Chapter 3
Intelligent Tutoring and Games (ITaG)

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ABSTRACT
Intelligent Tutoring Systems (ITSs) have been producing consistent learning gains for decades. The authors describe here a conceptual framework that provides a guide to how adding game-based features and components may improve the effectiveness of ITS learning environments by improving students’ motivation to engage with the system. A problem consistently faced by ITS researchers is the gap between liking and learning. ITSs effectively produce learning gains, but students often dislike interacting with the system. A potential solution to this problem lies in games. ITS researchers have begun to incorporate game-based elements within learning systems. This chapter aims to describe some of those elements, categorize them within functional groups, and provide insight into how elements within each category may affect various types of motivation.

INTRODUCTION
Many contend that the future of affordable, high-quality education lies in harnessing the potentials of computer technologies. While implementing computer technologies in schools has had both failings and challenges (Dynarski et al., 2007), significant progress in the quality of education to some extent depends on our ability to leverage the many advantages of computer technologies. Recent advances in computer technologies include interactive tutors that can mimic very closely the best features of human one-on-one tutoring. Intelligent Tutoring Systems (ITSs) afford adaptive, one-on-one tutoring to individual students in the classroom and have demonstrated remarkable success in helping students learn challenging content and strategies (Woolf, 2009). Nonetheless, we propose that a new generation of learning technologies will emerge from hybrid systems that combine ITS and
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game-based principles. Whereas ITS principles maximize learning, game technologies maximize motivation. Hence, serious games can be expected to optimize learning with the incorporation of ITS principles, and ITSs should be rendered more engaging to the student by incorporating inherently motivating game components. We call this combination of best practices, Intelligent Tutoring and Games (ITaG). In this chapter, we focus on the potential benefits of integrating game-based features into existing ITSs. For this purpose, we propose a conceptual framework that can be used to guide the integration of games into ITSs.

BACKGROUND

Game Research

Game research is booming. In 2007, industries such as music and movies saw either negative or stagnant growth (-10.0% and +1.8% respectively), but the gaming industry reported dramatic growth (+28.4%; Combs, 2008). It is arguably the fastest growing area of learning research in the 21st century, and spans multiple disciplines, including: computer, education, and social sciences.

There are numerous goals of game research. One area has examined whether, how, and what students learn from entertainment games (e.g., SimCity, World of Warcraft). A second area concentrates on the development of serious games and evaluates the degree to which these games both engage learners and help them learn. A third area of research focuses on identifying the features of games that best promote learning in the context of serious games.

In this chapter, we propose two additional areas of research that have yet to be extensively promoted in the literature. The first is to examine the benefits of adding ITS or learning principles to serious games. Learning principles would include notions such as the importance of generating information, paraphrasing, summarizing, explaining, observing and evaluating examples, modeling-scaffolding-fading, cognitive disequilibrium, practicing skills, and receiving feedback (as well as principles on how to schedule feedback). For example, research has indicated that various forms of instructional support can facilitate learning from games (Moreno & Mayer, 2005; Rieber, 2005; Shaffer, 2007; Swaak & de Jong, 2001), including guidance, tutors, explanations on feedback, and prompted reflection. The second relatively new area of research under focus in this chapter is on the benefits of incorporating game-based principles into established ITSs. Together, these two areas of research form the essence of ITaG, the optimal fusion of principles of learning and motivation for creating games that are enhanced with learning and game principles. The ultimate goal is to better understand the features of ITSs and games that can be most effectively merged within a learning environment (i.e., optimizing learning, motivation, and engagement).

Goals for Learning Technologies

Educational problems in the United States are readily apparent. These problems are manifested in national and international tests of reading, science, and math. Students in the United States score lower on measures of reading comprehension than students in many other countries (Snow, 2002). A staggering 26% of 8th grade students cannot read even at the basic level (Donahue et al., 2003). Test scores indicate that our students’ reading comprehension scores have not improved in over a decade. In 1992, U.S. 8th graders scored an average of 260 (out of 500), whereas in 2007 U.S. 8th graders scored an average of 263 (Snyder, 2009). Our record on science achievement is even worse. In 1996, U.S. 12th graders scored an average of 150 (out of 500) but in 2005, U.S. 12th graders scored an average of 147 (Snyder, 2009). The NAEP scores in 2000 and 2005 (National Center for Education Statistics, 2001, 2006) have generally declined; indeed, at grade 12, the per-