Chapter 33
Authoring Adaptive 3D Virtual Learning Environments

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ABSTRACT

The use of 3D and Virtual Reality is gaining interest in the context of academic discussions on E-learning technologies. However, the use of 3D for learning environments also has drawbacks. One way to overcome these drawbacks is by having an adaptive learning environment, i.e., an environment that dynamically adapts to the learner and the activities that he performs in the environment. In this paper, the authors discuss adaptive 3D virtual leaning environments and explain how a course author can specify such an environment (i.e., authoring). The approach and tool that the authors present allow authors to create adaptive 3D virtual learning environments without the need to be an expert in 3D or using programming or scripting languages. The authors also conducted an evaluation to validate the approach and the usability and acceptability of the authoring tool. Based on the results, recommendations for authoring adaptive 3D virtual learning environments have been formulated.

INTRODUCTION

Virtual Reality (VR) is gaining in popularity and its added value for learning is recognized. VR provides ways to use 3D visualizations with which the user can interact. For some learning situations and topics, this may be of great value because the physical counterpart may not be available, too dangerous, or too expensive. The most famous example is the flight simulator that teaches pilots safely how to fly a plane in various circumstances. Another example where 3D has been used successfully is the domain of medicines, e.g., to simulate operations or to study the human body. Virtual worlds (such as Second Life (2003) and Active Worlds (ActiveWorlds, 1995)) are complete 3D computer environments in which the user can navigate and interact with the 3D (and possibly also 2D) objects contained in the environment. In general, some of the objects have behaviours, and users are represented by means of avatars. These virtual worlds are also called 3D Virtual Environ-

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ments. In collaborative environments, such as Second Life, users can also meet each other and collaborate or socialize. For certain subjects and for certain types of learners using a 3D Virtual Learning Environment (3D VLE) may be much more appealing and motivating than the use of classical learning material, e.g., to simulate the effect of physical laws (Cobb, Neale, & Reynolds, 1998); to simulate social environments and allow people to practice social skills (Adams et al., 2008); or to learn about history (Dede, Ketelhut, & Ruess, 2003; Di Blas, Hazan, Bearman, & Trant, 2003).

Although 3D VLEs offer many opportunities for learning, they also have their weaknesses. A novice user may be overwhelmed or get lost in the 3D VLE (Bricken & Byrne, 1992), not knowing what to do first or next. For these learners, the time required to get acquainted with such a 3D VLE may be long (i.e., low score on learnability) and therefore their short-term satisfaction may also be low. On the other hand, youngsters used to play video games, may spend their time in activities not very much related to the learning activities, especially if they have low motivation for learning. In that case, effectiveness will be low. These concerns are confirmed in Dede et al. (2003) and in Virvou and Katsionis (2008).

One way to solve these problems is by equipping 3D VLE with adaptive capabilities, i.e., allow the 3D VLE to adapt dynamically (i.e., at run time) to the individual learner and to the progress that he or she makes during the learning process. Properly designed 3D VLEs with adaptation capabilities and strategies have many advantages (Chittaro & Ranon, 2007). It could mediate the distinction between education and entertainment that could improve the learner experience and motivate him or her. Furthermore, adaptivity may be used to prevent the learner form being overwhelmed in the 3D VLE. For instance, it may be more effective to guide a learner through the 3D VLE according to his or her background and learning goals, or only show the learner the objects that are relevant for his or her current knowledge level, or adapt the environment to his or her learning style. Also adaptivity may be used to decrease the risk that learners are distracted too much and are therefore not able to focus on the actual learning task (De Troyer, Kleinermann, & Ewais, 2010). As a result, one might conclude that one of the main benefits of adaptive 3D VLE could be increasing the educational effectiveness.

However, research on designing such adaptive 3D VLEs is still in its infancy. Designing an adaptive 3D VLE involves not only the design of the 3D VLE, but also the design of the adaptive aspects of the environment, which have their own difficulties (Brusilovsky, Kobsa, & Vassileva, 1998). However, different approaches have been proposed to support this activity. Some approaches use an Artificial Intelligence approach to provide the adaptivity in an automatic way (Dos Santos & Osório, 2004), while other approaches allow the author of the course to specify when and how the environment needs to be adapted. This last approach is usually called authoring, as the author of the course is making the design. Some of the authoring approaches adopt the idea of extending adaptation techniques and architectures developed in the field of adaptive hypermedia and improve them to support adaptation on 3D contents in virtual environments as proposed by Brusilovsky (2004). Our research also follows this approach. We have extended a classical web-based adaptive learning environment towards a 3D web-based learning environment. The work has been done in the context of the GRAPPLE, which stands for "Generic Responsive Adaptive Personalized Learning Environment"), an EU FP7 STREP project aimed at the construction of a generic adaptive learning environment that can be used/accessed at home, school, work or on the move. GRAPPLE includes authoring tools that enable educators to specify adaptation strategies for the content and activities of their courses. GRAPPLE is mainly oriented towards classical learning resources (text