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# Exploitation of Croquet CVE Platform for supporting Collaborative e-Learning Environments

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## Abstract:

*This paper reviews the features of five 3 dimensional networked virtual environments which support collaborative learning applications, through the comparison of the tools and services they offer. Following that, we justify our choice of platform, which is the Croquet platform, and discuss design and implementation issues. Finally we present the results of the evaluation process of the virtual environment we developed, which consisted of the participation of twelve postgraduate students who completed questionnaires regarding its applicability in education.*

## 1 Introduction

Collaborative learning is a general term used to describe a multitude of educational practices based on the simultaneous cognitive effort of students and/or educators. Developed initially by Charles Findley as part of his research on the classroom of the future, this type of learning takes place through an electronic conversation between self led co-students and experts [5]. Students share a common goal, depend on each other and are mutually responsible for their success or failure.

Research ([1], [6], [7]) has proven the effectiveness of collaborative learning compared to other educational practices (e.g. competitive or personalized learning). Researchers that speak in favour of the use of computers in the collaborative activity, praise this method's way of aiding the acquisition of higher level cognitive abilities, problem solving abilities, ease in scientific expression and the development of communication, social and higher order thinking skills. Also, researchers conclude that collaborative activities, centred on a cognitive goal and supported by experts, result in the more meaningful and efficient acquisition of knowledge.

The main focus of this paper is on computer supported collaborative learning virtual environments. According to [4], a collaborative environment is an environment in which:

- The users participating have different roles and privileges;
- The educational interactions in the environment transform the simple virtual space into a communication space. Meaning that multiple communication channels are available to the users, allowing them to interact in multiple ways with each other inside the virtual environment;
- The information in the environment is represented in multiple ways that can vary from simple text to 3 dimensional (3D) graphics;
- Students are not passive users but can interact with each other and with the virtual environment;
- The system that supports the environment integrates multiple technologies;
- The possibility of implementing multiple learning scenarios is supported;

- Recognizable elements from the real world are visualized.

Collaborative virtual environments (CVEs) have many advantages compared to tools supporting traditional teaching methods. These advantages vary from student motivation and entertainment to the simplification of the development of cognitive models from complicated or abstract material. Virtual worlds let users experience environments, which, for reasons of time, distance, scale and safety, would not otherwise be available, especially to those with disabilities [8]. In addition, these systems allow the participation in virtual meetings or educational seminars from geographically remote locations in real time. Finally, through CVEs, education is more student-oriented. Students of multiple different personality types can enjoy and use the environment to discover aspects of their own identity and strong foundations from which classroom discussions can emerge are created [2].

This paper is structured as follows: In section 2 we justify our decision of platform and in section 3 discuss design and implementation issues, concerning the development of our 3D educational environment. Following that, in section 4 we present the statistical results and conclusions derived from an evaluation of the platform conducted in the computer lab with the participation of twelve postgraduate students from the Computer Science Department of the Aristotle University of Thessaloniki (A.U.TH.). Finally, some concluding remarks and planned next steps are briefly described.

## 2 Selection of CVE Platform

In this section we justify our selection of platform. The decision of examined CVEs was based on popularity and proven educational or collaborative value. After examining five 3D collaborative environments (those of Active Worlds <http://www.activeworlds.com/>, Croquet <http://www.croquetconsortium.org>, I-maginer, <http://www.i-maginer.fr/>, Second Life <http://secondlife.com> and Workspace 3D <http://www.tixeo.com>) we chose to utilize the Croquet platform for the design and development of a 3D educational environment. This choice was made mainly because it's based on a peer to peer architecture [3]; it has cross platform capabilities and is also an open source software application [10].

This peer to peer based architecture achieves increased load balancing and facilitates the shared used of bandwidth [5]. Furthermore, Croquet's cross platform capabilities and virtual machine framework guarantee a simple and quick installation on any operating system. Finally, being an open source application grants designers the freedom of manipulating the code and creating a multitude of user interfaces, simulations and environments.

