Chapter 10
Multi–User Mixed Reality Environments for Distance Learning

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ABSTRACT

Technological innovation is changing every aspect of our lives and extending into education, where it is introducing profound changes to both the traditional classroom and online learning environments. This chapter explores the future of MUVEs, focusing particularly on immersive mixed reality learning environments and the challenges involved in the shift to multidimensional environments in education. It reviews the earlier developments in MUVEs and identifies a barrier to their deployment in science and engineering education: their inability to support physical collaborative laboratory work. The chapter then explains how advances in mixed-reality research may offer a solution to this problem through a case study of a cutting-edge example of such an approach, the BReal Lab, together with a summary of evaluation results gained from a trial involving students in 5 different countries. Finally, the chapter concludes by reflecting on the issues raised and speculates on possible future directions that work on mixed-reality MUVEs might take.

INTRODUCTION

The use of online technology has opened opportunities for students to learn, without being constrained to a particular time or space. On-demand content allows learners to have 24/7 access to materials and resources, collaborating synchronously (e.g., chat, video conferences) and asynchronously (e.g., forums,
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wikis) with their peers, introducing social interaction which has been shown to be a key element on the learning process (Dillenbourg, Järvelä, & Fischer, 2009; Nicholson, 2008; Smith & Macgregor, 1992). Multi-user virtual environments (MUVEs) provide a 3D virtual canvas for users to populate with 3D representations of the real world, or simplifying visualisations of complex abstractions, enabling multiple simultaneous participants to access virtual contexts, interact with digital artefacts, communicate with other participants and experience situations that reflect real world dynamics (Dede et al., 2005). Traditionally MUVEs have been regarded as standalone entities separated from the real world, where users can create virtual worlds which could follow realistic physical laws and rules (e.g., gravity), or, where advantageous, differ from reality (e.g., flying, non-human avatars, etc.). They bring a sense of community and belonging which provides conditions for free and open dialogue, critical debate, negotiation and agreement, which are the foundations of education (Garrison & Kanuka, 2004). Moreover, they provide opportunities for distant participants to engage and participate in collaborative learning scenarios. Through immersion of the simulation and engagement with authentic tasks, the learners are supported in understanding the principles and concepts together with acquiring the reasoning and procedural skills needed to test their ideas (Dieterle & Clarke, 2006).

This chapter addresses innovative learning spaces created by combining MUVEs and mixed reality technologies with a particular focus on multi-user immersive reality environments, identifying relevant technologies and highlighting current trends for future advances in technology and educational applications. In doing so, the first section of this chapter introduces concepts relating to multidimensional spaces and proposes the use of mixed reality in a distributed learning environment, establishing potential benefits of using such environments over current alternatives for hands-on activities. The second section describes some of the technologies and underlying pedagogies involved in different implementations of mixed reality learning environments. In the third section, this chapter identifies the challenges faced in the shift to multi-user mixed reality learning environments. The fourth section illustrates the ideas being advocated through the presentation of an exemplar system, BReal Lab, a proof-of-concept of a multi-user, mixed reality, learning laboratory prototype, tested across three continents with culturally diverse learners. This section includes a summary of the findings from these tests. Finally, the chapter concludes by reflecting on the discussion and considering future research directions for multidimensional spaces in education.

BACKGROUND

E-Learning is perhaps the best-known form of distance learning, involving students accessing online education materials through network enabled computers, in much the same way as we might browse regular libraries and books. It is generally understood as encompassing all forms of electronically supported learning and teaching (Rosenberg, 2000). Thus, the traditional learning paradigm has shifted to a blended learning scenario, with the possibility of combining traditional classroom methods with computer-mediated activities. Garrison and Kanuka (2004) defined a continuum of e-learning with face-to-face (F2F) enhanced classrooms in one end and complete online experiences on the other, where Blended Learning is situated on any point that mixes these two approaches. Blended Learning can be understood as the thoughtful integration of F2F instructional learning experiences with computer-mediated learning experiences. The use of the term “learning experiences’” is important because immersive technologies,