Online Virtual Learning Environments:
A Review of Two Projects

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ABSTRACT

This article is an overview of online virtual learning environments for discovery learning. The paper defines Virtual Learning Environments and discusses literature findings on the benefits of using web-based VEs for self-directed learning. It gives an overview of the latest technologies/platforms used to develop online VEs, discusses development and delivery challenges posed by complex, information-rich web-based 3D environments, and describes possible solutions that can be adopted to overcome current limitations. The paper also presents and discusses two 3D web-deliverable virtual learning environments that were recently developed by the authors: the "Virtual Tour of the Muscatatuck State Hospital Historic District (MSHHD)" and the "VELS: Virtual Environment for Learning Surveying". The "Interactive 3D Tour of MSHHD" is a web-based digital heritage application that uses Virtual Reality as a tool to document and preserve historic sites and educate the public about them; the "VELS" is an online virtual learning environment whose objective is to help undergraduate students learn surveying concepts and practices.

Keywords: *Digital Heritage Applications, Discovery Learning, Engineering Education, Self-Discovery Learning, Virtual Learning Environments*

1. INTRODUCTION

An online interactive Virtual Environment (VE) is defined as a web-deliverable designed "information space in which the information is explicitly represented, educational interactions occur, and users are not only active, but actors, i.e., they co-construct the information space.." (Dillenburg, 2000). VEs offer three main benefits: (a) representational fidelity; (b) immediacy of control and high level of active user participation; and (c) presence. "(a) Representational fidelity refers to the degree of realism of the rendered 3D objects and the degree of realism provided by temporal changes to these objects. (b) User control and high level of participation refer to the ability to look at objects from different points of view, giving the impression of smooth movement through the environment, and the ability to pick up, examine and modify objects within the virtual world. (c) The feeling of presence, or immersion, occurs as a consequence of realism of representation and high degree of user control." (Dalgarno et al., 2002).

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An online virtual world is a particular type of web VE where users can interact with each other. It is defined as "an electronic environment that visually mimics complex physical spaces, where people can interact with each other and with virtual objects, and where people are represented by animated characters" (Bainbridge 2007). The features of virtual worlds include shared space, graphical user interface, immediacy, interactivity, persistence, and community (Lesko & Hollingsworth, 2010; Duffy & Penfold, 2010).

Virtual Environments can be non-immersive (i.e. desktop VEs) or total immersion. Non-immersive virtual environments can be viewed on a PC with a standard monitor; interaction with the virtual world can occur by conventional means such as keyboards, mice, trackballs, and joysticks or may be enhanced by using 3D interaction devices such as a SpaceBall or DataGlove. Non-immersive VR has advantages in that it does not require special hardware; it can be delivered via web, and therefore can reach broad audiences. Immersive VR applications are usually presented on single or multiple screens, or through a stereoscopic head-mounted display unit. The user interacts with the 3D environment with specialized equipment such as a data glove, a wand or a 3D mouse. Sensors on the head unit and/or data glove track the user's movements/gestures and provide feedback that is used to revise the display, thus enabling smooth, real time interactivity.

In this paper we focus on non-immersive, single-user VEs.

2. VIRTUAL ENVIRONMENTS AND LEARNING

2.1. Discovery Learning

Discovery learning is defined as a "self-directed way of learning in which the planning and monitoring of the learning process are in the hands of the learner" (de Jong, 2005, p. 218). Virtual environments support discovery learning as they are motivating, active experiences controlled by the individual (Coffman & Klinger, 2008). Immersion of students within a virtual environment can cultivate "learning by doing" as students use and apply their related prior experiences and further develop them by interacting with the environment (Land, 2000). The discovery learning provided by virtual environments also supports the upcoming generation of "digital natives" (Prensky, 2001, p.1) which think and learn in interactive, multimedia environments and need options for learning that are collaborative and creative (Loureiro & Bettencourt, 2010). Learning is shifting from sets of knowledge transferred between teacher and students towards a more learner-centered approach focused on experience and exploration (De Freitas et al., 2009). Previously, a significant focus of education has been to teach the basics of literacy and mathematics, but now, with the advances of technology, it is becoming necessary to address 21st century workforce skills, such as digital literacy, which will ultimately impact productivity and creativity (Bavelier et al., 2010).

2.1.1. Pedagogical Benefits of Interactive Virtual Learning Environments

The pedagogical benefits of interactive Virtual Learning Environments have been examined by researchers in the areas of computer graphics, cognitive psychology, visual cognition, and educational psychology. In general, research findings show that Virtual Learning Environments are often more effective than traditional teaching tools (Dalgarno 2004; Shin 2003; Winn 2002). More specifically, learning affordances include: "the facilitation of tasks that lead to enhanced spatial knowledge representation, greater opportunities for experiential learning, increased motivation and engagement, improved contextualization of learning and more effective collaborative learning as compared to tasks made possible by 2-D alternatives" (Dalgarno & Lee 2010, p.10). Technologies, such as VR, can be used to create interactive learning environments where learners can visualize abstract concepts easily and receive