An Online Virtual Learning Environment for Higher Education

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An Online Virtual Learning Environment for Higher Education

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Abstract— This paper describes a novel online virtual learning classroom like environment focused for higher education. Students can login to this virtual world in the form of their avatars and follow lecture classes and laboratories in a collaborative manner. To prove the feasibility of the system, the lecture materials from '3D Graphics Programming' module were ported into the online virtual learning environment. Initial evaluation with 20 users showed that overall the online virtual learning environment is enjoyable and has the potential to be used for the development of distance learning courses and degrees.

Keywords – serious games, virtual environments, computer graphics, education and learning.

I. INTRODUCTION

The use of virtual worlds has become very popular over the last years, and users have already been taking control over experiencing virtual worlds within social groups and environments. The control element makes using virtual worlds appealing and as such engages users. Recent studies indicate that there are more than 100 virtual world applications available [1], and more than 100 virtual worlds for children and young adults are now live or under development [2]. Classroom teaching with the use of games (i.e. game-based learning and serious games), is an area that higher education would like to engage with [3]. In 2008 alone, the serious games industry was worth US$1.5 billion, being described by some analysts as the next wave of technology-mediated learning [4], and online serious games are currently among the most successful type of computer game represented on the global market.

The migration of education from the real life to virtual is growing fast and with the technology playing a crucial role, the educational institutions are trying to make students participate in online virtual learning environments. The main advantage of these environments is the remote participation of learners of all ages from all around the world by providing: (a) easier access to higher education and at the same time (b) an online knowledge based centre. Obviously, the learner's behaviour will differ compared with teaching in the traditional manner. Learners in the form of active participants could learn from their own responses and make improvisation in their own direction.

Virtual environments also support a range of functionality that includes supporting social interactions, modelling real environments, document sharing and recording facilities that allow users to replay activities undertaken in-world [1]. According to recent research [5], the introduction of virtual environments into higher education has the potential to bring a positive change in the learning experience. However, not many of the institutions make use of this method of teaching [6] and some common issues include: *what is the best virtual environment*; *what is the level of realism and interaction required*; *how best to design activities and experiences for learners*.

The aim of this research is to address some of the above issues by designing a novel online virtual learning classroom like environment and experimentally delivering a 2nd year computer science undergraduate module. Students can login to the environment in the form of their avatars and learn remotely new things as well as interactively share their views and opinions with other students. To prove the feasibility of the system, the lecture materials from '3D Graphics Programming' module were ported into the online virtual environment. Initial evaluation with 20 users showed that overall the online virtual learning environment is enjoyable and has the potential to be used for the development of distance learning courses and degrees.

The rest of the paper is structured as follows. Section II provides a brief overview of similar systems. Section III presents how our online virtual learning environment was designed. Section IV describes the overall functionality of the virtual environment whereas section V demonstrates how teaching can be performed. Finally, section VI illustrates initial evaluation results and section VII presents conclusions and future work.

II. BACKGROUND

The main issues involved and technologies used in online virtual environments have been documented in a recent white paper [1]. The main strengths of virtual worlds could be generalised as being in the areas of communication, visual expression of information, collaboration mechanisms, interactivity and entertainment [7]. As a result, virtual worlds have the potential of offering new capabilities for users to enhance and promote educational and learning in a

number of potential scenarios such as higher education. Some of the most characteristic examples of virtual worlds include Second Life [8], Active Worlds [9], OpenSimulator [10] and the OLIVE platform [11].

Second Life is a cross platform application powered by proprietary new technologies, creating a robust and endlessly modifiable platform for entertainment, business, communication and creativity (Linden Research 2008). All content including objects, textures, audio, video and motion is streamed to the users in real-time. The capability of streaming positional voice creates a rich audio landscape that conveys distance and direction. The Second Life Grid uses industry-standard cross-platform technologies, including: OpenGL, UDP networking, Linux servers and Ogg-Vorbis compression for audio and supports multiple communication channels, international languages, and 3D proximity-based spatial awareness [8].

