Interaction in Educational Collaborative Virtual Environments

Mario M. Kubo
Romero Tori
Cláudio Kirner
{mario.kubo, tori}@poli.usp.br, ckirner@iae-sp.br

Abstract
The educational collaborative virtual environment supposes the active participation of students and teachers, interacting highly and aiming the knowledge exchange and creation of new abilities. The learning becomes a process that one assists the other to reach the objective, by changing experiences, dialogues, discussion of ideas, accomplishment of group, and individual activities that can be shared with the group, allowing the creation of knowledge based on the collective involvement. In this context, this paper describes and discusses the aspects and methods of interaction between students and teachers in the educational collaborative virtual environments and presents an application based on the Virtual Teacher Project.

1. Introduction
The new educational trends make the limitations, still imposed nowadays by hardware and software and the individual difficulties yet persistent when manipulating computing systems, overcame by development of systems more and more adapted to the collaborative systems needs, particularly those directioned to education. The research of new ways for distance interaction, result valuation and users motivation is necessary.

At present, several enterprises, institutions and research centers devise the development of many applications destined to education. These applications can be found in most varied forms and styles. A common point among them is the development of interfaces capable to support a relationship between teachers and students. In such application, that relationship can be done through synchronous and asynchronous communication. An asynchronous communication is that one which has no need of information exchange on real time, like when we use electronic mail or take part on a discussion list, whereas a synchronous communication is that one which needs information exchange on real time, like video and sound conferences and textual chats. Once the interaction

between student and teacher regard to technology is extremely important to make the application a successful one, Virtual Reality raises as a new human – machine interaction way.

Virtual Reality integrated to collaborative systems originates what we call collaborative virtual environments. Making use of collaborative virtual environments theory, educational systems can be created by three-dimensional modeling of a multi user environment generated by computer, representing the environment to be shared between students and teachers (i.e. laboratories, study rooms or meetings).

The collaborative virtual environments, when used as interface on educational systems, are able to provide the following characteristics:

- Visualization of the information by its three-dimensional representation;
- Presentation of a large amount of information during a simulation;
- Support to several conventional and not conventional mechanisms;
- Naturalness interaction mechanisms between students and teachers;
- Simplicity to notice activities from others students and teachers contained at the virtual environment;
- The different tools composing the system can be represented at the virtual environment and used concurrently or alternately by students and teachers.

The goal of this paper is to describe teachers and students representation at the “Virtual Teacher Project” educational collaborative virtual environment [1] [2] [3].

The work is organized as the following description. Section 2 describes concepts about Virtual Reality and Education; Section 3 shows the Virtual Teacher Project; Section 4 describes representation forms of students and teachers at the educational collaborative virtual environments; Section 5 presents students and teachers aspects; Section 6 illustrates ways of interaction between students and teachers; Section 6 introduces one Virtual Teacher Project application developed; finally, Section 8 presents the conclusions.

2. Virtual Reality and Education

According to Kirner & Pinho [4], Virtual Reality can be seen as the most graphical Human-Computer Interaction evolved form available until now.

Virtual Reality comprises advanced interface technologies that allow user make immersion, navigation and interaction on a synthetic three-dimensional environment generated by computer, using multi sensorial channels [4] [5]. This new interface can actuate over two different approaches: on the users' motions and acts analysis, like a traditional interface, or provoking sensations on the user, as an answer to his actions, actuating on vision, hearing and tact.

A Virtual Reality important advantage over other Human-Computer Interaction forms is that the environment can be visualized from any angle and in real time. Behaviours and attributes can be assigned to environment objects, what propitiate answers and functions simulations of the real world. To support this kind of interaction, users are provided with not conventional devices, such as visualization and control helmets, gloves, spaceball and joystick. These devices give to the user a feeling that the application is working at the real three-dimensional environment, allowing environment exploration and natural handling of objects – for example, point, catch, drag and rotate [6] [7]. Another advantage of this kind of interface is that the intuitive user knowledge about the physical world can be transferred to manipulate virtual world.

A Virtual Reality system wraps studies and resources linked to perception, hardware, software, Human-Computer Interaction human factors and applications. To build Virtual Reality systems is necessary to have some mastery on: not conventional I/O devices, high performance computers and good graphical capacity, parallel and distributed systems, three-dimensional geometrical modeling, real time simulation, navigation, collision detection, evaluation, social impact, interface design, and simple and distributed applications over several fields [4].

