

The use of cyber campuses to support online learning for students experiencing barriers accessing education

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Abstract

Attendance and participation in education are important for students to obtain the experiences necessary to develop their knowledge. However, there are some students who experience challenges hindering their access and participation in Higher Education. To support students, Universities utilise E-Learning. One of the many E-Learning tools is the use of virtual worlds in the form of cyber campuses. This paper investigates the extent to which cyber campuses can help to mitigate barriers and support students experiencing them. A prototype has been developed and a series of empirical studies have been performed. The results of this research suggest that a cyber campus environment can be used as an alternative learning support tool that can enhance online learning experiences, and help to mitigate some of the barriers that hinder access and participation to education. The associated limitations of this research and the future work planned out are also presented.

Keywords: virtual worlds, cyber campuses, online learning, TEL, VLE

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1. Introduction

Technology in education has been introduced to effectively support and enhance learning with great success over the past few years. However, while universities offer a range of on-campus degrees, there are students for whom access and participation to education is challenged, missing the important learning experiences developed through classroom interaction. There are many reasons and barriers hindering access to education for some students, significantly affecting their learning experience [1]. To mitigate the effects of such barriers, e-learning technologies are widely used. One example is the use of Multi-User Virtual Environments in the form of cyber campuses. These are 3D graphical environments

where students can meet, and synchronously communicate and collaborate in online learning activities [2]. 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* of the environment [3].

The educational capabilities of cyber campuses have been investigated thoroughly in the literature [4]. However, little is known about the extent to which cyber campuses can effectively support students experiencing barriers hindering access to education. To investigate this, a cyber campus prototype has been developed to conduct a series of experimental studies with. An evaluation of the efficacy of the environment to support synchronous online learning activities was conducted. In addition, a qualitative investigation

of the extent to which such a tool can help to alleviate barriers and support students participate in online learning activities was also performed. The findings of this investigation are presented in this paper, together with the associated limitations and future work that is planned as a result of this research.

2. Background

Over the past few years, technology in education has been introduced to effectively support and enhance learning with great success. However, while universities offer a range of on-campus degrees, there are students experiencing barriers impeding accessing education and participating in learning activities, missing important educational experiences. The barriers hindering access to education for students are complex and wide ranging [5]. Discussing each barrier individually is difficult and lengthy; therefore, several scholars have attempted to categorise them. The most cited approach is the Cross' framework [1: 97-100], which classifies barriers into situational, institutional and dispositional. 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 [5].

As a way to address institutional barriers, universities provide online courses and learning support tools. However, the educational 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 [6]. Thus, online learning tools are available utilising E-Learning technologies. E-Learning supports education using technology that enable students to construct and share knowledge through synchronous and asynchronous interactions at

their own time and pace [7]. This provides opportunities for accessible education that increases learning independence [8]. However, the conventional E-Learning tools currently in use lack effective social interaction. This has a negative impact on learning, in that conventional online learning tools on their own are not enough to support effective socialisation [9].

In the process of enhancing interactivity, dynamism and socialisation of conventional online learning tools, and considering that students learn in socially constructed ways, the use of virtual worlds in the form of cyber campuses has been introduced to enhance this aspect of E-Learning [10]. Virtual worlds are networked computerised systems offering multi-dimensional graphical environments and are designed to accommodate people, simulating places that are shared for multi-user interaction [11, 12]. These are persistent environments that exist even when no one is interacting with them, and are experienced by people represented by "avatars", that co-exist and interact between them in the same shared space [11]. The avatar is the user's viewpoint of the virtual world, and is also the link between the user and the community as a mean of social interaction [13-15].

Virtual worlds can take many forms and be designed in ways that represent educational institutions and learning spaces, and are often referred to as cyber campuses. Cyber campuses are meeting points where students gather, and share information, communicate and collaborate in 3D shared spaces [2]. Cyber campuses aim to facilitate learning through environments often replicating realistic educational settings, or experiences that deviate from reality but contribute to effective teaching and learning [2, 16, 17]. Cyber campuses host interaction and collaboration allowing experimentation, are stimulating imagination, creativity, and offering immersive learning experiences [18].

Many educational institutions are using cyber campus environments for their needs. There are more than 500 cyber campuses in Second Life alone, and are used for a wide variety of purposes [4, 19]. Over the past few years, it has been identified that there is an increase in the use of MUVE for many educational purposes [4].

According to De Lucia and his colleagues [3], in such environments, learning is strongly related to students' perceptions of presence, awareness, communication and the feeling of belonging to a learning community. One of the most important advantages of 3D environments is the strong presence sensation that generates the feeling of the user's actual presence in the environment [20]. Presence is considered as the extent to which the individual feels present in the virtual environment rather than the physical [21], and provides the "illusion of 'being there', whether or not 'there' exists in physical space or not" [22: 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 [23: 32]. Witmer and Singer [20] propose that the stronger the feeling of immersion and involvement, the greater the sense of presence. Immersion enhances collaboration and socialisation [24] and is strongly related to learning, as "increasing presence also increases learning and performance" [3: 222]. Witmer and Singer [20] suggests that to measure presence in a virtual environment, measures should comprise factors that influence involvement and affect immersion; identifying the following: control, realism, distraction and sensory factors. Control factors (CF) relate to the user actions and the expected behaviors of the environment according to them. Realism factors (RF) include the realism of the scene, the content, information consistency and meaningfulness of the experience. Distraction factors (DF) relate to distractions that may occur during the experience that could diminish the sense of presence. Sensory factors (SF) refer to the information received mainly visually and is strongly related with the environment richness.