Active Worlds offers an online comprehensive platform for efficiently delivering real-time interactive 3D content over the web. For consumers, Active Worlds hosts a Universe of over 1000 3D virtual reality worlds where users can choose from a vast array of avatars that fit their personality. The browser has web browsing capabilities, voice chat, and basic instant messaging in real-time. Similar to Second Life, users can use move about, play online games, shop and make friends with people from all over the globe. It is also possible to stake claim to a piece of land and build virtual homes, mansions, estates or castles [11].

On-Line Interactive Virtual Environment (OLIVE) is a software platform that allows customers, partners, and developers to create persistent virtual worlds where users can collaborate over networks to communicate, train, rehearse, analyse, experiment, socialise, and entertain (Forterra Systems Inc. 2008). OLIVE employs a client-server architecture where PC clients are connected to a central server via a network. The architecture ranges from single user applications in one physical location to large scale, simulated environments supporting many thousands of concurrent as well as geographically distributed users [11].

It is worth-mentioning that there are also custom online virtual gaming platforms originating mainly from Universities and research institutes. As a result, a number of experimental systems have been prototyped, but also custom online virtual gaming platforms originating mainly from Universities and research institutes exist [7]. An early example is an engineering educational online virtual and augmented reality (AR) enviroment that allows users to interact with 3D Web content (Web3D) using natural interaction techniques [12]. In this approach the lecturer's traditional delivery is enriched by displaying multimedia content locally or over the Internet, as well as in a tabletop AR environment. The prototype implementation of this framework was composed in an XML data repository, an XML-based communications server, and an XML-based client visualisation application.

The aspects of integration and automatic deployment of educational games in Learning Management Systems (LMS) was also investigated [13]. Their approach is based on the automatic packaging and exportation of games as self-contained learning objects that can be easily distributed through any LMS compliant with the current interoperability standards. The considerations and methodologies to achieve adequate privacy of training sessions in 3D virtual classrooms in Second Life Grid (SLG) and OpenSimulator were recorded by [14]. The study found that a SLG or OpenSimulator installation in a private network is needed for that level of privacy to avoid privacy issues between members of different training groups using a single server.

Apart from the provision of educational content, some serious games try to improve the student's learning experience through the provision of realistic virtual tutors that they can interact with in a similar manner to a human lecturer. These autonomous intelligent tutoring systems allow students to learn at a pace that they have set themselves by adjusting their virtual teaching strategies to the needs of the students [15]. Virtual tutors in such serious games often resemble the human tutors' avatars that can be found in virtual multi-user learning environments, employing additional techniques from the domains of conversational user interfaces and interactive digital storytelling [16].

III. Designing The Environment

The design stage is crucial for the accurate specification of the online virtual learning environment. OpenSimulator was selected as the online virtual learning platform, because it is an open source cross platform and multi-user 3D application server. Another advantage of OpenSimulator is that it can be used to create dynamic virtual environments which can be accessed through a variety of clients on multiple protocols. Moreover, it allows the designer/developer to customize and extent rapidly the online virtual environment [10].

Each object built in OpenSimulator generates an XML file (located in the bin folder of the system) which can be imported/exported from the machine and can be executed on the visualisation client, called the Viewer (Hippo Viewer). Then it is turned into computer graphic and added to the real-time simulation. It also supports different database systems depending upon data in the standalone or the grid modes. In particular, SQLite is a lightweight database that does not require any additional configurations (this is the quick mode database and not used for the production usage). MySQL is fully supported for the small standalone mode whereas MSSQL database is partially supported and has limited functionality.

The overall functionality of our online virtual learning environment is represented in terms of a UML case diagram which models the overall functionality of the system (Figure 1).

