Reflecting on using a theory seeded methodology for designing and building effective 3D Multi-User Virtual Environments for vocational education

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A design-based theory seeded methodology was used in a pilot study that undertook to develop a 3D multi-user virtual environment (MUVE) for temporary traffic management education. This methodology is a synthesis of educational design-based research and software development practices. However, learning affordances in 3D MUVEs have yet to be considered. Simulation and social communication are treated as essential features that indicate affordances of 3D MUVEs. In the next iteration of the design, social communication activities, and simulation are to be explicitly used in the development of a 3D MUVE to use for training ship's bridge personnel how to communicate on the bridge in emergency situations.

Keywords: Theory seeded, education design-based, methodology, 3D multi-user virtual environment, 3D Virtual World, vocational, and technology.

Introduction

A 3D multi-user virtual environment (MUVE) for creating simulated Temporary Traffic Management (TTM) scenarios was partially developed using a theory seeded methodology (Cochrane, Davis & Morrow, 2013). Two theories were used to seed the design of the 3D MUVE. Legitimate Peripheral Participation (LPP) (Lave & Wenger, 1991), considers participants as they work to become recognized members of a trade, discipline or vocation. Technological Pedagogical Content Knowledge (TPACK) described by Mishra and Koehler (2006), is used to clarify concerns in the application of the digital technology, with pedagogy and content knowledge of traffic management in the design. While these theoretical frames were used as the principle lenses in the development of the 3D MUVE, learning trajectories (Cobb, Confrey, diSessa, Lehrer & Schauble 2003; Hunter, 2006) were also integrated into instruments (for example, semi-structured interviews) that were used to gather requirements and identify needs.

Background: developing the methodology

Plomp (2007) presents educational design based research (DBR) as having three phases, all of which include an essential overarching process that improves the theory base of education. In a preliminary research phase "needs, content analysis, literature review and the development of a conceptual or theoretical frame" (Plomp 2007, p. 15) are undertaken for the study. A prototyping phase in which "iterative design … consisting of iterations, each being a micro-cycle of research with formative evaluation as the most important research activity" (Plomp 2007, p. 15) is undertaken to improve and refine the intervention being designed. This is followed by an assessment phase that undertakes a "(semi-) summative evaluation to conclude whether the solution or intervention meets the pre-determined specifications." (Plomp 2007, p. 15). The final phase can produce recommendations for improvement, hence this phase is called the 'semi-summative phase' (Plomp, 2007). As supported by Dede, Nelson, Ketelhut, Clarke and Bowman (2004), the Design-Based Research Collective (2003) and Reeves (2006), throughout all the research activities: "the researcher or research group will do systematic reflection and documentation to produce the theories or design principles ... as the scientific yield from the research." (Plomp, 2007, p. 15).

Plomp (2007) identifies these phases in a number of DBR projects, including MacKenney's CASCADE-SEA (Computer Assisted Curriculum Analysis, Design and Evaluation for Science (and mathematics) Education in Africa). MacKenney's CASCADE-SEA, as described by Plomp (2007) was used as a basis for the methodology described in Cochrane, et al. (2013). By actively engaging tutor practitioners in a preliminary development phase and in all other phases, MacKenney's process provides for the identification of detailed curriculum by tutors who are in a real-world community of practice or discipline, reflecting a vocational education requirement.

The DBR phases described by Plomp (2007) are similar to phases described for software development. For example, as in an iterative human computer interaction design life-cycle model described by Sharp, Rogers and Preece (2007): identify needs/establish requirements, (re)design, build an interactive version (prototype) and evaluate. Given the similarity between the stages in DBR and generic stages in software development it seems methods and processes used in software development could be applied in the development of educational 3D MUVEs.

The 3D MUVE development methodology, introduced in the pilot study (Cochrane et al., 2013), uses a Scrum based Agile (Clifton & Dunlap, 2003) approach for the development of software components. An Agile approach undertakes development in "short iterative cycles of development driven by product features, periods of reflection and introspection, collaborative decision making, incorporation of rapid feedback and change, and continuous integration of code changes into the system under development"(Nerur, 2005, p. 75). The short cycles are called 'sprints'. The iterative and reflective nature of Agile software development matches the iterative and reflective nature of a DBR project.