In addition, through Croquet's multi-user 3D virtual environment users can share files and applications, collaboratively browse the web, co-author documents and presentations and communicate through text, VoIP or video. Also, out of the five platforms examined, Croquet is the only one to feature portals which link virtual worlds together. Portals allow users to peer into other environments and share files. Seeing through nested portals is also supported, as is a physics engine capable of simulating vector fields such as wind and gravity [11].



Figure 1: Web browser inside Croquet

### 3 Design and assessment of a Collaborative e-Learning Environment

During the design process of the educational environment it was decided that it would consist of three virtual spaces. These would be the students' personal spaces, a virtual lecture hall, and a virtual collaboration room. A portal enabling travel between the lecture hall and the collaboration room was regarded as necessary. In addition, we concluded that the students' personal spaces should be actualized in the form of three dimensional windows which contained basic programming and multimedia tools. In the next section we will present in more detail the concepts that were introduced above.

#### 3.1 Students' personal spaces

It was considered necessary to grant the students a personal space in order to assist them in keeping notes and expressing their ideas and opinions more effectively. This function was realized through the introduction of a 3D window containing basic tools, provided by the Croquet platform, into the environment. This was achieved by creating a morphic project (basically a Squeak programming code container) consisting of these basic tools and inserting it as the content of a three dimensional window.

The students' personal spaces contain various categorized tools. Indicative tool categories are multimedia, programming and graphics editors. Multimedia tools include a virtual piano, an MPEG player, a sound recorder and others. It should be noted that although the personal space was designed with a single user in mind, it can also be used collaboratively. In other words, multiple students can watch videos or play the piano simultaneously.

Programming tools include tools for the creation and editing of object classes, debugging tools and tools which allow the importing of classes from different versions of the Croquet platform. Furthermore, students can use Computer Aided Design (CAD) tools for brainstorming sessions, presentation programs to create slideshows and word processors in order to take down notes.

#### 3.2 The virtual lecture hall

The lecture hall is the central space of the virtual world we developed. This is the room where presentations and lectures occur. This space has three noteworthy features: the initial location of the students' personal spaces, the portal that connects to the collaboration room and the large amphitheatre (see points 2, 1, and 3 in Figure 2 respectively). In addition, point 1 in Figure 2 is the initial insertion point of the environment for the users and also the location they appear at when returning from the collaboration room.

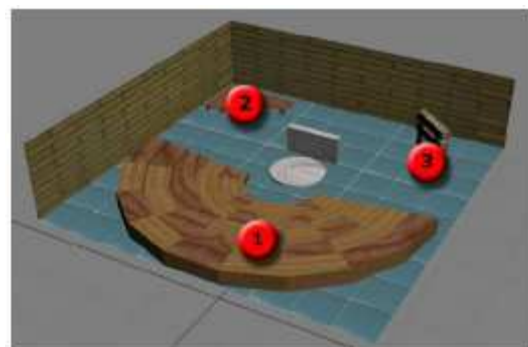
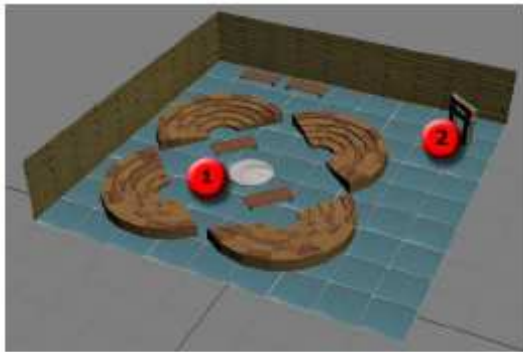


Figure 2: The lecture hall

### 3.3 The collaboration room



**Figure 3: The collaboration room**

the portal which connects to the lecture hall (1 and 2 in Figure 3 respectively). It should also be mentioned that point 1 in Figure 3 is the location the students appear at when coming through the portal at point 3 in Figure 2 of the lecture hall.