The virtual reality gives to educators a new way to teach with effectiveness and, to students, a strong motivation. The most obvious reason, as Byme claims [8], is that the virtual reality is a new and different way that lets people do things they couldn’t do in our real world [9].
Interaction in Educational Collaborative Virtual Environments

According to Souza [10], we can assure that, virtual reality has the potential to modifying shape as people learn, lying in the fact that it lets students explore the environments, processes or objects, not by means of books, pictures, movies, but by means of manipulation and analysis of its own aim of study. What lets students learn about a subject put inside its own context of its subject, and receive, in each action they take, a refreshment of such context.

According to Pantelidis [11], there are several reasons for the usage of a virtual reality in Education, which are:

- It gives much more motivation to the users;
- It has an illustration power for some processes and objects which is stronger than other types of media;
- It gives the objects not only a close analysis, but also a far one;
- It lets handicapped people do certain things that are not possible otherwise;
- It gives opportunities for understanding based in new perspectives;
- It lets the learner develop his work in his own time;
- It lets the learner proceed through an experience during a period of time that is not limited by the period of a regular student;

According to Stuart & Thomas [12], the applications of the virtual reality can prepare students in order to:

- Explore existing places and things that students couldn’t have access otherwise;
- Explore real things that, without alterations of the scale in the size and time, they could not be examined indeed;
- Create places and things with a natural or changed quality;
- Interact with people who are in remote places;
- Interact with people in a non-realistic way;
- Interact with virtual beings, such as representations of historical people;
- Create and manipulate abstract conceptual representations, such as data structure and mathematic functions.

3. Virtual Teacher Project

Virtual Teacher Project [1] [2] [3] has as main goal the development of a computing system directioned to Distance Teaching. The system shall allow interaction between teachers and students. Teachers and students will be virtually transported to a classroom or any other virtual environment that will be able to aim teachers and students offering to them the support of Distributed Systems and Virtual Reality technicals. Moreover, system will offer support to teachers, like virtual laboratories and study rooms. These support features represent a tool set that will not only help the teacher, but also allow the making of several experiences.

This project intends to spread knowledge and guidance to a higher number of persons, by integrating Distance Teaching and Virtual Reality fields. With the use of Virtual Reality technicals, it wishes create a low cost system that will be able to offer support to education all over the country. The project also intends to introduce and spread Virtual Reality potentiality as an educational support tool.

Virtual Teacher Project has been subdivided among three modules:

- Human-Computer Interface – it’s related with students and teachers behaviour, based on their actions among themselves and with the equipments. The interface is responsible by mapping users actions with input devices, application processing and results presentation at the output devices;
- Remote Interaction – based on analysis and definition of interaction forms to naturalness communication between students and teachers;
- Distributed System Support – analysis and implementation of data distribution mechanisms between students and teachers at the system, having in view the several computer resources.
3.1. Avatar: Students and Teachers Representation

An avatar (Figure 1) is the representation of a user at the virtual environment. It may be a common user (student or teacher) or an automated entity that represents a process – limited entity which executes actions inside a virtual world. The avatars at Virtual Teacher Project have the freedom of modifying objects and parameters and send messages to any other entity that belongs to the virtual environment (audio, video, text and image connections).

3.2. Teachers and Students’ Aspects at the Educational Collaborative Virtual Environment

Figure 2 shows the relationship between students and teachers at the educational collaborative virtual environment, by using the Use Case Diagram – Unified Modelling Language (UML) [13]. At the educational collaborative virtual environment, students and teachers’ roles suffer some variation when comparing with the traditional educational system.

Students are no more under teacher’s dependence, they assume a more participative and interactive role with the knowledge they’re seeking for. This knowledge is built in a gradative way through individual and group performance. Students learn, interacting with one another, even with the teacher, being able in this way to actively take part on the learning process. The experience and previously acquired knowledge exchange enlarges the content proposed by teachers, making possible overcome any difficulty that some member of the group can eventually feel, when operating the system and increasing tool usage, by suggestions that should be sent by the participants of the work groups.

