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Virtual Worlds. Opportunities and Challenges in the 21st Century

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Abstract

This paper offers a broad vision of the potential benefits which virtual worlds may provide for improving learning, collaboration, motivation and therefore, the improvement in academic performance of students. The paper underlines how virtual worlds may offer new experimental platforms through new interactions perceiving the changeable nature of technology. The article is based on the results of the experience developed in the mainframe of the educational innovation project performed at La Laguna University during the 2012-2013 academic courses. The technological infrastructure has been created already and the 3D graphic modelling was designed using open source software aiming for creation of the 'La Laguna Virtual University' virtual world. Teachers have given ubiquitous classes in this virtual environment interacting with students. All feedback from teachers and students has already been gathered in this experience.

Keywords: Virtual worlds; On-line teaching; Engineering education; Computer Aided Design.

1. Introduction

Most definitions about the virtual world state that it is a computer-based environment for large numbers of users. Castronova, defines virtual worlds as "crafted places inside computers that are designed to accommodate

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large numbers of people" [1]. Following this statement, Bell pointed out that a chat room or a shared document would be also be a virtual world [2]. Because of this reason some authors have underlined that a virtual world should be based on a virtual reality environment, that is "a high-end user computer interface which involves real time simulation and interactions through multiple sensorial channels"[3].

Besides, some authors [4], [5] have emphasised that virtual world environments should be persistent, i.e. they should continue to exist and keep working even after the users have left. Koster defines a virtual world as "a spatially based depiction of a persistent virtual environment, which can be experienced by numerous participants at once, who are represented within that space by avatars" [4]. The definition provided by Koster also points to another requirement for the existence of virtual worlds, namely the avatar, without which "a virtual world would be an empty data warehouse" [2]. According to some authors the term "avatar" originated from the Hindu philosophical term avatāra, meaning "incarnation" or "appearance" and "manifestation" [6], [7]. In the context of virtual worlds, the term "avatar" refers to the digital (graphical) representation of the user within the virtual world. The avatar is thereby more than just a simple label or name. It has agency (an ability to perform actions)" and "is controlled solely by a human agent in real time" [2]. Thus, virtual worlds are distinguished from social network sites such as Facebook and Myspace, which, despite having a persistent environment, do not provide an avatar for their users.

Therefore, as a more complete definition, a virtual world is defined as a persistent computer-simulated environment allowing large number of users, who are represented by avatars interacting in real-time with each other at the simulated environment.

The existing virtual worlds on the Internet are quickly becoming into Internet-mediated 'spaces', where groups of people gather and interact in real time while they experience a shared sensation of being together in this virtual space. These spaces allow ubiquitous interaction and collaboration in a far more enriching way than other collaborative environments based on traditional ICTs (Web 1.0 and platforms 2.0, websites, wikis, blogs or even social networks). These kinds of environments or virtual worlds are promising having in mind the benefits provided to fields such as education, training, entertaining, social networks, e-commerce, investigation, teleworking, teleconferences and public sector information [8], [9], [10].

Education and training are the two most promising application fields for the virtual worlds. Actually, there are more than 150 universities present at the Second Life virtual world although there are many educational centres that opted for developing their own virtual world including private access to their students. There are several factors which have brought forward to universities and educational institutions to adopt this kind of environments: both face-to-face and group interaction between students and educators around the world, access to wide resources and knowledge, voice communication as well as examination of abstract and complex models through 3D visualisation or projections of visual information. Besides, virtual worlds provide realistic and interactive role-playing simulations for training situations.

The virtual worlds allow researchers, businesses and users to collaborate in the development of new products and services. A successful case of R&D which got benefit from the use of virtual worlds was the development of the Toyota Scion prototype as it allowed the 3D visualization, visual information projection and close interaction between all participants. This project from Toyota International Corporation used Second Life to create this prototype through discussion, evaluation, modification and development of this model carried out by users through their own avatars.