Awareness relates to the feeling of anticipating the existence, location and actions of others in the environment [3]. It refers to the user becoming aware of a particular instance or occurrence that happens in the environment [25]. It furthermore relates to being aware of who is talking to whom in the virtual environment, that may lead to impromptu interactions, relationships and development of communities [26, 27].

Communication concerns the verbal and non-verbal communication established within the

virtual world [3]. Virtual worlds establish and handle synchronous communication among users [28], allowing effective communication and collaboration to be facilitated within the virtual world [29].

Sociability relates to the ability of the environment to be a sound social space that facilitates social situations and provide the feeling of belonging to a community to its users [30]. This can help in the development of essential group dynamics that contribute to reducing the loneliness and isolation of students [31]. De Lucia et al. [3] suggests that these characteristics contribute to the development of learning-efficient virtual worlds. These characteristics may also contribute to increasing the social dimension of E-Learning activities [32]. Thus, it is very important to further investigate and understand how these characteristics can support students experiencing barriers hindering access to education.

3. Research Methods

The educational affordances of cyber campuses have been investigated thoroughly in the existing literature. However, little is known about the extent to which cyber campuses can support students experiencing barriers impeding access and participation in education. Therefore, further investigation is required to identify the characteristics of cyber campuses to facilitate access and participation in learning activities and support those students. To investigate this, a combination of quantitative and qualitative research is chosen and 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?

To investigate this, a cyber campus prototype was required as the medium to conduct empirical studies. Thus, the *SHU3DED* cyber campus was developed and its design details are presented in Section 3.1. The theoretical framework proposed by De Lucia, Francese, Passero and Tortora [3]

was utilised to evaluate the efficacy of the prototype to support synchronous online learning.

Prior conducting the environment evaluation study discussed below (Section 4.1), two studies were performed to test and perfect the experimental design and procedures, and initially evaluate educational potentials of the environment [33, 34]. Following the environment evaluation, its ability to support students experiencing barriers accessing education was then investigated. A virtual focus group study was conducted and investigated experiences of barriers impeding access and participation to education, and the extent to which a cyber campus can support students experiencing them.

3.1 The SHU3DED Cyber Campus

To perform this investigation, the *SHU3DED* (Sheffield Hallam University 3D Education) cyber campus has been developed using Opensim[†] virtual world [35]. The design is based on examples of virtual worlds used in academic contexts, guidelines and suggestions from the literature (Figure 1, 2, 3). The prototype has realistic look and feel of a common learning setting, providing recognisable facilities and surroundings.

SHU3DED provides a number of rooms and areas, featuring different functionality each. The main building consists of the courtyard, main hall, lecture, library, meeting and assessment rooms and a quiet area (Figure 2). On a separate building, there is the orientation area. Outdoor lecture space, meeting and recreational areas are also available, together with fantasy and sandbox areas, in which the building and flying functionalities of the environment are not restricted (Figure 3).

To equip the prototype with educational functionalities, Moodle[‡] and Sloodle[§] plugins were deployed. Moodle is an open source learning management system that is partially integrated in virtual worlds using Sloodle, offering a number of

educational tools and functionalities to be ported in the virtual world. Sloodle then establishes communication with Moodle through objects in the environment, retrieving the activities designed within the virtual world.