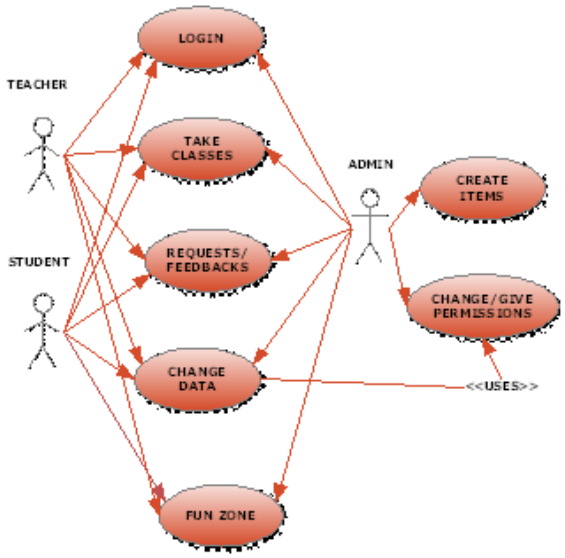

Figure 1 Use case diagram for the virtual learning environment

Figure 1, illustrates three Actors including the 'Teacher', 'Student' and the 'Admin' (Administrator) which triggers the functionality of the system. The user in this scenario would be either 'Student(s)' or Teacher', having specific privileges assigned to them by the 'Admin'. At the basic level where all the users can use them irrespectively of the privileges which include 'Login', 'Take Classes', 'Requests/Feedbacks', 'Change Data' and 'Fun Zone'. The use case 'Change Data' is functionally depended on the use case 'Change/Give Permissions' from the 'Admin' side. The 'Admin' has to give proper privileges depending upon their role (either student or staff) and can upload teaching material or modify them.

Figure 2, illustrates dataflow diagram between the 'Students' and the system as well as the 'Admin' and the system. Students can initiate the process (using the 'Login' button) and that generates the process with the appropriate login credentials. This allows for the automatic setting of the appropriate permissions.

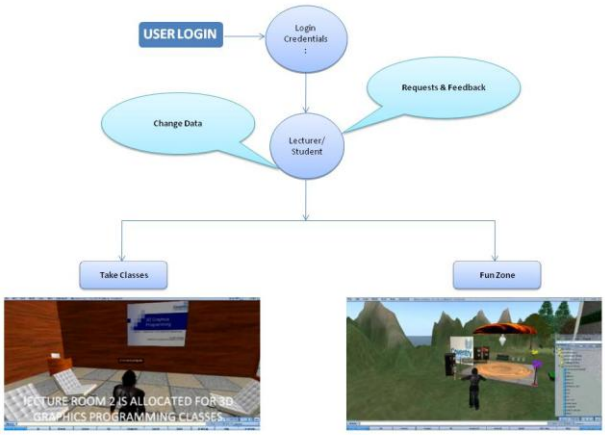

Figure 2 Data-Flow diagram between the User-System

Figure 2, also illustrates how students can get access to all the activities in the virtual learning environment ranging from *taking classes*, *request some kind of materials or information*, *receive feedback from the lecturer* etc. The staff (Lecturer/Teaching Assistants) can post new teaching materials in the virtual lecture room and have appropriate permissions on that with the group monitored by the administrator. The 'Fun Zone' area refers to the other activities which the students can perform in their free time. Some examples that have been implemented include: listen to music and dance as well as network with other students.

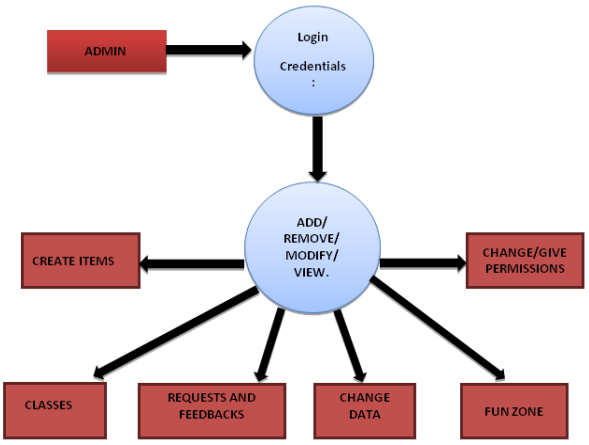

Figure 3 Data-Flow diagram for the 'Admin'

Next, Figure 3 illustrates how the 'Admin' gets access to the system resources and initiates the process by logging to the system with the credentials. The 'Admin' has the options to 'Modify' or 'View' the data (lecture material). This is connected to a number of processes including: *change the permissions*, *build items in the world*, *serve student requests*, *getting on to the fun zone*, and *recording feedback*.

