activities had engaged users, made them feel present in the environment, and contributed to effective participation in activities. This concurs with Witmer and Singer's (1998 :230) suggestion that presence increases as the situation presented becomes more meaningful to the user. The findings of this research project suggests that the ability of seeing and understanding the actions of others improve the realism and awareness of the environment, concurring with Konstantinidis et al. (2010a :92). This also makes the experience more meaningful. For example, a speech animation can be utilised to represent teacher's gestures during presentations. Similarly, the virtual world provides a '*typing'* avatar animation when a user is typing something on the nearby chat, showing that the user is doing something (typing) rather than just standing still. Animations can be achieved by scripting objects that when interacted animate the avatar accordingly. For this reason, the educator can utilise the animations and gestures libraries provided by the virtual world to represent activities, for students to understand what activities and actions are performed. It is also important that the educator caters for the users' awareness of the existence and actions of others in the environment. Similar to the previous recommendations of allowing users seeing each other in the design of the setting; it is recommended that the educator designs and concentrates learning activities on relatively small spaces within the avatar's viewer rendering distance. Many examples were observed during the experimental studies in which users approached others to seek guidance, shared information, collaborated or observed their actions, demonstrating the concept of peripheral awareness as discussed by Benford et al. (1994) and Redfern and Naughton (2002). These observations are also demonstrating the concept of action awareness as discussed by Schmidt (2002), and De Lucia et al. (2009). Based on these observations, it is suggested to provide adequate peripheral space around students to perform tasks. To achieve this, the educator needs to ensure that when allocating spaces or designing activities, the students are able to clearly establish visual contact of the existence, location and actions of other users. It is important to ensure that users visibility is not obstructed from other avatars, buildings or other objects that may be on their way during activities.

It is also important to allow students understand the roles of others in the environment. It was observed during the initial evaluation experiments that the use of the avatar outfit contributed to distinguishing roles in the virtual world, in occasions when users located and approached the moderator or team leaders for information request and sharing. This implies that when is possible to distinguish people having different roles in the virtual environment, then group structural awareness is supported, supporting Greenberg et al. (1996 :30). When activities require students to be in teams, for example, providing a '*leader t-shirt*' or coloured team outfits to members can provide visual information to determine the various roles of each participant in the environment. In addition, it is also recommended that each team have a distinguishable logo or badge that can be used to reserve areas in the virtual world. For instance, a team's flag may be used to reserve a meeting room for a group activity, allowing other users in the virtual world to be aware and distinguish the various teams.

Designing activities and interactions in close proximity, in which users are near each other caters for effective communication. It was frequently observed throughout the experimental studies, and identified in the chat logs, that when users were in close proximity they approached and communicated both formally and informally. Observations during this research project indicated that the awareness of the existence of others in conjunction with the ability to communicate in the environment had contributed to effective collaboration in activities, concurring with the findings of Koutsabasis et al. (2012 :36). Furthermore, the findings of this research project imply that effective communication and collaboration was indeed facilitated within the virtual world, concurring with the results of Konstantinidis et al. (2010b :614). However, it was also observed that when a team collaborated within the text chat range of another team, this had caused confusion, as the public text chat displayed messages from both teams. Subsequently this also applies to voice. In addition, if an avatar moves outside the team chat range, it will not be able to see or hear what has been said, even if the user can still have visual contact with others. For this reason it is recommended that visible and natural boundaries are implemented to divide the working spaces and prevent users departing from the communication proximity zones during activities, to avoid loss of communication and confusion. This is similar to Schmeil's (2012 :140) suggestion for implementing barriers that users can understand. This can be achieved by concentrating the team workspace or sandbox within areas according to the communication proximity distance as set in the server configuration (Section 8.4.1.1). For example, designing short wall barriers (as shown in Figure 4.11b) that restricts users from departing the collaborative zones but do not limit visibility of the rest of the environment is suggested, to ensure that users will receive all messages from the public text chat. It was also observed that when teams comprised of many members (e.g. more than 7), the workplace becomes overcrowded and conversations are muffled because many users try to communicate at the same time. For this reason, it is suggested that group activities involve small number of students to cater for better conversation management and more effective collaboration. This can also cater for ensuring adequate peripheral and action space as previously suggested. However, when activities require large groups of students, the larger collaborative areas may be utilised that ensure adequate user peripheral space. Because a larger space will affect the visibility of the communication of the public text chat, the use of IM group communication and group voice chat can then be utilised to enable communication between the group members. It is recommended that educators create voice and IM chat groups for students to join and contribute to the discussions, post updates and share notices for every member's attention, allowing reaching every member of the group instantly.