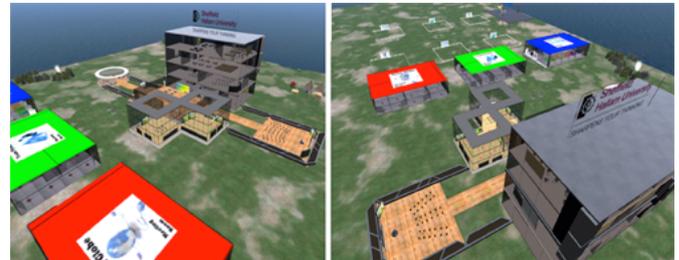


Figure 1. The *SHU3DED* Cyber Campus

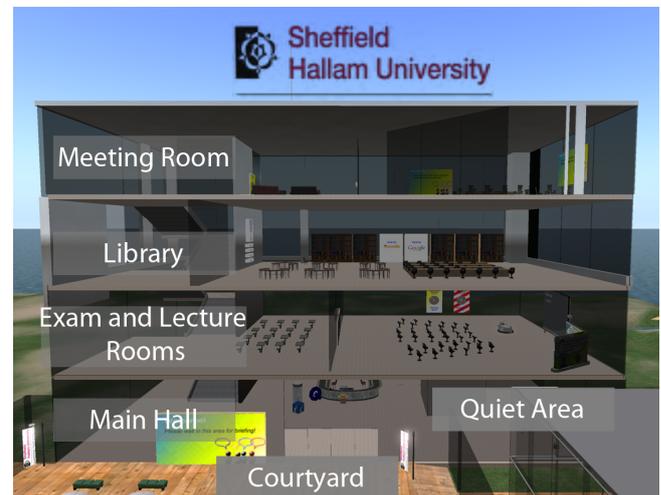


Figure 2. The *SHU3DED* Main Building



Figure 3. The *SHU3DED* Overview

[†] <http://www.opensimulator.org>

[‡] <http://www.moodle.com>

[§] <http://www.sloodle.org>

3.2 Sample

To establish the sample of this investigation, a criterion-based convenience sampling method was employed, recruiting people with experiences in barriers accessing and participating into Higher Education. A call for participation was advertised online for a period of three weeks. Second Life virtual world was also used to invite members from groups with interest in educational virtual worlds, subject to qualifying to the sampling criteria. 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 [36]. From the call, 24 people volunteered to participate in the environment evaluation study, of whom 12 males and 12 females, between 19 and 57 years old. The sample included 15 Higher Education graduates and 9 university students.

The participants of the environment evaluation were then invited to participate in a follow-up qualitative study. From this invitation, 19 people participated (9 males, 10 females), between 19 and 57 years old, of whom 6 were Higher Education students and 13 graduates. Participants who could not attend were emailed an open-ended questionnaire with questions similar to the ones used during the focus groups (See Appendix A), and two additional responses were collected (28 and 52 years old females, graduates).

3.3 Instruments

To collect data for this investigation, mixtures of instruments were utilised. First, the subjective evaluation of the environment was performed and pre and post experiment surveys were administered to participants via the web. The pre experiment survey was designed to collect data based on participants' skills with virtual worlds, demographic details and personal experiences with barriers accessing and participating education. The post experiment survey was administered after they experienced the environment, collecting perceptions of presence, awareness, communication and sociability, together with a specific evaluation of the

environment, productivity and satisfaction of the experience (See Appendix B). To measure presence, the short version of the presence questionnaire (PQ) as proposed by Witmer and Singer [20] was adopted. PQ 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). To measure the user awareness and communication effectiveness in a virtual world, the Awareness and Communication scales as proposed by De Lucia et al. [3] were adopted. Awareness scale measures 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 other users in the virtual environment. The Communication scale measures the user perceptions of the system ability to provide interfaces that support easy and effective communication. To measure the perceived degree of sociability of the environment, the Sociability scale as proposed by Kreijns et al. [30] was adopted. To evaluate the environment, the collaborative virtual environment evaluation scale (CVE) was also adopted from De Lucia et al. [3]. This scale comprises a set of general questions that evaluate the design and interface usability of the environment, productivity and general satisfaction of the experience. PQ was measured in 7-point Likert scale, and the other scales in 5-point Likert scale. The chat communication between users was also recorded for further analysis.

To conduct the qualitative portion of this research, virtual focus group sessions were conducted within the cyber campus. These sessions aimed at collecting data to understand 1) the barriers hindering access and participation to Higher Education, and 2) how a cyber campus can be used as a tool to support students experiencing such barriers. The questions discussed during the focus groups are shown in Appendix A. During the sessions, the chat communication was established through the nearby chat and was recorded. A hybrid thematic analysis utilising both deductive and inductive approaches was employed to identify, analyse and report themes emerging through data [37].

3.4 Procedures

Participants in both studies were remotely located, and prior to their interaction with any of the study material their informed consent was sought online. Participants first completed the pre experiment survey, and installed a preconfigured virtual world viewer to access the environment. Participants logged in the environment and spend a few minutes in the orientation area to get familiar with the functionalities of the system. A brief introduction of the activities was performed, followed by a lecture in the outdoor lecture room (Figure 4). During the lecture, artefacts were rendered to support the lecture, for example, a temple was rendered to demonstrate the environments' ability of to recreate high detailed monuments. After the lecture, participants were allocated in teams and navigated to their meeting rooms where a brainstorming activity focussing on how virtual worlds can be used in education took place. At the end of the session, participants completed the post experiment questionnaire online. The total duration of the evaluation session was 120 minutes.

Participants were then invited to take part in three virtual focus group sessions conducted on different days. An additional replacement session for people who missed them was also conducted. The duration of each session was 120 minutes (replacement session was 50). The meeting room of the cyber campus was used as the place to facilitate the discussions (Figure 5).



