THREE-DIMENSIONAL COLLABORATIVE VIRTUAL ENVIRONMENTS TO ENHANCE LEARNING MATHEMATICS

Rosa Maria Reis
GILT- Graphics, Interaction and Learning Technologies
Instituto Superior de Engenharia do Porto (ISEP)
Rua Dr. Bernardino de Almeida, 431, 4200-072 Porto-Portugal

ABSTRACT

Web2.0 platforms are allowed to implement worlds completely virtual through technological devices, where the user has the ability to be anywhere anytime and can do almost anything you can imagine. These worlds allow to rediscover the senses through the use of technology. The virtual space can be used to bring students and teachers to this space because they promote new concepts, new approaches and new strategies, that in the educational field have been changing the paradigm of teaching and learning. This study aims to investigate how the students react to the three-dimensional collaborative virtual environments and to what extent does it affect their learning behavior patterns.
OpenSim, an immersive virtual environment, was selected as a platform to develop one collaborative virtual environment that presented instructional materials to support a math class for students of the 5th year of basic education. The results suggested that the three-dimensional collaborative virtual environments can contribute to the involvement of the students in the resolution of the activities motivating the spirit of help among students.

KEYWORDS

3D Virtual Environments, Immersive, Collaborative learning, OpenSim

1. INTRODUCTION

Nowadays the education increasingly must resort to new forms of learning, emphasizing the new environments called the three-dimensional virtual environments because the new generation of students are attracted by technologies that make the articulation between communication and social networks. (Ayres,2009).

A growing number of studies have explored affordances of three-dimensional virtual environments (3DVEs) in education. The 3DVEs allow learners to create and manipulate virtual objects, explore novel environments, have embodied experience and interact with others through avatars (Dalgarno & Lee, 2010). 3DVEs provide "an electronic surrogate for face-to-face interaction and allow the creation of simulated environments and experiences that otherwise not possible due to high cost and physical or logistics constraints. By providing a platform that closely resembles physical interaction, 3DVEs permit interaction with a computing environment and the work of other users, while creating the perception that one exists within the environment "(Arya, et al, 2011). 3DVES have peculiar characteristics, such as, synthetic, immersive, presence, interactive, realistic and three-dimensional space, that allow giving support for innovative pedagogical paradigms enabling teachers exploring effective educational formats (Reis, R. et al, 2011). 3DVEs can being used in the learning process where we can create spaces which provide set of services.

Despite the potential of 3DVEs we must have attention that these environments by itself are not the solution to increasing student learning. The 3DVEs must be combined with teaching method to influence the way in which a way in which a student receives, processes, learns, applies, and reflects on the content. "*Educators and technical advisors not only seek to teach students about the content; they also explore ways to engage students in the learning process. Educators must be lifelong learners willing to understand the ever-evolving teaching practice*". (Hodge and Collins, 2010).

To obtain a comprehensible view of this trend, this paper analyzes "How do students react to the availability of an environment developed based on our criteria and to what extent does it affect their learning behavior patterns?"

In this sense paper is organized as follows: section 2 introduces the 3CVE whose main objective is to support the teaching/learning process in mathematics; in the section 3 whole the process of developed is described, whose main objective is explained how we idealized this application; in section 4 is demonstrated the analysis and results obtained and finally some the conclusions will draw.

2. SPECIFICATION OF 3CVE

This project consisted in the development of a prototype of an educational virtual collaborative environment to support a Mathematics class for students in the 5th year of the second cycle of basic education. The subject to be addressed is part of the programmatic content of this curricular unit - Geometric Solids.

The syllabus of this subject, are based on the proposal of the Ministry of Education, whose general learning objectives should allow:

- to describe geometric solids and identify their elements;
- to understand the properties of geometric solids and classify them;
- to identify the elements of a polygon, understand its properties and classify polygons;
- to relate the number of faces, edges and vertices of a pyramid and a prism with the polygon of the base;
- consolidate previously completed learning;
- to identify solids through representations in the plane and vice versa;
- to Identify I, validate and design solid planning and build models from these planning;
- to have tasks that provide opportunities to observe, analyze, relate and construct geometric figures and operate with them. Thus, we have a dynamic learning of geometric concepts and the deepening of their understanding;
- the students should be able to solve problems, communicate and to think mathematically in situations involving geometric contexts.