IV. Online Virtual Learning Environment

The region name in OpenSimulator can be any character or group of characters and number. The region name for our virtual learning environment was specified as 'vikramcoventryas'. In the present scenario, the coordinates (10005, 10055) was chosen for the setup of the online virtual environment (see: http://www.osgrid.org/elgg/pg/utilities/opencoordinates). The Internal Port is chosen as 9000 as per the OSgrid standards after the InternalAddress. An indication of where the virtual learning environment is located in the virtual map can be shown in Figure 4.

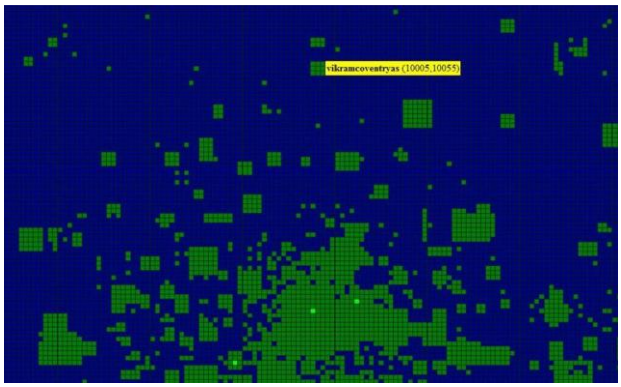

Figure 4 The region 'vikramcoventryas' in the OSgrid Map

The three-dimensional modelling of the teaching environment is based on 'Armstrong Siddeley' building at the Faculty of Engineering and Computing at Coventry University, UK. The exterior appearance of 'Virtual Armstrong Siddeley' was modelled so that it 'looks' similar to the real building (Figure 5).

Figure 5 Coventry University's virtual representation (a, top) real 'Armstrong Siddeley' building, (b, bottom) virtual 'Armstrong Siddeley' building

Students can be teleported to 'Virtual Armstrong Siddeley' and then navigate around the environment. It is worth-mentioning here that the 'Fun Zone' is built just outside the building and allows students to experience an entertaining experience while studing (Figure 6).

Figure 6 Virtual fun zone for students

On the other hand, the interior has been modelled based on a futuristic approach providing a more gaming environment appearance. This was done on purpose to provide students a more 'familiar' and 'entertainment' environment. The main virtual rooms that have been designed include: *lecture theatres*, *computer laboratories*, *staff rooms*, *open access rooms* (for students) and *staff rooms* (for lecturers/teaching assistants).

V. ONLINE TEACHING

The success of virtual environments in educational scenarios is based on the combination of audio-visual media content that is prevalent in these applications and enhances the absorption of information in the learner's memory [17], [18]. Recent research found this to considerably improve the process of learning [19]. The problem of delivering online learning is closely related to the integration of online games with other learning contents (traditional materials or other educational games) in bigger courses [13].

As a case study, a 2nd year computer science undergraduate module has been ported into our online virtual learning environment. The module is called '3D Graphics Programming' and introduces 3D computer games graphic programming fundamentals to the students. The theoretical part covers issues such as textures, global illumination and the simulation of physical phenomena. The module emphasises on the programming aspects of computer graphics, especially the efficient use of advanced Application Programming Interface (API) features.

The proposed system allows students to use the virtual facilities like the lecture rooms where '3D Graphics Programming' sessions are carried out. Students can get online help from different types of online virtual tutorials. In particular, students can have tutorials and classes on '3D Graphics Programming', and 'Learning C# Programming Language' similarly to a laboratory environment. Figure 7, illustrates how the virtual classroom environment looks like. A virtual blackboard is used to present the lectures slides that are delivered. Students can interact with the lecture material by clicking on them using the mouse (or any other input device). This will direct them to relevant tutorials on the Web (i.e. a YouTube video, graphics tutorials, etc).

Figure 7 Online virtual classroom

Figure 7, shows how the classroom is been deployed in the virtual learning environment. Students can click on the prims to get the options and that would trigger an action: *either playing the slide show* or *opening a hyperlink that would connect to the World Wide Web and open up the tutorials online*.

