

# Chapter 12

## Computer–Generated Three–Dimensional Training Environments: The Simulation, User, and Problem– Based Learning (SUPL) Approach

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### **ABSTRACT**

*Problem-based learning is an instructional strategy that emphasises the accumulation and development of knowledge via an active and experiential based approach to solving problems. This pedagogical framework can be instantiated using gaming technology to provide learners with the ability to control their learning experience within a dynamic, responsive, and visually rich three-dimensional virtual environment. In this regard, a conceptual framework referred to as the Simulation, User, and Problem-based Learning (SUPL) approach has been developed in order to inform the design of 3D simulation environments based on gaming technology within a problem-based learning pedagogy. The SUPL approach identifies a series of design factors relative to the user, the problem-solving task, and the 3D simulation environment that guide the learning process and facilitate the transfer of knowledge. This paper will present a simulation environment design according to this conceptual framework for a problem-solving task within the context of an underground mine emergency evacuation. The problem-solving task will be designed to satisfy learning objectives that relate to the development of knowledge and skills for emergency evacuation of the Dominion Mining's Challenger mining operation located in South Australia.*

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## **INTRODUCTION**

Computer-generated three-dimensional (3D) simulation environments allow users to experience real, recreated, abstract, or imaginary environments that may be of impractical size, infeasible distance, prohibitive cost, or too significant a hazard to experience in person (Baylis, 2000). As such, 3D simulation environments provide safe and effective tools for education and training, enabling the development of knowledge and skills for use in real world environments. Most importantly, the virtual environment can authentically represent aspects of the real world to enhance learning transfer (Brown, Collins, & Duguid, 1989; Dobson et al., 2001).

The technical development of 3D environments has been heavily influenced by innovations within the gaming industry, where high consumer demand has driven rapid advancements in associated hardware and software technologies. This is particularly evident with regard to First Person Shooter (FPS) games, where the player is provided with a first person perspective of a three dimensional environment. FPS games are typically characterised as being on the cutting edge of gaming technology in terms of visual fidelity and performance, and have amongst the highest of expectations placed upon them by the gaming public. The abilities of 3D gaming technologies, in particular the game engines used to power FPS games, have not gone unnoticed, with proponents of computer assisted learning recognising the potential of these technologies to function as simulation environments. This has given rise to the serious games movement, which focuses on the application of gaming technologies and concepts for simulation and learning purposes. FPS game engines have been successfully used to this end in fields such as architecture, defence, mining, and occupational health and safety (Bonk & Dennen, 2005; Malhorta, 2002; Mantovani, Gamberini, Martinelli, & Varotto, 2001; Orr, Filigenzi, & Ruff, 2003).

In order to facilitate learning in a simulation environment, the environment must go beyond modelling the system to provide goals and guidance for the end user (de Jong et al., 1998; Withers, 2005). One such framework that is consistent with the experiential and user-focussed nature of 3D simulation environments is that of problem-based learning. The process of solving problems and the subsequent knowledge that is acquired during the learning process supports the generation of contextual knowledge for use in future applications (Hmelo-Silver, 2004). Problem-based learning promotes active, transferable learning whereby learners use the task to develop a strategic model that can go beyond the specific problem to solve future problems (Barrows & Tamblyn, 1980).

## **2. PROBLEM-BASED LEARNING WITHIN A 3D SIMULATION ENVIRONMENT**

Problem-based learning is an approach to learning that is situated in problem-solving experience and consistent with experiential-based learning (Hmelo-Silver, 2004). Two fundamental postulates drive problem-based learning; that learning through problem solving is more effective in the creation of bodies of knowledge usable in the future, and that problem-solving skills are more important than memory skills (Barrows & Tamblyn, 1980). Problem-based learning uses problems as the stimulus and focus for student activity and differs from other instructional methods in that it begins with problems rather than with the exposition of disciplinary knowledge (Boud & Feletti, 1997). Problem-solving forms the primary process through which learning takes place. This is influenced by both factors internal to the problem solver, in terms of their existing knowledge, skills, and experience, and external in terms of the variable characteristics and representation of the problem (Jonassen, 2000; Lee, 2004; Newell & Simon, 1972; Smith, 1988; Zhang, 1991).

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