Figure 4. Examples of Activities During the Environment Evaluation

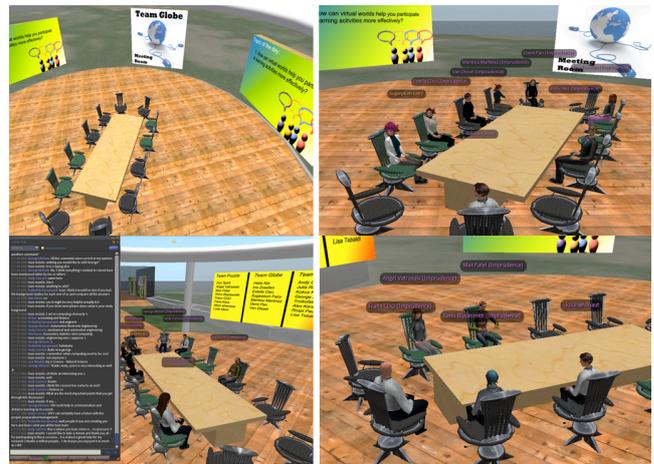


Figure 5. Examples of the Discussions During The Virtual Focus Groups

4. Results

This Section presents the results of the environment evaluation (Section 4.1), and qualitative study (Section 4.2).

4.1 Environment Evaluation

The pre experiment questionnaire was analysed first. The results indicated that from the total of 24 participants of this study, the majority had no previous (46%) or little (24%) experience with virtual worlds, and 29% were experienced users. The participants' experiences with barriers in accessing and participating education included disabilities, distance, family responsibilities, financial and work related barriers.

The results of the post experiment questionnaire were then analysed. Before conducting any data analyses, the degree of data normality was tested and normality assumptions were fulfilled, thus parametric tests were used. The results of the PQ were analysed first (Table 1). The total presence score is calculated by aggregating all items for each participant (Min=19, Max=133), and each presence factor is also presented individually. Results revealed high sense of presence in the virtual world with positive perceptions towards the users control on the environment (CF). Similar results have been revealed for SF, RF, and DF, with relatively low data dispersion. Table 2

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presents the results of awareness, communication and sociability, together with the evaluation of the environment’s design, productivity and user satisfaction.

Table 1. Presence Results

		Mean	Sd	Min	Max
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
Legend: CF=control factors, SF=Sensory Factors, RF=Realism Factors, DF=Distractions Factors					

Table 2. Results Concerning the Additional Environment Evaluation Factors

Factor:	Mean	Sd	Min	Max
Awareness	4.39	.46	3.33	5
Communication	4.22	.74	2	5
Sociability	4.17	.52	3	5
Environment Evaluation	4.35	.49	3.29	5
Productivity	4.17	.64	3	5
Satisfaction	4.42	.72	3	5

The results were also analysed for relationships between the evaluation factors and the sample’s previous experience with virtual worlds as collected through the pre experiment questionnaire. A Pearson’s product-moment correlation coefficient was computed, revealing no significant results; implying that students do not need previous experience with virtual worlds to be able to use the environment and participate in activities (Table 3b). The test however revealed significant correlations between all the environment evaluation factors, demonstrating the importance and contribution of each factor to the user experience in the virtual world.

The results were further analysed to identify differences between participants’ gender and academic status, with their perceptions of the

environment. A series of one-way-ANOVA tests were conducted revealing no significant differences (Table 3a); implying that gender and academic status were not differentiating factors in the participants’ perceptions of the environment.

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

Participant 15: *“It is amazing how many things you can do in here... Sky is the limit... this easily suits my learning needs”*

Participant 3: *“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”*

During the evaluation, participants actively participated in all activities, they were extensively using the text chat to communicate and socialise, and equally contributed in the discussions. Let us note that many of the users remained connected for some time in the environment after the end of the session and continued to socialise.

Table 3a – ANOVA Tests

Gender and Environment Perceptions	
PQ	F (1, 22) = 0.13, p = 0.72
AW	F (1, 22) = 0.79, p = 0.38
COM	F (1, 22) = 3.2, p = 0.09
SOC	F (1, 22) = 3.5, p = 0.08
CVE	F (1, 22) = 1.6, p = 0.22
PRO	F (1, 22) = 0.4, p = 0.53
SAT	F (1, 22) = 0.31, p = 0.58
Academic Status and Environment Perceptions	
PQ	F (1, 22) = 0.5, p = 0.49
AW	F (1, 22) = 0.02, p = 0.88
COM	F (1, 22) = 0.51, p = 0.48
SOC	F (1, 22) = 0.02, p = 0.9
CVE	F (1, 22) = 0.35, p = 0.50
PRO	F (1, 22) = 0.10, p = 0.75
SAT	F (1, 22) = 0.02, p = 0.89
Legend: PQ= Presence, AW= Awareness, COM= Communication, SOC= Sociability, CVE= Collaborative Virtual Environment PRO= Productivity, SAT= Satisfaction	

Table 3b – Correlations Between Users Experience with VW, and the Evaluation Factors

	VWE	PQ	AW	COM	SOC	CVE	PRO	SAT
VWE	---							
PQ	.20	---						
AW	.01	.54	---					
COM	.17	.59	.63	---				
SOC	.32	.74	.63	.72	---			
CVE	.14	.71	.65	.71	.79	---		
PRO	.005	.50	.56	.7	.65	.80	---	
SAT	-.15	.47	.59	.7	.65	.73	.7	---
Legend: VWE=Virtual Worlds Experience, PQ=Presence, AW=Awareness, COM=Communication, SOC=Sociability, CVE=Collaborative Virtual Environment PRO=Productivity, SAT=Satisfaction								

4.2 Virtual Focus Group Study

Following the environment evaluation, a number of virtual focus group sessions were conducted. The results were first analysed to identify barriers impeding access and participation to education.

