Chapter XXXIX
Designing a Computational Model of Learning

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ABSTRACT

What would a game or simulation need to have in order to teach a teacher how people learn? This chapter uses a four-part framework of knowledge, learner, assessment, and community (Bransford et al., 2000) to discuss design considerations for building a computational model of learning. A teaching simulation—simSchool—helps illustrate selected psychological, physical, and cognitive models and how intelligence can be represented in software agents. The design discussion includes evolutionary perspectives on artificial intelligence and the role of the conceptual assessment framework (Mislevy et al., 2003) for automating feedback to the simulation user. The purpose of the chapter is to integrate a number of theories into a design framework for a computational model of learning.

INTRODUCTION

The key question of this chapter is, "What would a game or simulation need to have in order to teach a teacher how people learn?" The chapter assumes that it is possible and desirable to create such a computational model for several reasons. First, a groundswell of research indicates a wide range of interesting benefits of educative games and simulations (Prensky, 2002; Beck & Wade, 2004; Gee, 2004; Squire, 2005): why we should build educative games (Galarneau & Zibit, 2006; Jones & Bronack, 2006), and what options and frameworks are available for building them with a technical and artistic balance of pedagogy, simulation, and game elements (Aldrich, 2005; Becker, 2006; Gibson, 2006; Stevens, 2006; Van Eck, 2006). Second, training needs in business, government, industry, and the military are already being addressed by a variety of games and simulations, but few if any efforts are addressing the need for effective training of the instructors. Third, teacher shortages and the lack of adequately

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prepared teachers who persist in the profession are perennial challenges of K-12 education—a situation that may be improvable through games and simulations. Fourth, teachers who learn by playing games may be more open to the motivational potential of games and more likely to use playful engagement strategies in their teaching.

It is important to combine and to an extent equate digital games and simulations. While there is a difference in emphasis in the two approaches, they are united in that both utilize some kind of application engine that displays an interactive microworld to a user and invites "playing around" within the boundaries of that system (Gibson, 2006). As the user interacts with the application, expertise develops. The subtleties of whether there are clear goals, rewards, and an emotionally charged atmosphere embedded in the interaction (as found in many games) or whether the user sees and acts within a realistic microworld (as found in many simulations) are important considerations, but not essential to the exploration of the characteristics needed to build a game or simulation capable of teaching a teacher about how people learn.

Recent efforts to research, design, and implement games to improve teaching have begun to surface. *Classroom Sims,* marketed by Aha! Process, Inc. is based on work by Dr. Ruby Payne. *Cook School District,* by Drs. Gerry and Mark Girod of Western Oregon University, is based in the "Teacher Work Sample Methodology." *simClass,* in two versions developed by graduate students of Dr. Youngkyun Baek of the Korea National University of Education, is based on the ARC model of motivation, multiple intelligences, and other theories. *simSchool,* developed by me, Bill Halverson, and Melanie Zibit, is based on psychological models integrated with ideas from learning theory, cognitive science, computational neuroscience, complex systems, and artificial intelligence. This chapter will use *simSchool* as an illustration to help make the ideas more concrete.

The characteristics of a game or simulation designed to improve teaching need to take into account four broad arenas of learning theory supported by cognitive science and the research on teaching and learning, outlined in a National Research Council report on the "How People Learn" (HPL) framework (Bransford et al., 2000). The HPL framework elements are:

1. The characteristics of the learner,
2. The nature of knowledge,
3. The role of a community in shaping expertise, and
4. The role of feedback in shaping performance.

It is important to point out that the HPL framework, and the goal of computationally modeling it, is not a model of "transmission of knowledge to students." Rather, it is a whole-systems perspective on how people learn, a subset of which learning takes place in traditional classrooms. There are aspects of the art and science of teaching that need more clarification in order to be computationally modeled, for example, how a teacher motivates students, how attitude changes take place, and how affective behaviors are shaped. The aspects offered in this chapter are a starting point, not the last word, on modeling how people learn in a classroom.

A game or simulation that intends to improve teaching needs to take the HPL domains into account as a natural part of the "game-play," not as didactic elements to be presented, reinforced, and tested in order to take advantage of the important difference between "teaching about something" using didactic methods and "teaching through action" using direct engagement and practice. Consider the difference between reading a chapter on flight and practicing in a flight simulator, then flying a real plane. The approach taken here concentrates on what it would take to create an engaging hands-on first-person experience that allows developing and practicing one's teaching

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