Chapter 12
Virtual Reality in Education

Chris Christou
University of Nicosia, Cyprus

ABSTRACT

Virtual Reality is implemented by a combination of technologies that are used in order to visualize and provide interaction with a virtual environment. These environments often depict three-dimensional space which may be realistic or imaginary, macroscopic or microscopic and based on realistic physical laws of dynamics, or on imaginary dynamics. The multitude of scenarios that VR may be used to depict make it broadly applicable to the many areas in education. A key feature of VR is that it allows multi-sensory interaction with the space being visualized. Here we look at how this combination of multi-sensory visualization and interactivity make VR ideally suited for effective learning and try to explain this effectiveness in terms of the advantages afforded by active learning through experiences. We also consider some of the applications of VR in education and also some of its drawbacks.

INTRODUCTION

Virtual Reality or VR allows a user to interact with a computer generated three-dimensional model or virtual environment. This environment may be realistic, in the sense that it is familiar to us at a macroscopic scale, it may be realistic in the sense that it depicts the physical world as known to science but which is not usually observable, or it may be used to visualize a world that is entirely imaginary. As such, VR is broadly applicable, and has been applied to, many different areas of education including the sciences, archeology, history and architecture. The advantage of VR over conventional methods of description is that the student is given the opportunity to *experience* subject matter that would be difficult, if not impossible, to illustrate or describe with conventional methods. We argue here that this experiential nature of VR together with its other key feature, interactivity, provides a valuable aid to conventional learning paradigms. In this chapter we give a brief description of common

DOI: 10.4018/978-1-60566-940-3.ch012

VR setups to give a feel for how a VR experience is provided. We also consider, from cognitive and sensory psychology points of view why learning may be facilitated by interactive multi-sensory systems and we provide some examples of the use of VR in educational contexts.

Modern education often requires a student to comprehend complex or abstract concepts or appreciate scenarios and situations that no longer exist. To this end, common mechanisms for teaching abstract concepts are the use of metaphor and analogy, especially within the sciences. By using an analogy we describe an event or abstract concept in terms of commonly observable reality. That is, we relate concepts to experience. The experience provides the material for the construction of a mental model of the concept, which in turn leads to the foundation of knowledge (Duffy & Jonassen, 1992). Humans learn by having experiences, by interacting with their environment and using their senses to derive information from the world. Virtual reality is a technology that replaces sensory input derived from the real world with sensory input created by computer simulation. It provides interactivity by responding to movements and the natural behaviors and actions of humans. In this respect VR may prove to be a powerful resource that can help in teaching by providing an environment that allows the student to experience scenarios and situations rather than imagining them. The experiential nature of VR systems derives from three sources: immersion, interactivity and multi-sensory feedback. Immersion means being enveloped or surrounded by the environment. The benefit of immersion is that it ensures a sense of presence or the feeling that one is really in the depicted world (Schuemie et al., 2001). Interactivity is the ability to control events in the simulation by using ones body movements which in turn initiates responses in the simulation as a result of these movements. The multi-sensory nature of VR means that information can be derived from more than one sense and adds to the experience by making it more believable, engaging (adding to the sense of presence) and providing redundancy of information which reduces the potential for ambiguity and confusion. Sensory combination reinforces information from two or more sensory sources. The aim of VR is therefore to replace the real world with a virtual world and to allow the user to behave as if they were in the real world.

The experiential nature of VR supports a constructivist approach to learning (see Winn, 1993). Constructivism is a theory of knowledge acquisition that states that humans construct knowledge by learning from their experiences. As popularized by Jean Piaget the theory states that the learner attempts to assimilate new experiences within their already established world model. If the learner cannot successfully assimilate new detail they change their world view to accommodate the new experience. When we act on the expectation that the world operates according to our world model and it does not then we must accommodate the new experience by reframing our model of the way the world works; we learn from the experience. This implies that learning is a form of active hypothesis testing. This should be contrasted with the view that learning is a passive accumulation or acceptance of facts. VR provides an environment for this active hypothesis testing and thus provides a powerful medium for learning. In general, and as suggested by Bruner (1961), students who actively engage with new material are more likely to retain this material and recall it at a later stage.

Table 1 lists some of the advantages and potential disadvantages of using VR in an educational context. After reading this chapter, the reader will be able to appreciate how these issues impact on learning. We begin by giving a brief description of VR followed by an account of how interactivity and multi-sensory stimulation (key components of VR) provide a basis for learning. We describe how the perceptual and cognitive processes responsible for learning benefit from interactivity and multi-sensory information. This section is