Based on the previous assumptions, our environment was developed to provide knowledge on the subject - Geometric Solids, using interactive activities where students can test the acquired knowledge and intuitively. Also, we wanted to encourage students to immerse themselves in a three-dimensional virtual environment, so that objects were to invade the real space of the user and this in turn, represented by an avatar, interacted with the objects in the same space.

The environment was implemented in the OpenSim virtual world. The choice was based on the following criteria:

- is an open source platform and has the current SL APIs;
- is compatible with Linux and Windows operating systems;
- is a platform where the creation of static content of users is simple;
- It allows the creation of content in real time, using its own tools that allow the sharing of text, images and video;
- Interactivity is achieved through the coding of scripts;
- the users interact with each other through avatars and they communicate through tools that exists in other virtual worlds, example, chat, voice, and asynchronous messages;
- allows to access to Moodle.

In this first phase, the proposed environment aims to support the classroom teaching and it is suggested as a means of communication. At a later stage, we suggest using as a form of interaction outside of classes, where students can exchange information, clarify of doubts and problem solving.

3. ENVIRONMENT MODELATION

The modelling of 3DCVE began after the identification of the requirements. Initially, an environment proposal was defined that would be useful for the classroom and would allow:

- as tool, bring the world to class – it is possible access to multiples information sources and online communities, from classroom;
- support the activities in the classroom for the possibility of evaluations and the realization of innovative activities;
- open the class to the world for easy access to information, viewing and contact with others.

Also, we tried to identify the essential needs for the development of the system, type of tasks according to the learning objectives and expected interactions that allow obtaining a suitable environment for target audience.

After this phase, the virtual environment was implemented iteratively passing through different phases of development, that we describe.

Analysis phase - begins by focusing on the functionalities, in terms of operations and conditions of the system leaving aside the details of the platform on which the environment will develop. From the information collected in the initial phase, we decided to divide the space into three main areas: space for discussion, information and activities, as we can see in figure 1.

Figure 1. Scenarios of the different spaces of environment

The aim of the discussion area is to allow teachers to clarify some concepts to the students and / or to propose something that is related to the subject, leading the students to reflect, debate and draw conclusions.

The information area presents all the didactic contents to be addressed. It has a set of panels that present the concepts related to the theme and some solids in 3D, where the student with a simple click can access the specific information of the solid in question. Finally, the area of activities has as main objective to present a set of activities that allow students to consolidate the concepts learned. Some of the activities can be accessed by links to collaboration tools found on the Web, such as Scribblar.

Throughout the area of activities students will be able to find indication of some problems to be realized. The activities are directed to be carried out in groups. Groups were defined by the teacher in the classroom. Each group chooses a representative to solve the problem. All members of the group should go to the panel that corresponds to the problem under analysis. The group leader should develop the problem under the guidance of others. all group members can help, through chatting, or other element of the group solves problem.

Typical examples of problems are crosswords and the jigsaw. The jigsaw is presented to students in the discussion space by the teacher (represented by their avatar). Each group is responsible for studying a component of the problem. The information and activities for each component should be found in the environment. After a certain time, the students return to the discussion space and discuss each component, among all (students and teacher).

When the group cannot resolve the activities in a given time, they receive penalties. These penalties interfere in the final test result, which each group member will resolve. This test must do when all students have been finished all activities. The test is intended to assess whether all elements of the group have learned the basics of geometric solid.

Design phase – the aim is to determine how we can facilitate interaction between the user and the environment. The activities were developed based on the personal intrinsic factors, such are curiosity, control, fantasy, and the challenge. "Assessing the factors deemed to support individual student intrinsic motivation may assist in enhancing intrinsically motivated behavior in technology-supported learning environments" (Shroff 2009). The figure 2 show some those activities. It was necessary to detail the interaction techniques associated with the learning activities.