Figure 1 depicts the design-based theory seeded methodology used in the pilot study. The methodology follows a process that extends MacKenny's process by putting an emphasis on theoretical outputs and adding Agile sprints for software development.
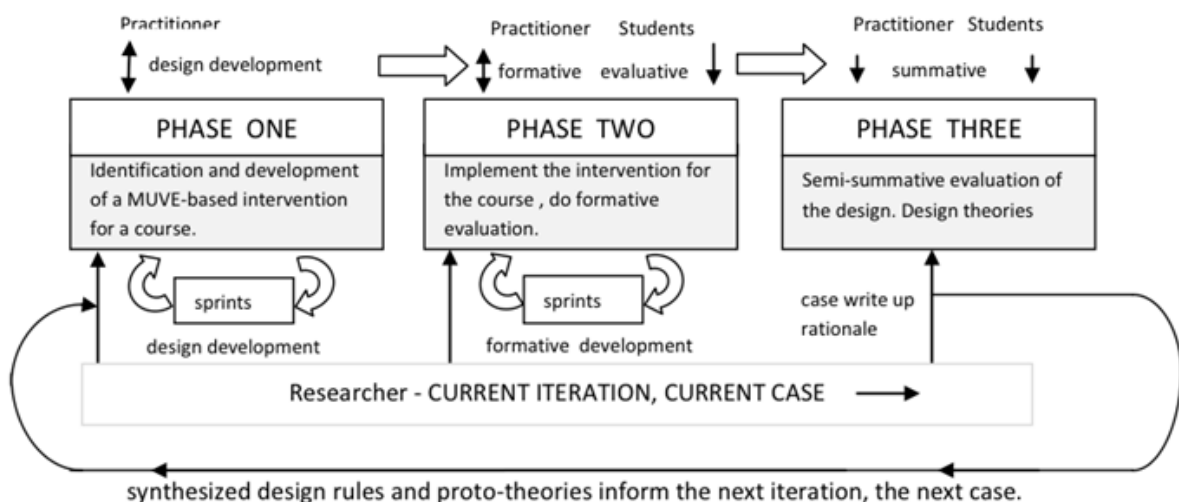

Figure 1. The processes in a methodology for developing educational 3D MUVEs.

Moving towards using affordances as part of the theoretical lens

After using the methodology in a pilot study the authors recognize that the theories applied using the methodology, while educationally appropriate in terms of using technology and for vocational education contexts, do not specifically identify affordances provided by 3D MUVEs. For example, Dalgarno and Lee (2010) identify affordances of 3D Virtual Learning Environments (VLE) in education, of particular interest is "3-D VLEs can be used to facilitate experiential learning tasks that would be impractical or impossible to undertake in the real world" (Dalgarno & Lee, 2010 p.19). In ongoing development characteristics of 3D MUVEs identified by Falconer (2013): social networking and communication, and participation in simulations, are treated as an outcome from affordances provided by 3D MUVEs.

Learning opportunities and situations in 3D MUVEs are not necessarily as a consequence of participation in a simulated situation. Mennecke, Triplett, Hassall and Conde (2010) when discussing a Share Presence theory in the implementation of an educational MUVE describe how even if the domain specific educator was not present in the MUVE, a willing educator present in the MUVE was able to provide students with assistance. Prasolova-Førland (2004) describes a MUVE, called Viras, which was based on a theory that "social awareness" affects the learner's capacity to obtain relevant information. The environment provides seeds for a structure in which members of specific communities are located near to each other, however no specific situation is simulated. The Media Zoo MUVE, as described by Wheeler (2009), was designed for staff at the University Leicester "to experience, interact and understand the potential educational applications of learning technologies" (Wheeler 2009, p. 427). The Media Zoo MUVE does not simulate a real situation for practice, it reproduces an environment to communicate with educators about learning technologies.

By contrast a number of vocational education 3D MUVEs are specifically simulation based. Broadrib and Carter (2009) describe a course where Second Life® was used to role-play office activities. They surveyed participants before and after but even though they found an increase in the capacity of the participants, as far as the learning goals were concerned, they could not attribute this directly to the MUVE. Walker and Rockinson-Szapkiw (2009), describe using Second Life® for education in clinical counselling, suggest that problems with the voice over IP system limits the authenticity of the experience. Vergara, Caudell, Goldsmith, Panaiotis and Alverson (2009) describe the Mr Toma medical simulation, a virtual patient implemented in a MUVE, that they conclude effectively replaces the physical experience with the virtual experience. Furthermore, Gerald and Antonacci (2009) and Hewitt, Spencer, Mirliss and Twal (2009) take the perspective that MUVEs should be used for the development of simulations of authentic situations rather than for constructivist learning experiences.

In the next iteration of the present research a 3D MUVE for a ship's bridge, in which bridge personnel can practice professional communication skills under extreme circumstances is to be developed. In this development social communication, and simulation are to be integral to the design of the requirements analysis instruments and throughout the development processes, alongside LPP and TPACK education theories.

Summary

A pilot 3D MUVE was developed using a developmental DBR methodology. The first use of the methodology did not integrate affordances from 3D MUVEs into the processes. Social communication and simulation are considered to demonstrate affordances of 3D MUVEs, hence these are to be made integral in the design of the instruments to be used in the next developmental case.

A ship's bridge personnel communication training has been selected because it contains strong simulation and communication requirements. This case is also an example of a 3D MUVE that, when implemented, affords experiential learning in situations that are impossible or impractical in the real world, as described by Dalgarno and Lee (2010).

Conclusion

Using a theory-seeded methodology in a DBR project to develop an intervention for a vocational educational context provides appropriate 'tools' for use in the design of real learning situations and also as 'vessel' for research. This design based methodology provides useful stimuli for reflection and development of educational theory, even in the initial stages of the development. Development of this TTM MUVE applied educational theories suited to the education context and also identified requirements for a second case. The next iteration of

DBR will investigate the integration of affordances into the development of an intervention with the 3D MUVE for training ship's bridge personnel in communication on the bridge during emergency situations.

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