Computers & Education 59 (2012) 1361–1376

Contents lists available at SciVerse ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

Studying the effectiveness of multi-user immersive environments for collaborative evaluation tasks

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ARTICLE INFO

Article history:
Received 29 April 2011
Received in revised form
6 February 2012
Accepted 6 June 2012

Keywords:
MMOL platform
Virtual world
Immersive education
Simulations
Mixed reality
Augmented reality
Socio-computacional system
Distributed learning environment
e-learning
Educational virtual world
LORI
Convergent participation model
SNA

ABSTRACT

Massively Multiuser On-line Learning (MMOL) Platforms, often called "virtual learning worlds", constitute a still unexplored context for communication-enhanced learning, where synchronous communication skills in an explicit social setting enhance the potential of effective collaboration. In this paper, we report on an experimental study of collaborative evaluation in an MMOL setting with 21 graduate students enrolled in university courses in technology-mediated teaching and learning. This study was carried out using a prototype of a 3D MMOL platform built around an interactive space called "*MadriPolis*". This space was used to recreate an adequate scenario for a collaborative experience about Learning Object evaluation using the mainstream Learning Object Review Instrument (LORI), which is based on a Convergent Participation Model (CPM). The same experience was carried out using a conventional LCMS (Learning Content Management System) platform with the aim of contrasting the outcomes and interaction patterns in the two settings. This study makes use of Social Network Analysis (SNA) measures to describe the interactions between tutors and learners. By dwelling on the advantages of immersive environments, SNA indexes revealed that these interactions were rather dense and that student participation was rather broad-based in the case of the MMOL. The results suggest that MMOL platforms could be used in collaborative evaluation tasks as a means to enhance both tutor interaction patterns and the strength of the group's relationship.

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1. Introduction

Different kinds of virtual environments are being increasingly used by universities and other institutions to enhance the learning experience of their students and staff (Menon, 2010). Collaborative Virtual Environments (CVEs) are nowadays a widespread collaboration and interaction platform for geographically dispersed participants. A CVE has been defined as follows:

> "A computer-based, distributed, virtual space or set of places. In such places, people can meet and interact with others, with agents or with virtual objects. CVEs might vary in their representational richness from 3D graphical spaces, 2.5D and 2D environments, to text-based environments. Access to CVEs is by no means limited to desktop devices, but might well include mobile or wearable devices, public kiosks, etc."(Snowdon, Churchill, & Munro, 2001).

Representational richness can also be extended to cover inputs such as sound and touch interfaces (Bailenson et al., 2008). Bowman proposes the term "Immersive Virtual Reality" (IVR), which can be defined as "complex technologies that replaced real-world sensory information with synthetic stimuli such as 3D visual imagery, specialized sound, and force or tactile feedback" (Bowman & McMahan, 2007). Among existing IVR, a category of virtual reality applications is designed for single user access which can be used in learning settings such as simulation or virtual experiences, as well as exploration of structures, spaces, buildings and other elements (Jackson & Fagan, 2000; Patel, Bailenson, Hack-Jung,Diankov, & Bajcsy, 2006). However, another category of systems is oriented to interaction inside groups of users, leading to immersive multi-user virtual environments that not only enable a perception of virtual presence resembling the real world but

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http://dx.doi.org/10.1016/j.compedu.2012.06.002

also supports collaborative activities through a number of tools. Virtual worlds can be viewed as a concept closely related to this one (Hendaoui, Limayem, & Thompson, 2008; Livingstone, Kemp, & Edgar, 2008). Unlike immersive multi-user virtual environments, virtual worlds are not only characterized by immersion and a feeling of presence and social interaction, but also by a long-lasting online environment where a large population of users can interact over time, with no time constraints. Recent examples of these environments or Virtual 3D Worlds (V3DW) are built on 3D models and enhanced 3D graphic and audio world presentations, but the human interaction "inside the world" is mainly restricted to a 2D computer screen, stereo sound, keyboard and mouse. This interface and user context is known as 2.5D. Such settings are viewed as not entirely immersive but are closer to technology that is mainstream in the consumer market (such as 3D displays, 3D video consoles or 3D Blu-Rays), and it is likely that such technology, together with improved interfaces, will soon overcome those restrictions (Kappe & Gütl, 2009; Schroeder, 2008; Sivan, 2008).

This is the perspective from which we consider Massively Multiuser On-line Learning (MMOL) platforms: immersive contexts including both a multi-user environment and a rich interface to combine real and virtual reality. However, it is important to bear in mind that we shall study MMOL platforms from an educational perspective which should always have a clear educational purpose. Therefore, for the purpose of this paper we will consider MMOL platforms as mixed reality environments constructed over virtual world servers that provide an interactive learning space by means of 2D, 2.5D or 3D technologies to build and manage collaborative and ongoing online learning environments in which individuals participate using a real or a figurative presence (avatar) (Lorenzo, 2010). The main differences between MMOL platforms and V3DW or immersive multi-user virtual environments are the following: a clear educational purpose, the integration of learning technologies/functions according to a convergent view, and the integration of the "real life learning experience" in the virtual environment (mixed reality environments).