To discuss the findings of this study, the Cross [1] framework was utilised to categorise barriers into situational and institutional. The findings concerning the educational characteristics of the environment were then analysed to investigate the extent to which a cyber campus can mitigate some of these barriers and support students experiencing them.

Presence, awareness, communication and sociability were analysed first, as these are the characteristics that contribute to the learning experience in virtual worlds [3]. The analysis continued to identify additional characteristics that contribute to learning support through the environment. The findings of this study, are organised and discussed in two main topics:

- Topic 1 - Barriers hindering access and participation to education.
- Topic 2 - The characteristics of the cyber campus that support online learning and help to mitigate barriers in access to education.

Topic 1 - Barriers Hindering Access and Participation to Higher Education

Situational barriers

During the data analysis, situational barriers were the most evident in the participants' educational experience. The main themes emerged included financial barriers, distance to education, family and work responsibilities, and health issues.

The financial aspects of education were frequently discussed, mainly including the need to work to manage financial obligations. It was identified that these issues limit study time, increases stress levels, lowers energy, affects concentration, motivation, and can even compromise the studies for some students.

Participant 1: *“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 education, its associated costs, the time, and effort of travelling were also established. It was identified that transportation costs have an influencing role in attendance to education, mainly because travelling is a time and effort-consuming task. It was also identified that students who have to leave home, travel to other areas and find term

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time accommodation encounter heavy financial challenges that can also be excluding factors.

Participant 2: *"I was staying far from the university, so commuting every day to attend lectures was difficult and time consuming. It is also expensive to drive to the campus every day"*

Difficulties concerning family responsibilities were also identified. In particular, multiple roles, conflicting responsibilities, and balancing family, work and education are issues found to pose difficulties, affecting learning time availability, and personal time. As a result, some students miss classes due to unscheduled events, get tired, and stressed. It was further identified that some students tend to concentrate more on family, side lining education. It was also pointed out that female students encounter difficulties in access and participation to education during pregnancy. In particular, participants explained that it was very hard to participate and concentrate on learning during pregnancy, and also they could not access education for a period after the delivery. The challenges of childcare in general were identified, with emphasis on how special arrangements are required for some students to find time for learning.

Participant 4: *"I have two children and attendance at university involves arranging childcare... [I have] to get up at 5 am! then travel back another 2 hours, to rescue my kids from whoever have had them :D"*

Situational barriers concerning the physical and health condition of some students were also identified. Participants with mobility disabilities talked about how these issues difficult access to education and participation in learning activities. It was identified that some participants experience difficulties attending and participating in certain classes, while others have may be absent for long periods, or cannot attend university at all. A particular participant with hearing impairments also explained that due to this disability it is difficult to follow oral presentations.

Participant 5: *"I have Ankylosing spondylitis, terrible pains on the back, lost as long as one year from my studies."*

Institutional Barriers

Institutional barriers were also identified, concentrating to tuition fees, layout and design of institutions, poor quality of services, and lack of available learning opportunities. Tuition fees were mentioned most frequently, focussing on the increase in tuition fees compared to previous years. It has been determined that this is a factor that difficult access or leads to exclusion from education.

Participant 6: *"Are the Universities willing to lower their fees?"*

Participant 7: *"Its £9000 in the UK now."*

Participant 8: *"Per year or the whole degree?... £9000 for university? That's a lot!!!"*

Many barriers associated to the physical design and inabilities of institutions to accommodate students with disabilities were discovered. Several examples of how physical obstacles and inaccessible facilities hinder access and participation were discussed. Furthermore, issues regarding lack and poor quality of services in some institutions were also identified, and some participants explained that in many occasions the facilities are not tailored according to their needs. It was identified that these barriers lead to late arrivals to classes, loss of important learning experiences, and cause frustration.

Participant 9: *"The first problem is reaching the campus... and then access to the room... restricted area in classroom... unusable desk space... The toilets usually are [at] another floor or the other end of the campus"*

Lack of available learning opportunities was also identified. Some participants explained that educational institutions around their areas do not offer courses of interest, or do not advertise educational opportunities. It has been determined that this may lead in enrolling to courses that are not of the students genuine interest, or register on educational institutions that are far from their home.

Participant 6: *"In my area there are no universities that offer the course that I would like to undertake... I cannot afford to go to the university that offer this course because it is far away and I work full time."*

Topic 2 - The Characteristics of the Cyber Campus to Support Online Learning

Presence

During the discussions, presence was identified as one of the most important characteristics of the virtual world. It was identified that during the participants experience in the virtual world, they developed the sensation of *'being there'*. Participants emphasised that the environment created the *"illusion that you are at a university"* (Participant 7), and implied that they felt present in the virtual world. It was determined that presence can develop more engaging and enjoyable experiences, and contributes to the overall online learning experience. It was also identified that the use of the Avatar contributes to the development of the sense of presence, and this can allow students to actively participate in activities.