1.1. Changes in teaching and academic institutions.

Technological advance and innovation have greatly altered both what is taught and how educators teach. In order to be ahead of the new trends, all universities will have to rethink where, what, when and how students learn. The changes of **how** students learn is essential and it's even encouraged by the ESHE. The teaching model focused on the teacher who delivers information to a classroom of students is abandoned. Teachers must

evolve to a more pluralistic and entrepreneurial approach to learning, where students take a much more active and independent role. We should rethink if what our students learn is based on paper-and-pencil, chalk, blackboard, power point presentation or any other method without any interaction. Digital technologies not only change **what** students *should* learn, but what students *can* learn. Topics and experiences can be explored using digital technologies. Without any doubt all digital information available would have been far too difficult to compile through textbooks, blackboards, and chalk. Besides, digital technologies allow learners to explore many more domains of knowledge in greater depth. As the amount of easily accessible information grows at an astounding rate, institutions will have to focus less on spreading information and more on teaching students how to access necessary information. **Where and when** people learn, educators must recognize that schools "…are just part of a broader learning ecosystem. In the digital age, learning can and must become a daylong and lifelong experience" [11].

Learning is an activity where location is less important as it doesn't rely on a physical space. The ICTs allow the connection and real time interaction among people. The educational institutions should aim to improve learning opportunities not only in schools, but also in homes, community centres, museums, and workplaces.

Moreover, we can considered that adoption of virtual worlds brings environmental opportunities resulting from their ability to replace both travelling and commuting, since people can meet in virtual worlds and still experience the feeling of 'being there'.

The conferences, congresses and meetings can be held at virtual worlds meaning substantial savings on time and travel expenses as well as a lower environmental impact on society. Virtual worlds also provide opportunities for the public sector to enhance its e-government services and public sector information. They would increase citizen participation among Internet users indeed while providing public sector information through a better interactive media. So, even when virtual worlds are not subject to analysis in this article, they may become an ally in the fights against climatic change while encouraging environmental growth awareness. The Organization for Economic Co-operation and Development [12] outlines the main fields of application for virtual worlds which appear to be the most promising based on available data and use cases analysed.

2. Opportunities and challenges for education using virtual worlds

Virtual worlds offer a chance for the faculty to move forward from a teacher-centered to a learned-centered model of instruction. They also become an excellent opportunity for educators to implement learner-centered pedagogies which promote active, constructivist, and inquiry or problem-based pedagogies. The students take an active role being constantly involved in the learning process through their experiences. Virtual worlds offer an opportunity for people to interact in a way that conveys a sense of presence lacking in other media [13].

Some learning activities are hard to perform in a real environment because of high expenses, lack of infrastructure availability or dangerous performance. In virtual worlds it's possible to perform simulations and activities of any kind, avoiding the learning barriers [14].

The Polytechnic University at Madrid has developed several virtual worlds about practice laboratories [14]. The aim is that student is able to perform any laboratory practice, be it from electronic systems, materials, biotechnology, chemistry, etc without needing to attend the real laboratory after all. Besides, there is also the chance that some equipment or infrastructure available through virtual labs is not available at the real facilities located in university. The student finds no issues for performing the practices because he completes them just like in a real environment. In the electronic lab's case (e-Lab3D), the virtual world allows both control and configuration of instruments and electronic circuit plaques in a real way which is not simulated indeed. The student can sit in his work post through his avatar and open doors of closets and drawers while gathering the needed tools for performing those practices.

Active participation or "learning by doing" is a model favoured by both students and many educators. Virtual worlds provide a means of creating models of this nature. "Virtual worlds and authentic learning

activities foster unintentional learning, where students discover and create knowledge not for its own sake but in order to accomplish something they want to do, resulting in stronger comprehension and deeper knowledge" [15].

A relevant aspect for creating knowledge is collaborative work. The virtual environments allow that several students can communicate among themselves collaborating on the same issue while interacting for discussing the strategies or sharing the experience. In these environments they will use websites, discussion boards, blogs and wikis [16].