MMOL platforms provide educators and students with the ability to connect and integrate all technologies and pedagogical principles in a way may potentially enhance the learning experience. Thus, the teacher could make use of a rich context to interact and collaborate with the students in a synchronous mode. The synchronous capabilities of MMOL platforms allow for a redefinition of the traditional teacher's role.

On the whole current e-learning approaches are based on the use of LCMSs and mainly rely on communication in asynchronous mode, using tools like forums, e-mail, HTML documents, blogs or webQuests. The collaborative aspects of virtual learning environments engage students in on-line dialog and discussion that is open-minded and cooperative in contrast to off-line debate, which is often narrow-minded and competitive. When used as learning platforms, virtual learning environments enforce student participation in a real immersive context, enabling learners to take a more active role in their learning. Moreover, MMOL platforms afford the means to take advantage of the pedagogical opportunities offered by V3DW or immersive multi-user virtual environments. In order to leverage the combination of communication tools, sense of immersion and opportunities for collaboration described above, social constructivist theories would seem to be the most appropriate (Girvan & Savage, 2010). However, 3D settings are assumed to bring about new possibilities but also new challenges when used as learning environments for online education (Petrakou, 2010). Their most significant contribution is the possibility of building active and realistic knowledge networks between real and figurative persons (avatars) around the world in a multi-user and mixed reality learning context which brings MMOL platforms to a realization of an environment supporting connectivism theory (Siemens, 2008). Additionally, they can provide exploratory learning, role-play simulations and diverse types of scaffolding to accommodate individual cognitive differences, cases in point being Situated Learning (Lave & Wenger, 1991) and Problem-Based Learning based on the educational theories of Vygotsky (Barrell, 1999). Therefore, the pedagogical framework of this new virtual context is based on the broad principles through which these theories are applied specifically to teaching practice. One benchmark is the Four Dimensional Framework – 4DF (De Freitas & Oliver, 2006) that provides a conceptual structure for understanding immersive learning, and has implications upon learning design as a whole.

This paper reports the outcome of a study of MMOL platforms for the specific task of collaborative evaluation. That kind of evaluative task is common in social learning theories in general, and can be applied to a wide range of situations. In our study, we focus on the evaluation of learning objects by means of mainstream evaluation instruments and methods. The approach to the evaluation is based on contrasting the evaluation task in two settings: the MMOL setting and a conventional setting using an LCMS and asynchronous interaction. Provided that the MMOL setting was hypothesized to achieve a better collaborative experience, the assessment employed Social Network Analysis (SNA) techniques to analyze the interaction patterns.

The rest of this paper is organized as follows. Section 2 outlines the main characteristics and functionalities of MMOL platforms that are relevant to the study presented here. Section 3 surveys related work done to date regarding the use of virtual learning environments. Section 4 presents the objectives and setting for the experiences conducted. Section 5 sets out the two case studies of learning experiences used to obtain significant data collections. Section 6 presents and evaluates the data and results from the case studies. Finally, in Section 7 some conclusions are drawn and indications given for future lines of research.

2. Background on MMOL platforms

A generic conceptual architecture of MMOL platforms is depicted in Fig. 1 which conceptualizes an MMOL platform from the perspectives of virtual/real participation on the one hand, and pedagogy on the other. As far as user participation is concerned, the access mode could be full immersive, 3D or 2.5D. The pedagogical framework is based on the use of collaborative and management tools like virtual world servers, collaboration and user profiling tools, storyboard kits and guides. The MMOL platform must be integrated with external services like WebDav, conventional LCMSs, repositories or 3D content creation suites.

Open virtual world servers and optimal render engines are the bedrock of MMOL platforms and, more particularly, the framework for virtual and inter-reality experiences. The server's functionalities need to be adapted in order to construct new convergent learning context. Anyway, one of the critical aspects of expanding the use of virtual worlds is their interoperability capabilities and subsequent, the possibilities they allow for analyzing data represented using common schemas (Lorenzo, 2011). Prominent examples of these virtual servers are:

- *OpenSim* (*http://opensimulator.org/*). The OpenSimulator project is a virtual world server for creating 3D virtual environments. It has been described as a reverse engineered Second Life that allows users to run their own Second Life Island on their own computer, and it is even possible to move objects between OpenSim and Second Life. OpenSim can be run as a standalone application or as a virtual world network in grid mode. Written in C# over .NET framework or MONO Project, it is modular, allowing developers to augment it with new functionalities via plug-in modules (similar to Apache web server). It is a real alternative to Second Life (SL) without a "darker side" (Berge, 2008b).

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