Participant 10: *"I am so immersed that I think I'm talking when I'm typing and hearing when reading"*

Awareness

The characteristic of awareness of the existence and actions of others in the virtual world was also established. Participants suggested that the use of the avatar made the existence of others apparent; made them feel present in the environment, and gave the impression of a team in a realistic way. The importance of awareness in understanding the environment, enriching the experience, and providing realistic participation to learning activities was suggested. It was identified that informal conversations were initiated as a result of seeing each other, and this contributed to developing the feeling of belonging to a group. Participants also found the ability to determine who was working with them very important.

Participant 2: *"You see them [other users], what they are doing. The whole thing looks alive. You can also understand where things are and what the buildings are for."*

Communication

The importance of the ability to textually communicate, and establish synchronous interaction, collaboration and socialisation in the

virtual world was identified. It was pointed out that text communication through the virtual world helps to express opinions, whereas in real life some students may not normally contribute to discussions. It was also identified that textual communication can help some of the students who speak a foreign language, or do not feel confident talking in public to contribute to the discussion. The use of gestures to communicate was also discussed. Gestures allowed participants to convey emotions, complement textual communication, and made the avatar more interactive. The ability of the system to keep communication records was also raised, and participants explained that this helped to catch up with responses they missed, and allowed them to take time to formulate their responses.

Participant 3: *"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"*

However, it was identified that prolonged typing during the textual discussions is difficult and tiring. It was also determined that when many users contribute to a public textual discussion, multiple responses are overfilling the chat window, causing confusion. Some participants recommended that this could be controlled by the use of gestures, or using a tool that allows people to take turns when typing in the public chat.

Participant 6: *"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."*

Sociability

The sociability of the environment was also identified as an important characteristic that contributes to participation. Participants expressed that being together in the environment influenced group communication, establishment of social relationships, and effective collaboration. It was identified that ability of the virtual world to become a space in which

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effective socialisation can be established, provides “*a nice alternative to attending on-campus lectures... without losing the interaction and belonging*” (Participant 2) when attendance is hindered. It was identified that being together within the environment enables students to feel members of the group, and to not feel alone during the experience. It was also indicated that working in groups can bring students together, provide and maintain social interaction between them during the activities.

Observations during the discussions indicated that participants became more familiar with each other, commented on each other posts, were engaged in discussions, and developed a friendly atmosphere, which are evidence of group cohesion and sociability.

Participant 12: “*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...*”

Environment Realism

Another characteristic that was also established as very important is the level of realism of the environment. Participants frequently discussed the ability of the virtual world to be “*a world without boundaries*” (Participant 13) that can replicate realistic environments, and also offer experiences that deviate from reality. The environment’s ability to graphically represent the real world in great detail was established, and found to engage participants in activities. The realistic feeling of the virtual world and the atmosphere it conveyed had put them in a “*ready to learn*”(Participant 9) mode, and participants felt that they were being within a learning environment.

Participant 6: “[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 [me].*”

The ability of resolving and building high quality 3D content in the virtual world to support online learning was also established. Some participants went on to explain how this

can be used for learning, and implied that many experiences can be constructed by utilising the environment’s ability to design realistic and unrealistic experiences.

Participant 10: “*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*”

Anonymity

The characteristic of anonymity of users within the environment, and its impact to participation was identified as advantage and a disadvantage.

It was identified that anonymity in the virtual world provides freedom from pressure and allow self-expression by preserving personal details and characteristics. Participants explained that the environment hid some characteristics that discourage participation through the anonymity offered by the avatar, and this allowed them to socialise and contribute more to the discussions. It was also established that remaining anonymous in the environment can enable students to be more expressive, can influence participation in learning activities, and may encourage quiet users to contribute to the discussions. Furthermore, it was pointed out that because the individual’s physical characteristics are protected in the environment, this could reduce judgment on appearance. Some participants also emphasised that anonymity can allow discussion of issues and sensitive matters that are difficult to discuss when face to face.

Participant 12: “*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.*”

However, it was also identified that anonymity in the environment can be misused due to the issue of not knowing who is behind the avatar, and implied that this might lead to inappropriate or hostile behaviours.

Participant 8: “*You can easily lie in virtual world... someone can take my avatar and pretend its me*”

Synchronicity

The characteristic of synchronous participation in online learning activities, and synchronicity in user interaction within the virtual world was also established. It was identified that this characteristic enables participation and synchronous interaction between peers, in which otherwise some students would not be able to because of barriers. It was identified that synchronous coexistence in the environment allows participation in online learning activities, and contributes to the development of the feeling of being together in the virtual world.

Participant 1: *“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, concerns regarding synchronicity in online learning were also identified. In particular, the issue of missing classes when synchronous participation is not an option was raised, stressing the need to follow the missed lesson on the students’ own time and pace.

Participant 14: *“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...”*

Lack of Human Interaction

The lack of the feeling of real human interaction in the virtual world was also pointed out during the discussions. Participants expressed that during the experience they were not able to see movement, facial expressions, and emotions of other users, and this caused some confusion. It was identified that the loss of facial expressions and emotions during the online experience is an important disadvantage of the virtual world.