Actually the virtual worlds ease the collaboration by providing means of communication which are more similar thank other popular technologies such as email, blogs and wikis. The virtual worlds are capable of integrating new functionalities and technologies (videoconferences, augmented reality, etc.). For example, a videoconference held between the same participants in real time allows not only speaking to the avatars but viewing the real person if there is a webcam available. It's also possible to project presentations, share desktops or enable streaming from any event. In this field, Avayalive Engage includes the latest technologies available. [17]. The common trends about integrated outputs in virtual worlds allow sharing your desktop, showing a presentation, adding files to a drop box, working at white boards, post and stream recorded video or project live video onto the video wall.

Virtual worlds provide an environment where educators can prepare learners for "the increasingly complex and interconnected global society in which they live and work" [18]. For becoming a virtual world's user, the student must consider adopting changes as virtual worlds require powerful computer equipments and a broad band internet connection. Sometimes this equipment is not available for students at their homes and sometimes they are also missing from classrooms or computer labs lacking the minimum or recommended specification for optimal use of virtual worlds.

Teaching in virtual worlds also presents a list of challenges. Creating classes in a virtual world requires skills that most educators don't have. The development time for courses is far beyond what is 'normally' required. For certain courses that have very specific learning objectives, the effort involved in designing a virtual environment is not justified [15].

Cost is another issue which must be faced. It's true that some open source software allows the creation of certain virtual worlds through apps such as Open Sim, Open Wonderland and realXtend. One of the most powerful virtual worlds with higher graphic quality tested by the authors of this work is AvayaLive™ Engage which provides a cloud based immersive space great for training, collaboration, or sales. AvayaLive Engage connects participants from around the globe in collaboration sessions featuring 3D visuals, video and spatial audio. Multiple, free-flowing discussions can take place simultaneously, and participants can have access to all materials related to the session so they can take full advantage of them.

Fig. 1. (a) Scenario and presentation on panel; (b) Scenario and comunication by WebConference on panel

3. Educational considerations

Virtual worlds are online virtual communities which allow the simulation of an artificial world inspired on reality where is possible to interact with other users through avatars as well as use of objects or virtual elements.

Virtual worlds are a kind of metaverse [19]. The main characteristics of metaverses are interactivity, corporeal nature and persistence. The virtual worlds are used by accessing to an online community, where an avatar can be customized by users for taking part on the online community. Besides, virtual worlds include other functionalities such as communication with other users through online chat.

Virtual worlds are mainly oriented towards entertainment; however their use with teaching aims is more frequent every time. The virtual worlds with specific learning aims are known as MMOLE (Massively Multilearner Online Learning Environments). Some of the outstanding strengths of virtual worlds inside the teaching environment are oriented towards the simulation possibilities these can provide. The virtual classrooms become an extended use platform at formative processes; however they don't allow the reproduction of simulations in artificial environments. Virtual worlds allow development of simulation activities which otherwise would be impossible to carry out due to its expense or location. Some examples are programming activities and design of objects.

The simulation environments are useful as a complement to virtual classrooms through e-learning, improving the involvement rate and the group link through socialization in the virtual environment. Taking part in virtual worlds stimulates active participation, minimizing difficulties of public intervention in front of a fairly large audience. Besides, it provides simplicity to those requiring LSSN support (Learning support specific needs). However, there are still some limitations in the teaching use of virtual worlds. Face-to-face interaction is irreplaceable as non verbal communication cannot be perceived.

4. Technical equipment

The following equipment has been used with the following characteristics:
- Processor: Intel Core i5 2.8+ Ghz
- Memory: 16 GB RAM
- Hard drive: 2 TB SATA2
- OS: Linux Debian 7.0 Wheezy (64 bits)

4.1. Server software

OpenSimulator (http://opensimulator.org/) is multiplatform open source software which allows interaction between several users in a 3D virtual world.

We have used setting from Open VCE (http://openvce.net/), including several buildings including an outstanding main hall where the classes were taught.

4.2. Client software

Client software is needed for accessing the server hosting the user's interaction in the virtual world. The software is called Cool VL Viewer downloadable from http://sldev.free.fr/ at the 'downloads' tab. This software is multiplatform.

