Chapter 1.17

The Path between Pedagogy and Technology:
Establishing a Theoretical Basis for the Development of Educational Game Environments

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ABSTRACT

The power of computer game technology is currently being harnessed to produce "serious games". These "games" are targeted at the education and training marketplace, and employ various key game-engine components such as the graphics and physics engines to produce realistic "digital-world" simulations of the real "physical world". Many approaches are driven by the technology and often lack a consideration of a firm pedagogical underpinning. The authors believe that an analysis and deployment of both the technological and pedagogical dimensions should occur together, with the pedagogical dimension providing the lead. This chapter explores the relationship between these two dimensions, and explores how "pedagogy may inform the use of technology", how various learning theories may be mapped onto the use of the affordances of computer game engines. Autonomous and collaborative learning approaches are discussed. The design of a serious game is broken down into spatial and temporal elements. The spatial dimension is related to the theories of knowledge structures, especially "concept maps". The temporal dimension is related to "experiential learning", especially the approach of Kolb. The multi-player aspect of serious games is related to theories of "collaborative learning" which is broken down into a discussion of "discourse" versus "dialogue". Several general guiding principles are explored, such as the use of "metaphor" (including metaphors of space, embodiment, systems thinking, the internet and

emergence). The topological design of a serious game is also highlighted. The discussion of pedagogy is related to various serious games we have recently produced and researched, and is presented in the hope of informing the "serious game community".

INTRODUCTION

The use of computer game technology, especially the deployment of commercial game engines such as Unreal Tournament 2004 (UT2004) is becoming an established activity with 'Serious Games' research projects. Despite these projects, there has been little attempt to develop a theoretical basis for the production of educational and training immersive environments (IEs). In this chapter we discuss our approach to establishing a theoretical basis for the construction of Serious Game IEs based upon pedagogical principles. The domain discussed in this paper refers to physics education, though our research has included other domains such as software programming, education of architects and artists, and training of police officers. In this section we establish a correspondence between the various affordances of the game engine and associated pedagogical principles. In subsequent sections we discuss several pedagogical principles which map neatly onto game engine affordances. Within a discussion of (i) non-collaborative, i.e. instructional and autonomous learning and (ii) collaborative learning, we highlight approaches derived from Concept Maps, Experiential Learning Theory, Adaptive Learning and the socio-cultural theory of Vygotsky. Within (ii) we apply theories of collaborative learning based on the cognitive approaches of Dillenbourg, discourse analysis and contemporary dialogic theory according to Bakhtin. Theoretical approaches are juxtaposed with a discussion of the practical affordances of the UT2004 game engine. Many, but not all of our theories and design principles have been tested in various IEs, yet we believe that a theoretical

approach, as suggested here, may be of great use to educational game developers. There is of yet, no 'theory' of computer games, since the discipline is too young, there is insufficient material to be subject to a scientific analysis and therefore to the establishment of a theory. The design of computer games is grounded in principles which have been informed by classical (e.g. board) games, as well as the digital technology which supports the development of commercial games.

An example of an IE created with UT2004 is shown in Figure 1. Here, in this room, two learners and an instructor are engaged in collaborative discussion about a physics experiment involving objects, shown as spheres, which move under the influence of gravity with or without the friction provided by air resistance. Each person has 'logged in' through an internet connection to the game engine supporting the IE. The engine faithfully represents the motion of the objects (through the physics engine component). Collaborative learning is supported through spoken communication; each person has headphones and a microphone. Through discussion they may negotiate which experiment to perform and how to perform it, setting parameters and analysing logged data. This room is connected to other rooms where additional approaches to learning about gravity are explored. Further rooms explore additional concepts associated with this aspect of physics.

Figure 1.
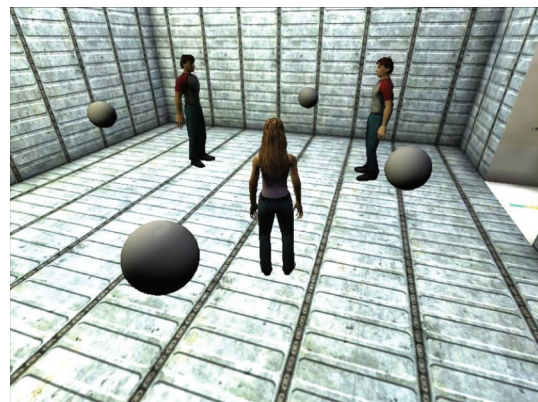
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