Moreover, there are dedicated rooms like Lab and Open access rooms for the students to utilise the resources provided to them (i.e. browse over the internet). A staff room is also allocated for the students who want to get things clarified further and they can approach the Lecturer in order to have a one-to-one discussion. It is worth-mentioning that the lecturer is responsible for allocating time for students.

VI. Initial Evaluation

To acquire feedback on the prototype application, a two-stage evaluation with 20 participants was performed and qualitative and quantitative feedback was recorded. The participants ranged from students to business professionals. All of the end-users had some experience with computer games, console games or online virtual environments. The evaluation lasted for approximately 1 hour per participant and the recorded feedback is presented in the following sub-sections.

A. *Qualitative Evaluation*

The intention of the qualitative evaluation was to gather information on the enjoyability and remote learning capabilities of the online virtual teaching environment, but also to discover potential technical problems. Feedback has been collected through live chat using both audio and video conferencing.

On the positive side, most participants noted that the platform is quite enjoyable and has a lot of potential for remote learning. One user mentioned that "I have a gut feeling that this is the future of learning and it would be a big boom in the technology market" and another one "Sounds like new learning curve". It was also recorded that there are extra capabilities for learning. One mentioned "That's a really nice system can learn new things around and do things which we cannot do it the reality". In addition users commented positive on the idea of remote learning. One mentioned that "Well developed, as I working full time and come back home around in the evening. So I can sit back relax and learn things staying back at my home comfortably" and another one "Great, shouldn't have to sit in the classroom physically all day".

Moreover, users liked the idea of having 'fun zones' close to the virtual classes. One mentioned that "Awesome work as I can learn do other things like enjoy music dance around interact with people more like in social networking share ideas and views and interestingly I can do e-commerce as well that's even better idea". Finally, one user preferred the combination of traditional methods with the proposed platform by stating that "Fascinating concept as I can learn things at my own pace, other than rushing all together in the traditional classes".

On the negative side, some participants did not like the idea of spending some time to familiarise with the platform. One mentioned that "I don't have time to use it" and another one "No time to get into the virtual world as busy with School". Only two users stated were unsatisfied with the learning platform and this was very encouraging. One stated that "I can learn things in the classroom rather than Virtually, bad idea would not work for me" and another one that "But I don't think it's any different from online learning classes, have all the features in them. So what's the use of virtual learning?". Some other issues that were mentioned include "Should get more people to login to the system so that I don't feel left alone" and "Only want to use the Virtual world for education and no other means".

B. *Quantitative Evaluation*

The first question concerned the evaluation of the virtual learning experience as a whole. Participants gave a very good response and they really liked the idea of learning things in the Virtual World (Figure 8).

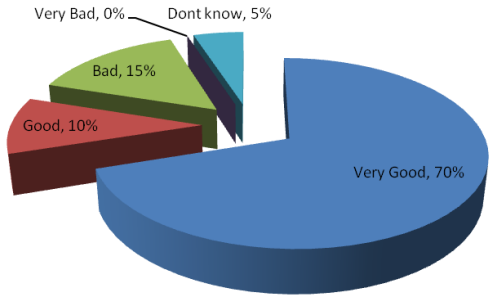

Figure 8 Virtual learning experience

It can be clearly incurred that the idea of Virtual learning has shown great curiosity among the individuals of all ages and 70% of then agree with the idea of learning things virtually in a classroom like environment and they think that the idea of learning things would be fun filled and different than traditional ways of classroom learning. The 10% individuals reported that the idea is 'good' but need an interactive teacher as well. The next type of the individuals who think the whole idea is 'bad' and confusing and they account for 15% of

the total. While rest of the users have responded as don't know as how far it is going to help the users and would that be useful in the real world?. These questions would be answered and resolve by the questions followed.

The next question concerned the distance learning experience of the users for interactive learning in higher education (Figure 9). Here participants have been asked this question to check and see how the Virtual Learning Environment would help them to learn things by staying at their home. They have the advantage that they can login to the system at any time and start following the module. They can also interact with their fellow students and the staff.