The collaboration room is the place where students can meet with the members of their team and work collaboratively. In other words they can browse the Internet together and cooperate on the authoring of a document or slideshow. The collaboration room isn't the private space of a specific student group. Its common use is not only allowed but also encouraged so that each team can motivate the other as they work. This space has mainly two features: the main collaboration space which consists of four smaller amphitheatres and

### 3.4 The portals

We created two portals inside the virtual space. These portals connect the collaboration room to the lecture hall and vice versa. While traversing these portals students have the ability to carry with them items such as web browsers, text editors, images, 3D objects they created inside the environment (using a tool called Sketch) and others. As has already been mentioned, the collaboration room portal is situated at point 2 of Figure 3, while the lecture hall portal (Figure 4) is at point 2 of Figure 2. The portals are initially closed and can only be activated by accessing the user interface located above their respective 3D windows.



**Figure 4: The lecture hall portal**

### 3.5 The user interface

The menu bar of the user interface we designed is situated at the top of the screen. Through this menu the user can create a new virtual space, three dimensional shapes such as cubes and spheres and add lighting. Also, through the menu s/he has access to tools such as the text editor, web browser (an embedded Firefox browser), or Sketch tool (which can transform a 2D drawing into a 3D object). In addition, s/he may choose to open an external file such as an image or video which will appear in the environment contained in a 3D window. Finally, communication with users both inside and outside (using Jabber) of the virtual environment is achieved through the use of the chat tool.

## 4 Evaluation of the virtual 3D educational environment

In this section we will describe the evaluation method followed and also refer to some of the results which were attained from the questionnaires filled in by the participants. Due to the extensive breadth of the results and because of the limits imposed on the length of this paper we will briefly summarize the most meaningful and informative of these.

### 4.1 A description of the evaluation method

In June of 2007, a presentation of the Croquet platform took place within the context of the course “Virtual Learning Environments”, taught during the spring semester of the second year, of the Postgraduate Studies Programme at the Computer Science Department of the A.U.TH.



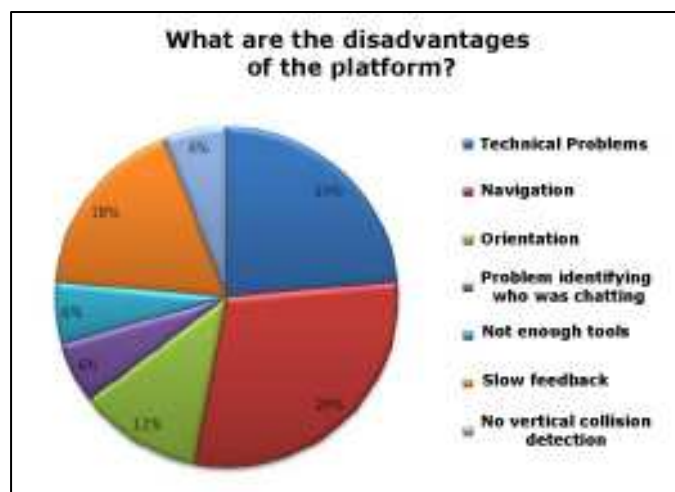
**Figure 5: The computer lab where the evaluation took place**

The presentation was held inside the computer lab (Figure 5) with the participation of twelve postgraduate students consisting of three boys and nine girls. Following a general presentation of the platform and its functionality, the students had a chance at navigating through the three dimensional environment we created and engaging in an educational scenario.

According to the educational scenario the students would collaborate in pairs of computer stations, attempting to complete four specified activities within the allowed time frame. We chose to split the students into teams of six, so that each session would comprise of three collaborating groups. When the permitted duration of time came to an end, the students had to complete two questionnaires. During the evaluation phase, the students filled in a questionnaire regarding the usability, functionality and future enhancements of the Croquet platform. Following that, they completed a personality test which was based on [9] and was processed by a postgraduate student of the Psychology Department of the A.U.TH. The ultimate aim of completing two questionnaires was the attempt to cross-correlate the personality traits of the students with their individual impressions regarding the virtual environment. Because our questionnaire sample was relatively small we cannot draw certain evident conclusions. We can, however, hypothesize and try to confirm our theories in future work.