Participant 8: *“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”*

4.3 Summary of the Ability of the Cyber Campus to Mitigate Barriers

During this study, many positive perceptions towards the ability of the cyber campus to

alleviate some barriers impeding access to education, and support participation in online learning activities were identified. Generally, the most frequently discussed attribute of the environment was the ability to offer access in education. It was identified that the ability to access immersive online learning activities in the cyber campus from anywhere, enables this tool to be an alternative solution to access learning when physical attendance is not an option (Table 4 – Quote 1). The environment’s ability to offer consistencies between educational experiences in real and virtual world was found capable to support participation in familiar and realistic learning activities when access to education is challenged (Table 4 – Quote 2). It was further identified that remote attendance through the cyber campus could help reducing some of the costs associated with traveling to the educational institution (Table 4 – Quote 3). Moreover, the use of a cyber campus can help to better manage family commitments and responsibilities in order to attend and participate in online learning activities (Table 4 – Quote 4). Also, the environment has the potentials to support female students, whom their learning experience is affected during pregnancy, allowing access and participation to education during the late stages and first few months after the pregnancy (Table 4 – Quote 5).

The ability to access information and meet with colleagues and tutors in the virtual world was established as very helpful for students experiencing work related difficulties impeding participation and regular attendance to classes (Table 4 – Quote 6). It was identified that a cyber campus could help managing time by enabling access learning from home; hence, students do not need to make special arrangements to attend classes. It also has the potentials to allow better preparation for the lesson, as this method saves time on travelling (Table 4 – Quote 7). The environment supports effective communication and synchronous participation in social learning activities, and this can improve the educational experience of online learners (Table 4 – Quote 8). Moreover, it was identified that participating in online learning activities through a cyber campus could

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alleviate some physical barriers that hinder transportation to institution and navigation around facilities for some students with mobility disabilities. The ability of the environment to provide access to social learning activities from remote locations might also save time and effort on preparation and transportation (Table 4 – Quote 9). Furthermore, it was found that the cyber campus can encourage participation in online learning activities by removing language barriers and shyness (Table 4 – Quote 10).

Table 4 – Virtual Focus Group Quotes

Quote 1 – Participant 2: <i>“Virtual worlds are a nice alternative to attending on campus lectures, [allowing to] collaborate with fellow students without losing the interaction and belonging [to the community] when access is difficult”</i>
Quote 2 – Participant 15: <i>“I see virtual worlds as a really good alternative of real life education. You can do lectures and seminars as you can do in a university... you are not participating physically, but the education is still there.”</i>
Quote 3 – Participant 16: <i>“I think that using a virtual world for learning can provide much cheaper education. Less expensive participation, no transportation and other associated expenses...”</i>
Quote 4 – Participant 12: <i>“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... you see the others, you make gestures, you can talk, you can express yourself...”</i>
Quote 5 – Participant 19: <i>“Being able to access education remotely when pregnant and participate in the activities in this way would have definitely helped me.”</i>
Quote 6 – Participant 1: <i>“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”</i>
Quote 7 – Participant 16: <i>“I can fit such style of education easy in my busy schedule. It is important that I don't have to travel to the institution as I am very busy with work and this can work quite well for me”</i>
Quote 8 – Participant 3: <i>“During this experience, I felt that I was somewhere familiar, [I could] sense people, I could navigate wherever I wanted... This could have really helped me on my distance course!!!”</i>
Quote 9 – Participant 14: <i>“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.”</i>
Quote 10 – Participant 12: <i>“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.”</i>

5. Discussion

One of the main aims of this investigation was to identify and understand the barriers hindering access and participation to education. Situational barriers were the most evident in the participants’ experiences. The identified situational barriers mainly included the cost of education, distance to the educational institution and associated costs, family commitments, work related responsibilities, time management, the individual’s physical condition, and health related issues. Examples of institutional barriers emerging through the educational institutions and their policies were also identified. These barriers concentrated around the physical design of institutions and their inability to accommodate students with disabilities, address students’ needs, lack and poor quality of services, and lack of available learning opportunities. The findings 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 findings contribute to understanding the source, nature and impact of these barriers to the students learning experience, and how these affect access and participation to education. The findings of this study confirm the existence of situational and institutional barriers, corroborating previous research [1, 5, 38-41]. Moreover, the findings imply that the Cross [1] situational and institutional barriers are still relevant in modern days.

The findings of this investigation also provide strong indications that *SHU3DED* has the potential to be an effective online learning tool to support students experiencing situational and institutional barriers accessing Higher Education. The environment evaluation results were very positive, and are consistent with previous studies where the same evaluation framework was used [3, 42]; implying that *SHU3DED* can be considered as an effective educational MUVE. The potential of the cyber campus to support students experiencing barriers accessing education was also analysed, and the identified environment’s characteristics

contributing to this are summarised in Table 5. The findings emphasise the ability of the cyber campus to offer access and participation to synchronous, immersive, and realistic online learning activities, characterised by high levels of presence, awareness of the existence of others, effective communication, social interaction and group cohesion.