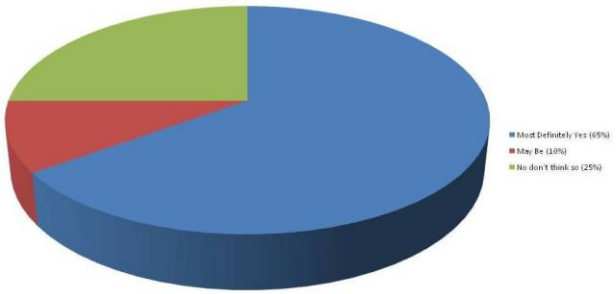

Figure 9 Distance learning experience

The responses in this aspect indicate that the 65% of the users from the survey think that it would be at easy of learning by staying at home and learning things virtually in the classroom like environment and the best part for them being is like they can finish the tasks at a given time and can come with innovative ideas of the concepts taught in the classroom. Users have come up with responses saying that learning certain sections and taking a break and then resuming with the learning also helps to succeed. There were few participants (25% of the total sample) that were unsure of the whole concept. Their main worry was that how potential queries can be answered in more detail. However, they have the option of arranging a one-to-one virtual meeting with the lecturer at his office. The rest 10% of the users responded that they don't have time to go through the process and thus prefer the traditional methods.

Moreover, participants were asked to comment on the effectiveness of the combination of audio-visual media. During a teaching session they have the option of navigating into webpages/blogs, streaming videos online, and activating executable demo applications. In this question participants have been mentioned and their reactions have been noted with the level of interactivity in the virtual worlds and hence their responses have been noted in the form of column graph as illustrated in Figure 10.

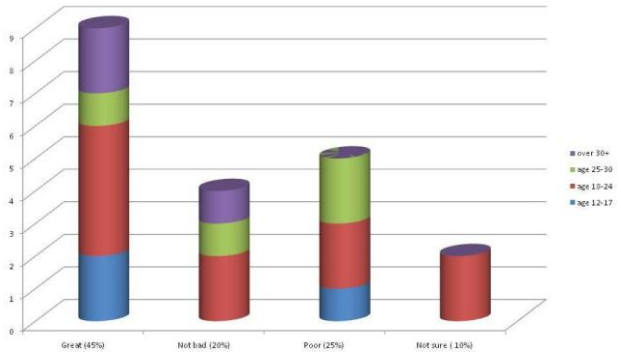

Figure 10 Effectiveness of the audio-visual media

The survey shows that the younger generation is much more interested in learning via a virtual learning environment for higher education. The 45% of the individuals of all ages combined think that the whole idea is really good and every age group has their own ideas of agreeing. As the younger users (ranging from 12 to 24 years old) reported that they can learn things from their home and learn at their own pace. Users in the age group of 25+ mentioned that they like the idea since they can learn things at their own time and pace.

Moreover, 20% of the users think that the whole idea is not bad and come up with certain dilemma that how user friendly is the virtual environment? Is it not time consuming process? The 20% of the individuals think that the idea is useless for them as they would not have time to login as they would be busy from their university or college and jobs. And the last 10% would think that as they don't have proper resources and slow internet connections so they are unsure how it really works.

The following question asked participants what other activities would be preferable beside education in the virtual world. This question aims to discover what elements would make things more interesting for them and keep the idea of opening the doors towards new type of education.

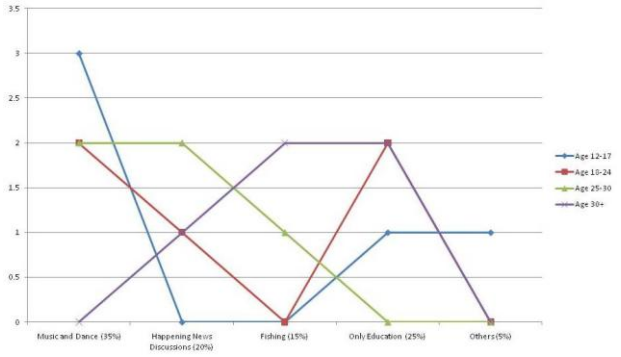

Figure 11 Other virtual activities

Figure 11 illustrates how the different age groups have shown interests in different aspects to do with the virtual learning environment. The individuals who were interested in music and the dance show a 35% among all the age groups and the age group 30+ has no interest in it. Now coming to the Happening News Discussion it

