

Virtual Reality and Virtual Environments in Education

Nicoletta Sala

Università della Svizzera italiana, Switzerland

INTRODUCTION

Virtual reality (2007), or VR, is defined in the *Encyclopædia Britannica* as:

the use of computer modeling and simulation that enables a person to interact with an artificial three-dimensional (3D) visual or other sensory environment. VR applications immerse the user in a computer-generated environment that simulates reality through the use of interactive devices, which send and receive information and are worn as goggles, headsets, gloves, or body suits.

Jaron Lanier, virtual reality pioneer, claims to have popularized this technology in the early 1980s, but the origin of the term “virtual reality” is uncertain. It has been credited to *The Judas Mandala*, a 1982 novel written by Damien Broderick, where the context of use is somewhat different from that defined above. One of the first applications of this technology was in the military area, especially in 3D interactive computer graphics and flight simulators. Another area of application for VR systems has always been training for real-life activities. A virtual reality system has the following three primary requirements: immersion (which permits to the user the physical involvement, capturing exclusive visual attention, and responding to three-dimensional input. For example, through a data glove, head-tracker, 3D mouse, or fully instrumented body suit); interaction (through the three-dimensional control device to “navigate” in the virtual environment); and visual realism (which is a representation of the virtual world using computer graphics techniques) (Roseblum & Cross, 1997). VR is usually classified according to its methods of display. We have: immersive VR and non-immersive VR. Immersive VR involves a high degree of interactivity and high cost peripheral devices, for example, the head mounted displays. This kind of VR can generate the “avatar” or “virtual body” (user’s

representation of himself or herself, whether in the form of a three-dimensional model). Non-immersive VR, often called “desktop VR,” is in the form of a windows into a virtual world displayed on a computer’s monitor (Earnshaw, Chilton, & Palmer, 1997). This article describes the use of low cost non-immersive virtual reality integrated in teaching path in a faculty of architecture, where this technology can help to define new paradigm in the architectural design.

BACKGROUND

Many researchers affirm that virtual reality offers benefits that can support education (Antonietti, Imperio, Rasi, & Sacco, 2001; Byrne, 1996; Gervai, Popovici, & Tisseau, 2003; Mantovani, 2001; Pantelidis, 1995; Sala & Sala, 2005; Shin, 2004; Stangel & Pantelidis, 1997; Winn, 1993; Youngblut, 1998). VR is also a good medium to apply the philosophy of constructivism and for making abstract concepts concrete, for example, to emphasize the physics’ laws or chemistry’s principles (Byrne, 1996; Johnstone, 1991; Jonassen, 1994; Zoller, 1990).

At the Human Interface Technology Lab (HITLab), a part of the Washington Technology Center (University of Washington in Seattle), some pilot studies have been performed to examine virtual reality’s potential in the field of training and education. For example, the Pacific Science Center Studies used 10 to 15 year old students who were attending a week-long summer day camp. Some of these students were novice computer users, while others had a good computer knowledge. In groups of 10 students, they brainstormed virtual world creations. In subgroups, composed by 2 or 3 students, they have created virtual objects for their world using specifications, for example, how the objects should be placed and moved in the virtual world (Youngblut, 1998).

Using the constructivist approach, Byrne (1996) created a virtual environment to stimulate the students to learn the chemistry by exploring and interacting with a virtual world. Instead of staying in a classroom and passively viewing images of the atomic structures, the students can place electrons in the atoms and they can see the atomic orbital appear as the electron buzzes.

Pantelidis and Auld (Virtual Reality and Education Laboratory (VREL), East Carolina University) used a software package called Virtus® VR on a group of primary school children. The aim of this activity was to promote children's abilities to conceptualize in three-dimensional space and to have fun and provide a sense of achievement while doing so. The children created the interior of a room or building, with walls, doors, windows, and furniture designed and edited and then placed in the appropriate part of the screen-based construction. Keyboard-controlled movement through the three-dimensional representation is possible at any time (Stangel & Pantelidis, 1997).

Gerval, Popovici, Ramdani, El Kalai, Boskoff, and Tisseau (2002) created a distributed virtual environment for children. The project, named EVE (Environnement Virtuels pour Enfants), involved nine partners (universities, primary schools, and small and medium-sized enterprises) for three different countries: France, Morocco, and Romania. On a pedagogical perspective, the main goal of the EVE project is teamwork. In fact, children from different countries are involved in cooperative work. They have to achieve a common task together, hoping that this will encourage respect in a multicultural framework. On a technical perspective, this project implements distributed virtual reality technologies. From both points of view, EVE is a NICE-like environment, being narrative, immersive, constructionist, and collaborative. The EVE application has been developed in order to help the primary school children learn French and especially the reading. The target of the project is twofold:

- To realize new cooperative working environment
- To create new products development such as pedagogical software for primary school children

Shin (2004) presented the educational possibilities of the Web-based virtual experiment environment in science education. He developed a virtual experiment environment supporting students to learn scientific

phenomena and concepts focusing on earthquake waves, radiation balance, movements of sea water, solar system, and earth's crust structure in the science field of middle school. These virtual experiments have been designed to be compatible to the learner levels through level analysis in the following cycle model: regular, advanced, and remedial course. The virtual experiments have been evaluated for six months using 701 middle school students, and 74.6% of students gave a positive response on the use of VR in the science experiments.

HOW TO APPLY VR IN EDUCATIONAL ENVIRONMENTS

Pantelidis (1997) presented a model for choosing where to apply VR in any one course. She proposes a model, based on the work of Leslie J. Briggs and Robert Gagné (Gagné & Briggs, 1979), which comprises the following 11 phases:

1. Define the objectives for specific course.
2. Mark the objectives that could use a simulation as a measurement or means.
3. Each of the marked objectives is examined: first to determine if it could use a computer-generated simulation for attainment or measurement, then to determine if it could use a three-dimensional (3D), interactive simulation.
4. Choose for each selected objective the level of realism required on a scale from very symbolic to very real.
5. Decide the type of interaction needed on a scale from no immersion into the 3D environment (for example, desktop VR) to full immersion (for example, using head-mounted display, data gloves, and so forth).
6. Establish the type of sensory output from the virtual world or environment desired, for example, haptic (tactile or feeling), 3D sound, or visual only.
7. Choose VR software and hardware/equipment.
8. Design and build the virtual environment (VE). The virtual environment may be built by the teacher, the students, or both.
9. Evaluate the resulting virtual environment using a pilot or experimental group of students.

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