Chapter 1
Design Models for Developing Educational Virtual Reality Environments: A Systematic Review

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ABSTRACT

Virtual reality, although not a new technology, has rapidly increased its popularity in the last few years. As a result, their use in educational environments has been a topic of interest in academic research. One of the first questions asked by education researchers has been, "How can we design an effective virtual reality environment?", which led to the development of many design models for the preparation of educational virtual reality environments based on various approaches. These design models have been systematically examined in terms of themes and codes within this study, in hopes this chapter may be of importance for guiding researchers who want to design an educational virtual reality environment or create a design model.

INTRODUCTION

The concept of virtual reality can be broadly defined as the ability of a user to perceive and interact with a real-world environment in a three-dimensional simulation on the computer with particular technologies that the user wears on his body (Freina & Ott, 2015; Neguţ, Matu, Sava, & David, 2016). Recently, educational research has shown an increased interest in virtual reality technology because of its ability to simulate real-world conditions. According to Fowler (2015), virtual reality technology is among the

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most promising up-to-date technologies in terms of potential for being effectively used in education and training activities. As a matter of fact, the advantage of using virtual reality environments in education has been noticed by numerous researchers and many studies have been carried out.

Monahan, McArdle, and Bertolotto (2008) point out that students can feel good about the presence of their classmates and teachers in a virtual reality environment; where they receive immediate feedback and have the opportunity to live in the same environment with their friends even though they are not physically in the same environment. According to Goodwin, Wiltshire, and Fiore (2015), virtual reality environments offer educational and experiential opportunities that can positively affect learners. In their study Freina and Ott (2015) identify some advantages of virtual reality as the ability to safely engage in real-world activities that involve risk, or the ability to experience situations that are physically inaccessible or that require high costs. The general conclusions obtained from research on the use of virtual reality in learning environments by different researchers can be listed as follows:

i. Virtual reality supports peer cooperative learning (Huang, Rauch, & Liaw, 2010)
ii. Virtual reality develops the ability of learners to solve problems and discover new concepts (Huang et al., 2010; Leite, Svinicki, & Shi, 2010),
iii. Virtual reality increases student motivation (Freina & Ott, 2015; Limniou, Roberts, & Papadopoulos, 2008; Ott & Tavella, 2009),
iv. Virtual reality offers a high level of interaction (Chittaro & Ranon, 2007; Lau & Lee, 2015)
v. Virtual reality enables learners to gain knowledge with less effort than traditional learning environments (Chittaro & Ranon, 2007),
vi. Virtual reality makes teaching processes more realistic and secure (Brasil et al., 2011; Dalgarno, Hedberg, & Harper, 2002; Johnson & Levine, 2008).

A fundamental aspect of educational virtual reality environments is their design phase, wherein practitioners strive to achieve the goal of enabling training in virtual reality environments that can be at least as effective as face-to-face education (Beaumont, Savin-Baden, Conradi, & Poulton, 2014). C. H. Chen, Yang, Shen, and Jeng (2007) have asked the question "What is the right model and theory that can be used to design virtual reality learning environments suitable for individuals." Chuah, Chen, and Teh (2011) argues that the development of virtual reality environments is a challenging process that requires accurate planning and design, pointing out that traditional instructional design models do not have the components and methods appropriate for current technologies. Similarly, Goodwin et al. (2015) claim that it is difficult to apply traditional teaching methods and strategies in virtual reality environments.

Hanson and Shelton (2008), who started with the question "How can I design an environment to teach what I am trying to teach on," suggest that in the process of designing virtual reality environments, the first step is to determine learning objectives. On the other hand, Grajewskia, Górskia, Hamrola, and Zawadzkia (2015) points out that virtual reality environments have a different structure than other computer simulations and that the greatest of these differences is the peripherals used. Also, many researchers have stated that realistic objects and avatar structures have an essential role in the effectiveness of virtual reality environments. (Ahmad, Wan, & Jiang, 2011; Dalgarno & Lee, 2010; Jong, Shang, Lee, & Lee, 2010).

Because of all that has been mentioned so far, it can be seen that researchers have different perspectives on the design of educational virtual reality environments. This chapter aims to make a systematic review of design models developed in accordance with the process of designing virtual reality environments. It is hoped that this review may serve as a resource that can help the researchers in selecting the