Chapter 14
Principles and Signatures in Serious Games for Science Education

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ABSTRACT

The World Wide Web Instructional Committee at North Dakota State University has developed a number of serious games aimed at science education. Their games are all multiuser, with a role-based orientation, promoting a task-and-goal cultural awareness. Constructed in collaboration with content experts, these games were developed under a proven set of design guidelines (design principles and signature elements) that serve to preserve consistency among the applications. As a consequence of this high-concept design constraint, their systems share important cognitive and pedagogical features that assist players in learning the serious game content while also allowing for consistent evaluation of learning outcomes across games. The authors have formatively evaluated these games and found them to be effective. It is now their hope that by sharing their design guidelines, others may be able to use and evaluate them to their advantage. The authors continue to develop and refine these design principles and signature elements through basic and evaluative research.

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INTRODUCTION

The World Wide Web Instructional Committee (WWWIC) has developed a number of serious learning games, all sharing the same strategic principles and signature elements. The games provide an immersive, spatially oriented, game-like, highly interactive, exploratory, goal oriented, learn by doing, role-based, and multiplayer experience. The underlying argument is that experiences and rehearsal lead to expertise, and so WWWIC games provide serious experiences to maximize learner achievement (Slator & Associates, 2006).

BACKGROUND

The WWWIC at North Dakota State University (NDSU) is an ad hoc group of faculty, staff, and students dedicated to the development of immersive virtual environments, or IVEs, for education. These serious games focus on physical and social science topics such as geology, cell biology, anthropology, and economics.

WWWIC games share a common “signature” on both the pedagogical design and implementation level. At a pedagogical design level are the qualities listed above: immersive, spatially oriented, game-like, highly interactive, exploratory, goal-oriented, learn by doing, role-based, and so forth. These principles are echoed by others working in this field such as Gaydos & Squire’s chapter on “designed experience” (in press).

At the interface and implementation level, NDSU WWWIC games combine the specificity of science-based educational games with techniques developed both academically and commercially to increase productivity and decrease development costs. We have developed a model for the creation of serious games based on this signature that we describe here for review, use, and evaluation by others working in this field.

This chapter will begin with a description of the design principles and signature elements of the WWWIC IVE model, followed by descriptions of a number of serious games and how they fit into the model. We end with a discussion for further research.

DESIGN PRINCIPLES

IVE Cultural Context

Contextual learning is the catalyst for new frontiers of learning research between anthropology and immersive virtual role-based learning computer sciences. The IVE “world” is both cultural artifact and sociocultural experience. This virtual world can be described as a semi-isolated cultural system.

The anthropological contribution to a science of learning involves understanding how student engagement of problems in a cultural context affects learning and affects individual and group knowledge. Following examples of ethnographic studies in education (Wolcott, 1985, 1991), immersive virtual role-based environments can be described as cognitive artifacts for education, that is, as tools for learning. Cognitive artifacts are fundamental to most of humanity’s learning processes (Bidney, 1947; D’Andrade, 1989; Norman, 1993). As cognitive artifacts, the virtual role-based worlds for education are constructed purposefully for student immersion in scientific and humanities problems.

Immersion in IVEs

Immersion in IVEs means the student is plunged into a virtual environment in the role of a particular persona. Scientists and scholars working with IVEs refer to these immersive contexts for learning as authentic scenarios. Anthropology defines these authentic scenario worlds as cultural in the sense that the world is made up by a selection of traits from a universe of possibilities (Batteau, 2000). Specifically, the world is designed to offer a
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