### 4.2 The results of the Croquet questionnaire

Because of the extensive breadth of the results, we shall only present the most meaningful. After observing the users, a difficulty with regard to the navigation and orientation inside the virtual environment was identified. Something which is confirmed by the students' answers to the question "Which are the disadvantages of the

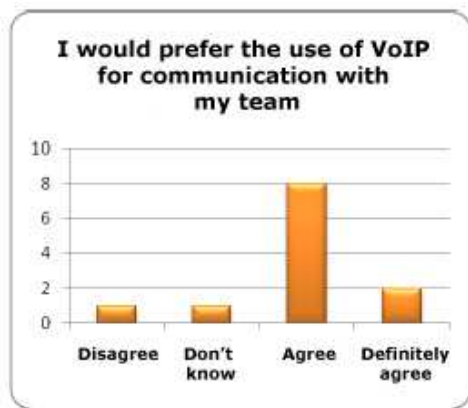


**Figure 6: The major disadvantages of the platform**



platform?” (Figure 6). It seems the students found the navigating more bothersome than any of the technical faults they encountered.

Despite the navigating difficulties, the questionnaires reveal an ease in grasping the general functionality of the Croquet platform, as well as a satisfaction gained from the use of 3D graphics. The users' first impressions of the virtual environment were positive overall, while 83% of the students mentioned that they would also like to use it under true educational conditions.

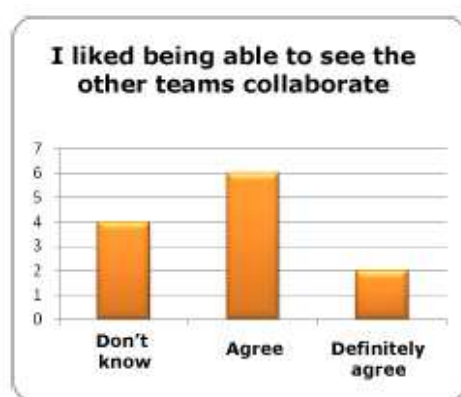


**Figure 7: Regarding the use of VoIP**

(Figure 7) to communicate with their team (a feature of the system not yet employed effectively).

From the students' answers we can surmise an uncertainty concerning the pedagogical value of the Croquet platform. As mentioned by one student in her questionnaire: “I found the software application entertaining even though I am not used to 3D environments, but I am also not sure about its educational value...”. Moreover, the students kept a neutral attitude regarding the degree of ease that they consider the organisation and following of courses through the virtual space, presents.

#### 4.3 The results of the personality test



**Figure 8: Regarding the ability to see the other teams**

The majority of the users appreciated watching the other teams cooperate (Figure 8) and reckon that their collaboration with the members of their team went well. Also, most teams managed to complete two out of the four activities within the available time, while one team completed them all.

The students used the chat tool extensively finding it convenient, but encountered difficulty identifying the user that was chatting. In other words, they couldn't easily relate the user avatars to the chat nicknames. Most students suggested either using speech bubbles, or

having the nicknames hover above the avatars. Also, the majority of the students would rather use VoIP

The personality test used was based on [9]. It includes six personality trait scales: Neuroticism, Extraversion, Openness to Experience, Conscientiousness, Agreeableness and Agency. These traits were measured using self-rating (on a Likert scale) of 30 adjectives. The data gathered was processed and analyzed using SPSS v.13 (Statistical Package for the Social Sciences). From this analysis we calculated that the value of the Cronbach reliability coefficient was 0,767. A satisfying value for the reliability of the results since it represents the high probability of the students giving the same answers to an identical test.

Despite the small size of our sample, which results in an inability for definite conclusions we can hypothesize and try to confirm our theories in future work. These theories could prove useful during the design process of a 3D educational environment, in order to satisfy the needs of our target group users. Because of the extensive breadth of the results, we shall mention the most meaningful.

From the analysis of the questionnaires we can theorize that users with low percentages of the agency trait usually have positive first impressions and yet they maintain reservations regarding the pedagogical value and educational use of the platform. On the contrary, individuals with high rates of agency have certain levels of previous experience with 3D virtual environments, consider that they collaborated well and they would have liked to have been able to modify the appearance of the avatar they used.