Figure 2. Scenario of some activities to be carried out by the users

In order to understand the decisions, we made, we decided to proceed with the creation of the first prototype of the environment. This environment was evaluated through a set of evaluation requirements, already pre-defined in the initial phase of the project with the aim to analyze whether requirements were being met.

Figure 3 shows the entire development process for the Geometric Solids application.

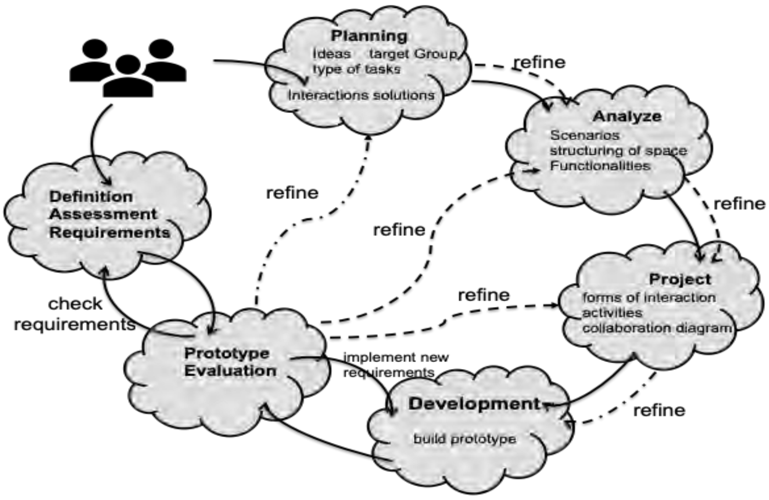

Figure 3. Development process of the Geometric Solid Environment

After completing the assessment requirements, we decided to make the environment available to students in the 5th grade of basic education in order to answer on the following question:

"How do students react to the availability of an environment developed based on our criteria and to what extent does it affect their learning behavior patterns?"

The environment was made available to a group of 20 students, aged between 10 and 11 years. Participants were asked to do a series of tasks involving research, and individual and collaborative activities.

Finally, the students were invited to completed one questionnaire. Here the students answered questions about the use of the system, especially about the usability, usefulness of the environment, satisfaction and motivation. For ethical reasons we had to require the authorization of the institution where the investigation was carried out, taking care to safeguard the interests and rights of all those involved in the study. We inform the students and request their collaboration and authorization to collect all the data.

This questionnaire was structured and oriented to the analysis of the degree of satisfaction of the student / environment because we wanted to collect data that would allow us to analyze rigorously the students' reaction to the environment, degree of satisfaction and degree of knowledge acquisition. This led to the design of a questionnaire consisting of a set of questions that were selected by the development team and the math teacher from the school where the test was held. Each question has a scale that allow a quantitative evaluation.

The collected data were structured in an organized way, allowing a triangulation of the information, which facilitated the confirmation of the assumptions initially established, and later were stored in spreadsheets designed according to the objectives outlined.

4. ANALYSIS OF EXPERIMENTAL RESULTS

To analyze the data, we established a formula to determine a percentage result for each scale of the questionnaire. This was necessary because we judged that a percentage result per scale, in addition to partial percentage values per question, would give a better view of the usefulness of the environment.

The data analysis about the use of the environment, it allowed us to draw some conclusions about usability, navigability, activities and know the general opinion of the students.

As noted throughout the session, most students easily used the virtual learning environment. Few students asked for help in gaining access to different areas of the environment. Most knew where to find what was needed to help solve the activities.

In fact, the data collected through the questionnaire confirm that most of the students considered it easy to navigate the environment (87%) and find the activities (100%). The remaining 13% had some difficulties, which were overcome with the help of the teachers present at the session. (figure 4).