would show a trend of 20% of the overall individuals in which age group 12-17 has no interest in them and 25-30 being the highest among the interest shown. Fishing has covered up to 15% individuals and that too from the people aged 25+ as they say that would help them relax and come from tedious educational routines. Some individuals specifically want to use the virtual world just for education and not more than that as they say it would be complicated to use other things other than education. The final question asked the individuals how they feel about the over idea and whether they would they be interested in recommending others about learning in the particular virtual environment.

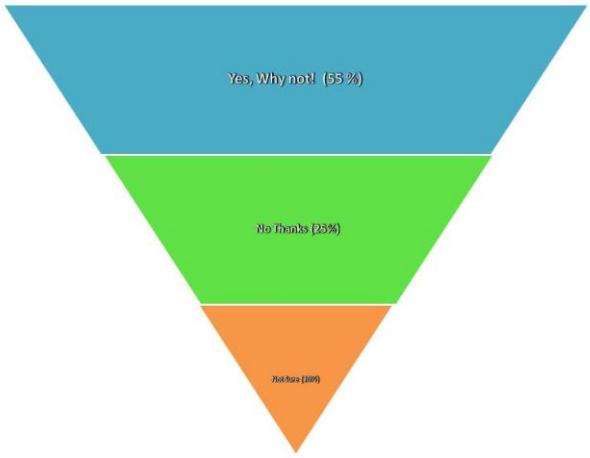

Figure 12 Recomending the online virtual learning environment

As illustrated from Figure 12, opinions of the individuals vary from person to person. About 20% mantioned that they are not sure if they would recommend it to others as they have not used them personally and also not sure if the learning virtually would be of any help. Next, 25% of the participants noted that they were not interested in the whole idea at all and they feel that the concept is really confusing to them and cannot follow the technology that far and would rather prefer the traditional ways of teaching methods. The ideas that would open the doors to the project would be the rest as well as majority of individuals supporting and would be interested in recommending to others would be 45%. They feel that the whole idea is interesting and open up new grounds for the learners and the teachers. The above reactions would clearly suggest that there is need for a change and 'We believe in change' type of reactions were received. So this would trigger in development of such prototype for the world which is moving at a fast pace and where the technology is growing enormously and changing rapidly.

VII. Conclusions and Future Work

As the technology advanced rapidly, the way users learn things is changing from the traditional blackboard to the projector enabled class rooms and e-learning over the internet. This paper is taking a step forward and indeed taking the technology to the next levels, introducing the concept where in the people can learn electronically in a classroom like environment created in virtual world, hence breaking the barriers across the world. As a case-study, the lecture material from a computer graphics course called '3D Graphics Programming' was ported into the environment.

Initial results with 20 users showed that overall the online virtual learning environment is enjoyable and has the potential to be used for the development of distance learning courses and degrees. Overall, the majority of the participants liked the concept and would like to see that applied in practice. Only two users were very negative and stated clearly that they prefer the traditional methods of teaching. The marriage of online virtual learning environments with higher education could result in better student engagement and possibly more effective learning. Those who are disinterested in traditional learning practices would engage and set things right for themselves and more importantly boost up their confidence levels.

In the future, more functionality will be included to the environment allowing users to interact more effectively with the teaching material as well as the environment. In particular, a number of different virtual buildings will be implemented, replicating the structure of the University. Moreover, more computer science modules will be ported into the system starting with another 2nd year module called "Physics for Computer Graphics". Finally, a large scale evaluation study will be performed online to assess better the learning effectiveness of the online virtual learning environment.

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Four YouTube videos that illustrate the online virtual learning environment in action can be found at:

- http://www.youtube.com/watch?v=rZ5vzsNugVQ&feature=mfu_in_order&playnext=1&videos=_6TNubnT0To
- http://www.youtube.com/watch?v=HI7nrORinrg&feature=mfu_in_order&list=UL
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