

## Chapter 16

# Establishing a Science of Game Based Learning

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### ABSTRACT

*Using video games to train and educate is a notion that is gaining traction among gamers, parents, and serious educators alike. Unfortunately, to date there have been few rigorous studies to determine whether games can be effective learning tools. Given their inherent features, the authors feel certain that games can teach, and they are interested instead in addressing the question of how best to design games that will optimize learning. To accomplish this goal, the authors offer a simple framework for organizing variables and then discuss findings from psychology and education as a basis to formulate a research agenda for game-based training. In doing so, they hope to stimulate researchers to conduct appropriately controlled experiments that will begin to provide insight into how various features affect motivation and learning. In this way, a true science of educational games can be formed.*

### INTRODUCTION

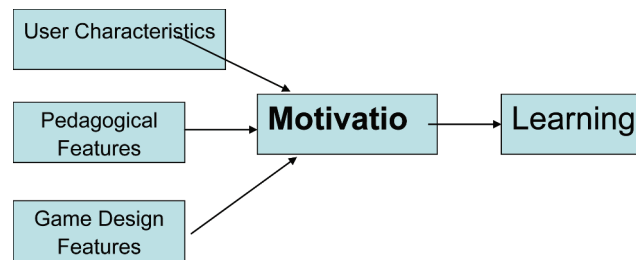
While preliminary evidence from literature reviews supports the potential effectiveness of learning through electronic games (Garris, Ahlers, & Driskell, 2002; Gopher, Weil, & Bareket, 1994; Green & Bavelier, 2003; Knerr, Simutis & Johnson, 1979; Sims & Mayer, 2002; Vogel, et al., 2006), considerable theoretical and empirical work is still

needed (Hays, 2005; O'Neil, Wainess, & Baker, 2005). Specifically of interest are the elements that differentiate games from other types of technologies used in learning and training settings; primarily simulations and virtual worlds.

The purpose of this chapter is to provide a foundational perspective from which a research agenda for studying games for education and training may be drawn. General conclusions from the science of learning serve as a basis to support the idea that games have the *potential* to teach and

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Figure 1. Framework for organizing gaming features and learning



train effectively; however, the burden lies with the researchers seeking to determine *if*, *how*, and *why* games improve learning. Therefore, we must consider a range of characteristics that may contribute to the effectiveness of games as learning tools. Of course, not all games will have all of these characteristics. However, through this decomposition of potential research variables, it is hoped that their individual, mixed, and cumulative effects on learning will be parsed. Variables ranging from user, pedagogical, design, and implementation characteristics are discussed for use in future research campaigns geared towards rigorous evaluations of their effectiveness.

## THE POTENTIAL OF GAMES AS EDUCATIONAL AND TRAINING TOOLS

Since empirical efforts to study educational games are few and far between, it is important to consider findings from psychology and education that have driven the education, simulation, and training industries for several decades. As such, we offer a fairly straightforward model of the learning process to serve as an organizing framework. As is evident from Figure 1, we posit that characteristics of the user, pedagogical features embedded in the game, and game design features can all affect the user's motivation to interact with the game, and in turn, influence learning. We also hypothesize that some of the features within these categories may exert a direct impact on learning.

An explanation of elements of this model, along with delineation of features that fall within these categories, is detailed in the following sections. We also include a discussion of implementation issues that could certainly have an impact on educational game effectiveness.

## MOTIVATION AND LEARNING

Motivation has been implicated as a crucial antecedent to learning (e.g., Clark & Wittrock, 2000; Garris et al., 2002; Tannenbaum, Mathieu, Salas, & Cannon-Bowers, 1991). For example, it has been found that motivation to learn can affect learning outcomes. Moreover, learners who have higher motivation may be more likely to voluntarily play a learning game, and/or spend more time playing it. In both instances, we would expect higher learning games. Hence, any feature of a learning environment that enhances motivation should also, theoretically, enhance learning. Research is needed to further explicate the motivational aspects of games. For example, we hypothesize two types of motivation that could have an impact on learning, *motivation to play* and *motivation to learn*, which may exert differential influences on learning, and be determined by different features of the game or environment.

**Motivation to play.** It is quite possible that what is traditionally measured as a person's willingness to participate in an activity could be separate from and might actually negatively impact a person's acquisition of knowledge. Motivation

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