Teacher assumes an incentive role on the group performance, executing actions like: identify difficulties in common and suggest new approaches, offer guidance on the solution of the most difficult problems, provoke discussions and reasoning among the group members,
propose new paradigms, and during the most part of the time, take part of the activities as he/she was just a student. The teacher, due the high interaction grade among students, will became almost a member of the group, learning with the development of experiences.

The activity in groups at the educational collaborative virtual environment will break the concept of traditional work groups, where every member has to accomplish his/her own task, and will become a moment of integration, of ideas and experiences sharing, where every member will contribute to the learning process of the entire group.

At Virtual Teacher Project there are several possible situations. To make the learning process active and reach all the different learning styles, teachers and students' roles have to be revised: the teacher should have a posture different from the traditional one, he/she should exert himself/herself to offer as many different stimuluses as possible to help students in building their own knowledge. In another words, learning will have its basis based on active participation, instead of a simple and pure transmission of a “ready” knowledge.

The student is the focus at Virtual Professor Project. He/she has his/her own characteristics kept, making possible a group forming within a context more adapted to its participants. This offers a richer environment, which favors the exchange of experiences and collaboration, feedbacking the process. The Virtual Teacher Project is able to contribute in offering new ways to support interaction among these groups, which will create their own identities.

Such communication forms intend to motivate students in adopting a more active, independent and responsible posture, allowing the improvement not only of oral and written communication skills, but also of research skill and ethical behaviour, keeping the students' individual style. By the other side, in face of these personal differences, it’s necessary to considerate that an outrage of freedom and flexibility can lead to negligent, inconsequent, irresponsible or systematically anonymous postures. Groups’ interdependency possibility also shows analogous positive and negative characteristics.

4. Students and Teachers Interaction

According Bishop et al. [14] and Kirner & Pinho [4], interaction between students and teachers in virtual environment regarding to real world have its basis based on usage of conventional or not conventional devices, communication process and technological mediation mechanisms. The general representation of interaction at a virtual environment can be seen at Figure 3.

Interaction in virtual environments can occur in two ways: single user and multi user. When in single user way, the
student or teacher takes part alone on the system, whereas in multi user way, a plenty of teachers and students can participate on the same application.

Single user interaction may be defined as one of these four forms: viewer, with real participation, with simulated participation and without participation or possible supervision. Most times, the virtual environment represents a real world, except when talking about simulated participation, when the virtual environment can also be an imaginary one. At the Viewer case, we’ve got, for example, some particular situation of telepresence system that only makes inspections; the real participation case is a typical example of telepresence system, the simulated participation is a Virtual Reality case; and the last one (without participation) can have as example a robot with supervision skill.

Multi user interaction among several students and teachers may occur as one of the following three forms: communication between students and teachers; virtual environment sharing; and cooperative work made at the real world through the shared virtual world, according Figure 4.

In order to define how teachers should relate with students, and vice-versa, using the collaborative virtual environment, we should analyze this by the following three points of view [2] [15].

- Cognitive: by cognitive point of view, the designer must observe how teachers and students think, learn and which are their skills in acquiring knowledge;
- Physics: it analyzes how teachers and students look like (height, age, gender) and which sensorial and motor skills they’ve got. From this analysis, we can define the most convincent sensors and devices to apply on project.
- Social: it observes teacher or student’s relationship when he/she is at his/her social environment, including group structure and dynamic, power, politics, and which social skills he/she has. With this kind of observation,
it’s possible to create an environment control hierarchy, meaning that it’s possible to know which kind of rights should exist within the environment, and how they’ll be distributed among teachers and students.

Interaction study on Virtual Teacher Project is related to the necessary interaction forms analysis and definition in such a way that the system will be able to provide a naturalness communication between teachers and students. To acquire this goal, teachers and students’ behaviour should be studied within a virtual environment.

According Hoffman & Mackin [16] and Martins et. al. [17], physical separation between teachers and students results in changes at the learning environment, generating others forms of relationships, such as student/interface, student/content, student/teacher and student/student interactions.

These interactions need to be used and known in an appropriate way in order to generate high quality and interactive courses on distance. Virtual Teacher Project is based on interactions defined by Hoffman & Mackin Martins et. al., described as it follows:

- **Student/Interface interaction**: it provides an access that allows apprentices receive not only training, but taking part of it. The apprentice/interface is the vital line between teacher and student; if it fails, training also fails. It’s necessary make the technology as most transparent and friendly as possible;

- **Student/Content interaction**: it’s called intellectual interaction. Here the student’s understanding, perception and cognitive structures are transformed;

- **Student/Teacher interaction**: it determinates information flow from teacher to student or vice-versa;

- **Student/Student interaction**: it offers to students an opportunity of expand and applicate the lessons content in another way.