The findings of this research imply that a cyber campus environment has the potentials to support students experiencing barriers hindering access to education. The findings argue that a cyber campus can be an alternative learning tool to consider when access to education is challenged. A cyber campus can help to alleviate and manage several situational and institutional barriers that affect students learning. Thus, a cyber campus can be considered for use by students who have to be absent from education for a period of time, cannot regularly attend, or experience similar challenging difficulties, impeding access and participation to education.

Table 5 – The Identified Characteristics that Contribute to the Students Online Learning Experience

Presence: The virtual world provides immersive experiences that 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 online 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.

6. Limitations and Future Work

One of the main limitations of this research is that the environment was evaluated through an artificially created learning experience, and this affects the ecological validity of the study. However, the activities were designed in ways that replicate realistic learning activities, to contribute to the quality of the study. The length of the conducted activities during the evaluation is also a limitation, together with the fact that the environment was evaluated through a single session. During this limited timespan, participants were offered a superficial experience of the environment mostly related to issues regarding the user interface and social experience than to online learning. Participants should have been investigated for longer periods to obtain data that is relevant for the factors that have been studied. Moreover, to better support the claims that a cyber campus can support students experiencing barriers hindering access to education, interviewed users should have been involved in activities carried out for more substantial periods of time. However, it was not feasible to hold participants for longer period, or regular participation. Due to this limitation, participants did not gain a complete online learning experience with the environment to properly comment on access and participation. Nevertheless, the length of activities can be considered appropriate to identify important environment features that support online learning activities, user preferences, and to collect opinions based on the ability of the cyber campus to support students and manage some of the barriers they encounter.

Another important limitation of this study concerns the small sample size involved. Thus, the findings cannot be generalised to the wider population. A larger sample would also allow conducting additional focus groups to achieve theoretical saturation. Also, data was collected from groups representing experiences of some barriers; therefore it is not appropriate to attempt drawing generalised conclusions for all barriers hindering access and participation in education. Nevertheless, the sample involved provided trustworthy and highly valid insights, revealing

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important insights of the impact of barriers in students learning experience, how a cyber campus can support participation in online learning activities, and help to manage some of those barriers. 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. Additionally, the conclusions are mostly based on participant's opinions, but it is arguable that more general conclusions may be drawn from those reflections. Furthermore, despite the fact that some negative perceptions about the environment were identified during the discussions (lack of human interaction, difficulties in chat communication, and issues of anonymity) there are others, for example technical issues [43], steep learning curve, usability issues [44-46], distractions [47] etc. that haven't been mentioned. The fact that only some disadvantages have been identified during this study could be a result of the participants knowing that they were observed and recorded, hence, expressing mainly positive perceptions towards the environment.

The use of virtual focus group to collect data also has some associated limitations. This method lacks real group dynamics, missing the important nonverbal input during discussions. In addition, qualitative research is a subjective approach that relies on the researcher's view of what is important, and is often criticised that it relies on the relationships established among groups during the data collection. In addition, data in qualitative research can be interpreted differently across moderators.

The work presented in this paper establishes a starting point for further investigation looking at how cyber campuses can be used to support online learning for students experiencing barriers hindering access to education. This 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, and extent the findings presented in this paper. Further work is on its way to identify

how to design and arrange cyber campus environments and relevant educational activities, to support students experiencing barriers impeding access to education.

7. Conclusion

Virtual worlds are not better or worse than other online learning environments but are different [48], offering unique characteristics that can be exploited for learning purposes with great success. The findings presented in this paper suggest that a cyber campus has the potentials to effectively support participation in online learning activities for students experiencing barriers hindering access to Higher Education. Based on the findings of this research, it can be argued that the unique characteristics of the environment can be exploited to enrich, enhance and make learning more engaging and enjoyable. But most importantly, these characteristics can allow students who cannot access education to participate in online learning activities. The findings of this research contribute into understanding the significance of a range of barriers and how these affect students learning experience. However, this research does not claim that all barriers accessing education can be mitigated through a cyber campus; it does not claim replacement of traditional teaching methods; or claim that virtual worlds better or worse than other online learning environments. This research argues that a cyber campus can be a useful tool to support online learning when access and participation to education is difficult or otherwise impossible.

Appendix A. Virtual Focus Groups 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 B. Post Experiment Questionnaire

Presence Questionnaire (PQ)	Factor
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 much did the visual aspects of the environment involve you?	SF
How natural was the mechanism that controlled movement through the environment?	CF
How compelling was your sense of objects moving through space?	SF
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 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 involved were you in the virtual environment experience?	
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
<i>Items marked with * were reverse coded.</i>	
Awareness Scale	
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 Scale	
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 Scale	
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
This virtual environment enables us to develop into a well performing team
This virtual environment enables me to develop good work relationships with my team mates
This virtual environment enables me to identify myself with the team.
I feel comfortable with this virtual environment
Environment Evaluation Scale (CVE)
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
This environment enabled me to learn
I am satisfied with the experience

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