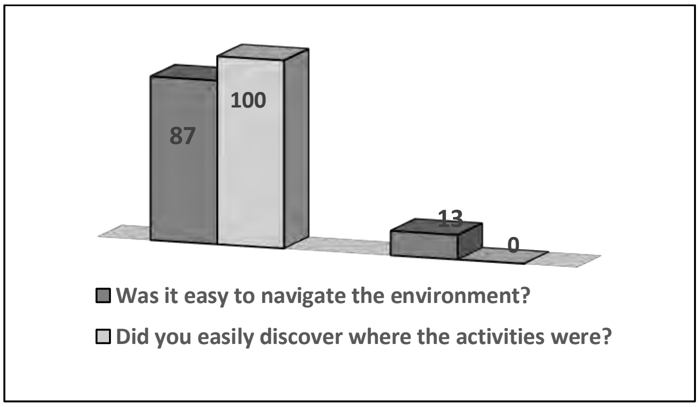

Figure 4. Aspect of use in terms of usability and navigability

Analyzing this data, the students throughout the session commented that liked the graphic aspect: It was simple, appealing and accessible; and, the text presented was quite clear.

When asked about what they liked most when they navigated throughout the environment, was verified that 70% liked to solve the activities and 30% liked watching the video (see figure 5).

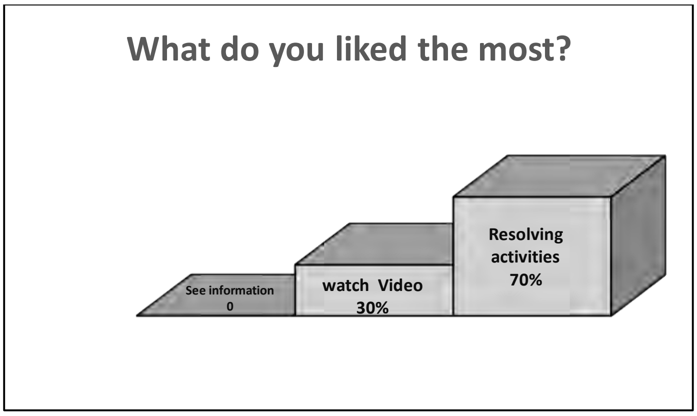

Figure 5. What they liked most in the 3DCVE

Indeed, these data allowing to assert that the computer generates a great interest to the students, because gives the opportunity to keep all students motivated and helps in to carry out the activities. In virtual environments, the student interacts through a set of resources, which make possible the development of learning, and these resources vary from environment to environment.

Regarding the accomplishment of the activities, the majority (87%) of the students did not experience difficulties in their resolution (figure 6). Only 13% felt difficulty in solving the exercises. It was because they did not follow the initial instructions to access the contents of the geometric solids.

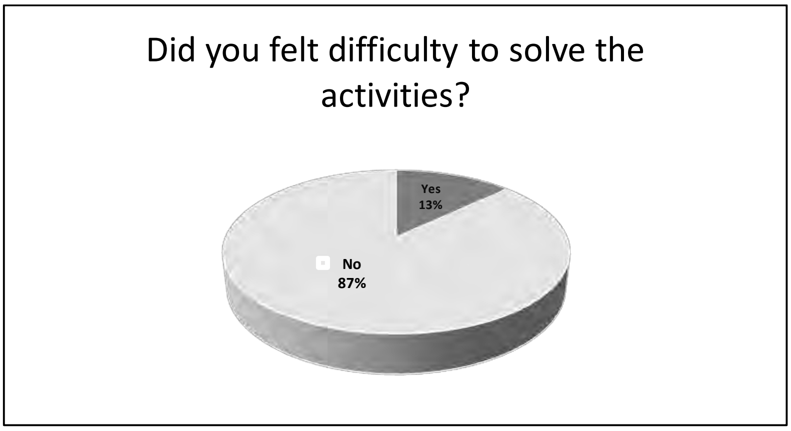

Figure 6. Opinion about the activities in 3DCVE

Finally, with regard to the presentation of data on the general opinion component of the prototype, the opinions registered were somewhat consensual: They said that they liked to use this environment more often and to use them in different curricular units, such as we can see in figure 7.