![Figure 5. Educational Collaborative Virtual Environment](image-url)
5. Educational Interactive And Collaborative Virtual Environment

Virtual Teacher Project aims to make a collaborative virtual environment, capable to support visualization and animation in three-dimensional spaces on real time. In this virtual environment, every computer receives a space description, detailing its objects as well the simulation process to be used. Each teacher or student’s interaction (movements and actions) can be visualized by the remote students and teachers. This attendance is made by diffusing movements and actions to the others system machines, which will renderize images locally. This allows the use of wide area networks, based on the low traffic among computers.

The developed application is a virtual meeting room, where the several participants are put together around a table to talk about a common subject (Figure 5). Every participant is represented by an avatar (three-dimensional representation) who is able to move freely through the virtual environment.

The participant may use a Virtual Reality head mounted display or simply a monitor to visualize the virtual room; his/her moves are controlled by keyboard or mouse functions.

The user will be able to move his/her visualization point according his/her head usual movement (up, down, left and right) and he/she won’t have any position restriction, being able to get up from chair and walk over the room. As it’s usual in any collaborative environment, all participants see the avatar movement.

The tools used to build, synthetize and make the interactions of Virtual Teacher Project application were: WorldUp Modeler [18] that is a tool used to create and edit three-dimensional objects, which compose the virtual environment; WorldToolKit [19] that composes a function set used to make three-dimensional simulations and Virtual Reality applications; and WorldToWorld [20], that makes easier the development of multi user applications when integrated to WordToolKit and WorldUp Modeler.

![Figure 6. Communication Mechanisms Among Students and Teachers](image-url)
Virtual Teacher Project is composed by the following features: communication between students and teachers, as showed at Figure 6; audio communication that aim for allowing real time voice transmission among all students and teachers at the virtual environment and media transmission while navigating at the environment; text communication, called chat, that makes data communication by texts sent among the several students or teachers' application, having as a goal to make easier the information exchange between the participants, like messages, formulas, values, symbols and etc. Written messages will be automatically sent to all participants, and communications generated from student or teacher (avatar's) are transferred inside the virtual environment. Student and teacher are able to handle, change, create and remove objects from virtual environment.

6. Conclusion

Nowadays we can see Virtual Reality technology participating actively on several fields. In a special way, it’s emphasized the usage of Virtual Reality technology on collaborative teaching. This kind of teaching aim for developing, through interpersonal activities, different situations that should favour the formation of new situations, ideas and solutions. Virtual Teacher Project allows making the collaborative teaching feasible with the use of Virtual Reality. Synchronous and assynchronous communications can be used to develop many activities, such as students’ attendance, valuations, discussions, exhibitions, references etc. These actions can favour teamwork spirit formation (when used in a convenient way), what is needed to make the educational collaborative virtual environment successful.

It was also discussed teacher and student’s role at collaborative teaching. This kind of teaching is embedded in constructivism, where a student learns what he/she himself/herself builds and deduces. Virtual Teacher Project at this point is a very attractive tool, as it favours group formation, where student participates as an active element. Such participation can be done in both synchronous and assynchronous ways. It’s good to emphasise that the interdependency of the group elements can be and should be explored (specially through the use of synchronous tools) intending to create more diversified and real situations, with several solutions. Although this interdependency should be explored, every one’s independency must be kept. In this way, the independency of the members to seek for different knowledgment sources, as well to think alone about some subjects, can lead to a growth not only personnal, but of the entire group, once that new ideas feed communication among group members. Teacher’s role in a team is the same of a mentor, capable to valuate the student and promote his/her integration and interest. Teacher can use the several communication tools to promote these goals, considering the profile of every student (i.e., maybe should be interesting communicate in private with a student through e-mail to not highlight some difficult that this student may have). Moreover, teacher also can play the role of a team member and, through his/her large experience, promote discussions and propose situations and even solutions.

This work is related to the continuous Project AVVIC [21], being developed by the Virtual Reality Team (GRV).

References