Users with high rates of conscientiousness found the interaction with the 3D windows easy to learn and would not hesitate to use the platform under true educational conditions. Also, students with high rates of openness to experience had difficulty with the user interface, suggesting that a map of the environment should be available to the user.

Individuals with low rates of neuroticism had no problem understanding the functionality of the platform and the user interface of the 3D windows. On the other hand, they had difficulty when navigating the virtual environment. Finally, they agree upon the applicability of special devices for the increased immersion of the user and the preference of VoIP for communication between their team members.

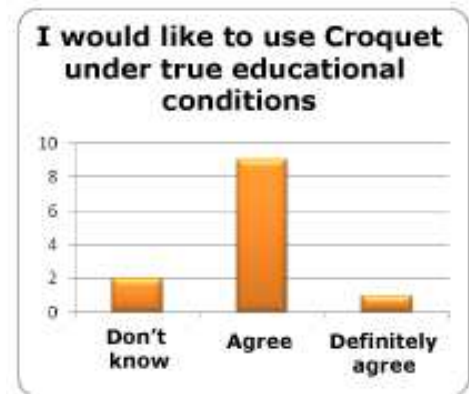


Figure 9: Regarding using Croquet under true conditions

## 5 Conclusions and future work

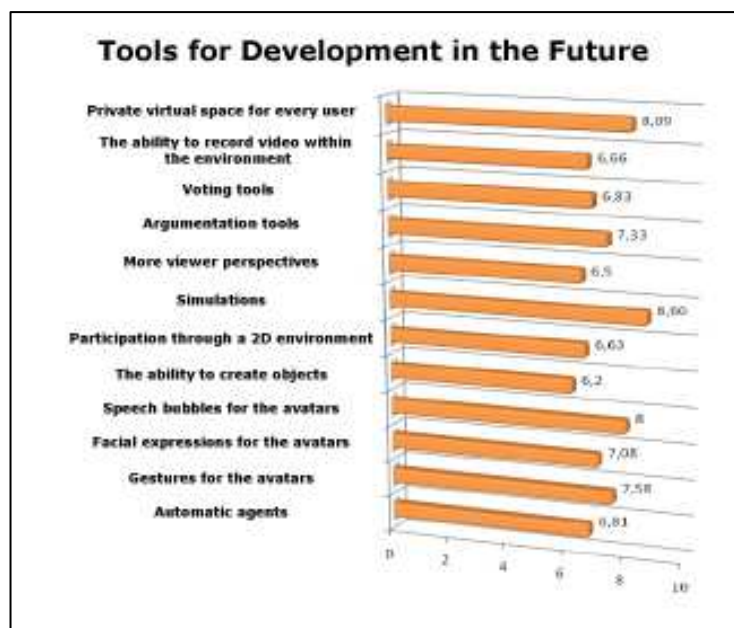


Figure 10: Tools for future development

From the completed questionnaires we can surmise that the participants found the use of the Croquet platform as an educational tool both inspired and entertaining. Although they were quite reluctant to admit its value as an education tool, we perceive this to be a result of their difficulty and lack of previous experience with navigating 3D virtual environments. Despite their individual difficulties, the participants were overall enthusiastic and curious about the future educational practices that could be envisaged and developed using this or similar platforms.

Regarding future work, during the evaluation of the platform users were called to rate twelve tools and functions, which will be developed for future versions of the platform, based on the importance and usefulness that was attributed to them.

As is visible from Figure 10, the most desirable features for a future version of the platform according to the students are the use of simulations, the existence of private 3D virtual spaces for each user and speech bubbles for the avatars (probably as a solution to the problem of identifying the person that is chatting which we mentioned previously). According



to the students, the less desirable features are the ability to create objects, the utilization of more viewer perspectives and the ability to participate from a 2D environment.

Based on the information reported above we plan to augment the educational environment with all the features that were deemed desirable. Following that, we will evaluate the new version of the platform through the implementation of a specific educational scenario. Finally, we will examine the possibility of installing and running the Croquet platform on the XO-1 laptop computer developed by the non-profit organization OLPC.

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