Catering for effective communication among students can also contribute to the sociability of the environment. The findings of this research project revealed the importance to cater for sociability and encourage the development of social groups within a cyber campus to support learning. Therefore, catering for the development of a sound social space that promotes the establishment of strong group connections and the sense of community is suggested, and the design of activities can contribute to this. During activities, it is important that the students feel part of the team and are comfortable enough to express their thoughts and concerns. This could be achieved by designing social activities that may be unrelated to learning, for students to participate together and meet each other. The educator can design activities such as meet and greet sessions, scavenger hunts or similar, to bring students together and make them feel part of the team. Observations during the experimental studies indicated that by developing and maintaining social relationships, participants shared information and contributed to knowledge construction more effectively. This is in line with the Kreijns et al. (2007 :13) suggestion that "*social interaction is considered to be the dominant factor affecting collaboration in groups and thus learning performances in those groups*". For instance, during activities that required input from all members, the shyness and awkwardness of initial interactions were replaced with warm, friendly and constructive conversations, and effective collaboration was observed. Therefore, it is recommended that educational activities require input from all students to promote socialisation. It is also recommended that the educator is involved to ensure that learning groups are not just people working together towards a common task, but teams consisted of colleagues who share mutual respect, trust and friendship, equally contributing to decision-making processes, knowledge construction and sharing. Kreijns et al. (2007 :2) elucidates that some educators neglect the importance of sociability and do not pay attention to group dynamics, as they are not aware of the importance and implications of sociability in collaborative learning. It was observed during the experimental studies that to encourage the development of sociability in the environment, students had to interact with each other and perform meaningful activities together, in order to meet and develop relationships between them. It was also observed that by allowing students to initiate non-task related conversations, they were getting more familiar and open with each other. To achieve this, the educator may want to consider providing additional time outside learning for socialisation purposes, in order to encourage users to spend time together, contributing to the development of social groups and relationships between them. It was observed, and also identified in the chat logs of the experimental studies, that the non task related conversation mostly included friendly informal interactions, concurring with Kreijns (2004 :70) view on non task contexts in CSCL environments. Therefore, it is important that the atmosphere conveys the feeling that the students belong in the environment and they are welcome; they have a purpose of being there, and can converse easily and freely with their colleagues and teachers. This is also in line with Deutschmann and Panichi (2009 :33) argument that informal interactions "*break the ice and creates a friendly atmosphere and a sense of group belonging*".

An additional recommendation to contribute to the sociability of the environment is to ensure that students are not alone in the virtual world during activities, and are near each other to encourage formal and informal conversations. Rovai (2001 :106) accentuates that "*distance-education courses must move away from imparting feelings of isolation and move toward generating greater feelings of community and personal attention*". The findings of the virtual focus group suggests that the virtual world can increase social interaction and mitigate the feeling of loneliness in online learning, supporting the view of Johnson et al. (2011 :14) and Stendal et al. (2011 :82). The study findings also imply that the sense of community can develop important group dynamics that contribute to reducing isolation of students, supporting the claims of Rovai (2001). However, the findings of this research project revealed issues regarding synchronicity in learning interactions, when students cannot attend and synchronously participate in activities; stressing the importance of catering for asynchronous participation in learning activities, supporting Petrakou (2010 :1026). It can be suggested that supporting asynchronous participation in learning activities can provide more control and flexibility to the student, an issue also discussed by Hrastinski (2007 :35). While asynchronous participation was out of the scope of this research project, its importance cannot be neglected. To accommodate for this, the educator may want to consider asynchronous means of participation to ensure that important learning experiences are not lost when students’ cannot synchronously participate. Thus, designing individual learning activities that do not require synchronous user interaction, and are accessible at any time is suggested. The use of Moodle can be used to create activities that do not require group input and can be completed from both within the virtual world or through the web interface. Utilising forums and emails and offline IMs to establish asynchronous communication can also contribute to this. Minocha and Reeves (2010 :133) suggests the design of asynchronous spaces to support learning and this may also be considered. However, this was out of the scope of this research project and was not investigated further.