As support to the teaching action performed, a screen was created in the virtual world where a live Google's Hangout was projected. This way, the students could follow the teacher's explanations about use of technical software

5. Experience

During the 2012-2013 academic course, an innovation project was held at the La Laguna University: 'Online Teaching using virtual worlds: opportunities and challenges'. This project aims for the creation of a virtual environment based on virtual worlds where students are able to learn online. Some of the lines of action from this kind of projects rely on innovating e-learning teaching methodologies as well as development of strategies for encouraging student's continuous work following the model of qualifications frameworks in the European Higher Education Area where the teaching is based on development of competences. The measure unit of this study (*European Credit Transfer System,* ECTS) performs an assessment on the time spent by the students for developing that competences.

This educative innovation's project was completed developing online teaching experiences in the second four-month period of the Computer Graphics Design subject during its first course where the student's ages rank between 18 and 20 years old.

One of the basic competences of Computer Graphics Design is the spatial visualization ability and knowledge of the graphic sketching techniques through both traditional metric and descriptive geometry as well as computer design apps. For achieving the development of this competence with our innovation project, the 3D modelling training with Autocad software was streamed by videoconference at the virtual world described at previous section.

The videoconference was streamed using Webconference by Hangouts Gmail–based La Laguna University institutional account so students were able to visualize the Autocad program use as well as the teacher's explanations. The class could be taught combining these tools without needing physical presence in a classroom as teachers and students attended the virtual room. Each participant has the chance to setup an avatar which will represent him in the virtual world.

The experience allows the participant's ubiquity during learning (home, library, cybercafé, etc). This platform allows spoken or written communication between present avatars. During launch, two sessions were held aiming for restricted access so two groups took part in the experience. The first group was composed by 15 students, who attended the first session meanwhile the second included 15 students who attended the last session. Two weeks before streaming the live master class, the students received instructions for downloading the Cool VL Viewer and they were provided with a personal access code as well. They were explained about the platform's basics as well as some directions on avatar's setup. In the virtual world 'La Laguna Virtual University', the students have the freedom for creating his avatar which makes attendance to any class far more attractive and motivating. Several days before the experience, the students were invited to access La Laguna Virtual University. This way, the student got used to the environment while interacting with other fellow students present at the virtual world. They also were instructed to access the platform fifteen minutes before the class so explanations could be held at the scheduled time.

Once streaming starts (Fig. 2), the teachers provides the students with instructions asking them to mute the microphones for avoiding their audio input during the teacher's explanations and also tell them to use the chat for asking any doubt which may arise, so teacher can repeat the given explanation.

Fig 2. The students began to access the platform.

Once explanations are over, the questions round will start as student are able to use audio again. At the virtual building's hall where the class is held there is also a screen where students are able to watch the video conference taught by the teacher. In this screen, the teacher will share his computer's desktop so any student present at the virtual world may see it. The teacher explains the Autocad concepts which allow generating 3D figures. The icons on the toolbars 'view', 'view options' and 'orbit' as well as 'modelling' (such as extrusion, push, pull, join, difference and intersection) are also explained. On figure 3 a teacher explanation's snapshot can be seen.

Fig. 3. Visualization of Autocad 3D figures' development.

It should also be underlined that in previous weeks, the students have received Autocad two dimensions classes already so they are used to the program's environment indeed.

Once the explanation about the generation of 3D figures through Autocad is over and some examples of 3D element's creation have been completed already, the teacher answered to student's queries. On the second session, the procedure is pretty much the same.

6. Student's satisfaction

The student's have stated feeling comfortable with the virtual environment. They consider the setting is nice, comfortable, spacious and suitable for learning. They regard availability of the screen integrated on the virtual setting where the teacher's support desktop is projected is correct due to the high sensation of immersion on the scenario.

This setting allows students to abstract from their real environments and chat to other students or listen to teacher's explanation through the virtual environment featured on their computer's screen. This communication method allows collaborative work and as well as work meetings.

The students also consider that contents taught in this experience through the virtual world are suitable so they wish to receive more teaching through this system. Their benefits are not just motivational but also time-saving as learning doesn't require physical attendance at the real classroom.

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