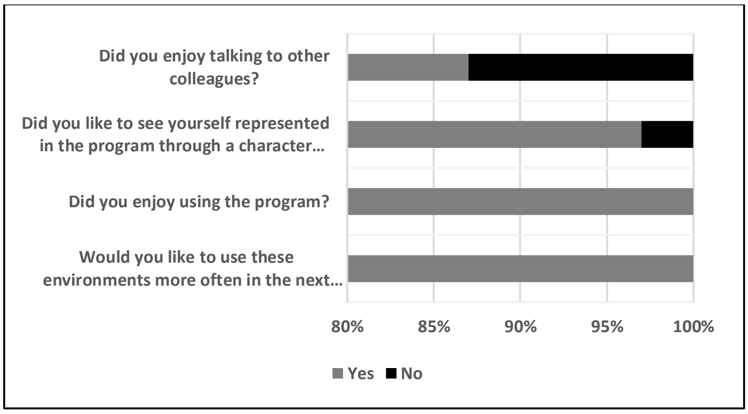

Figure 7. Opinion about the 3DCVE

After the students answered a questionnaire, they took part in a debriefing interview with the teachers. The interview was aims to know the opinion of students about learning activities conducted in environment. This allowed extract the information bellow:

- Most of the students evaluated their collaboration in the environment as very interesting and they liked teacher's presence in virtual environment because helps the clarification of doubts;
- The students expressed their desire to use the environment at any time in order to able to repeat the learning activities;
- Most of the students found voice chat more useful that text chat form communication.Thus, they have their hands free to for navigation and object manipulation.

In Summary

From what we observed regarding students' attitudes and opinions, regarding the use of the environment we can conclude that the majority felt motivated during the session period. This motivation was reinforced when several students expressed their willingness to continue using the environment after the end of the study.

From what was exposed, and although the indicators are quite positive regarding the adoption of virtual collaborative environments as a complement to face-to-face teaching, we are aware that more tests should be performed, since these data are not statistically relevant. However, this study allowed us to obtain some relevant qualitative data regarding the use and satisfaction with collaborative virtual environments for education.

From the analysis of the data extracted from the teachers' registers throughout the session, we have checked that all students collaborated with each other and engaged in the search for resources to achieve the proposed objectives and in the accomplishment of the tasks.

These conclusions allowed reinforce the idea that through virtual education, it is possible to achieve a better relationship with young people who will surely be grateful for a sign of desire to understand their modes of communication as transformation of traditional learning environments (Zorica, M. et al, 2009).

5. CONCLUSION

The main objective of this study was to verify if 3D collaborative virtual environments when used in a classroom context can help students to build their knowledge and modify their approach by increasing their ability to participate in the reality in which they are inserted (Ayres, 2009).

With this study we believe that the 3CVE can contribute for a significant improvement in the acquisition of skills and allow that students actively take part in the classroom activities, helping other students in study related subjects. Active participation is very essential for having clear understanding of the theories discussed in the classroom. We believe that satisfactory, engaging and effective collaborative learning activities can be realized in 3DCVE. Even though, 3DCVEs developed under platforms, such Second life, OpenSim, may never replace traditional labs and classrooms, they provide powerful and flexible alternatives that do not have the temporal and spatial restraints of the former, making more learning opportunities available (Vrellis et al. 2010).

However, we are aware that one of the limitations of the study is in the population sample. Only a small number of participants were involved, having chosen to sample consisting of students easily accessible, for reasons of proximity and because it is a less time-consuming process. Further studies are needed to validate whether the 3DVEs actually fulfills expectations. For example, more experiments should be performed for the results to be more accurate.

Also, further experiments should also be carried out with larger and diverse user groups, because with the use of a small sample of users only basic statistics can be applied. This can lead to inaccurate results. Large-scale experience allows us to use more accurate statistics techniques, which are better suited to handle large datasets.

We intend as future work to include some non-verbal communication capacities through real time motion capture in order to increase social presence and the quality of collaboration among the participants.

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