Chapter XIV
Current Practices in Serious Game Research: A Review from a Learning Outcomes Perspective

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ABSTRACT

Despite scant empirical substantiation, serious games are in widespread use. The authors review 28 studies with empirical data from a learning outcome perspective to outline the effectiveness of serious games (compared to other learning approaches and specific game features). They conclude that serious games potentially improve the acquisition of knowledge and cognitive skills. Moreover, they seem to be promising for the acquisition of fine-grid motor skills and to accomplish attitudinal change. However, not all game features increase the effectiveness of the game. To further advance game research the chapter proposes recommendations including the alignment of learning outcome(s) and game type, the alignment of the game complexity and human cognitive processes, attention for cognitive and motivational processes, research on specific mitigating factors like gender on game effectiveness and, finally, developing new ways of assessing game effectiveness.
INTRODUCTION

The use of games in learning and instruction, often referred to as serious games, has been propagated by many researchers. Serious games are hypothesized to address both the cognitive and affective dimensions of learning (O’Neil, Wainess & Baker, 2005), to enable learners to adapt learning to their cognitive needs and to provide motivation for learning (Malone, 1981). However, reviews focusing on serious games have revealed little substantiation for these claims (Fletcher & Tobias, 2008; Kirriemuir & McFarlane, 2004; Leemkuil, de Jong & Ootes, 2000; O’Neil et al; Vogel et al., 2006).

This review focuses on the learning outcomes for two reasons. First, typically serious games aim at specific learning goals and consequently for specific learning outcomes as well. Therefore it seems obvious to conduct the review from this perspective. Secondly, many studies on serious games have focused particularly on cognitive learning outcomes: learning of knowledge and problem solving skills. Consequently, previous reviews have focused on particular types of learning outcomes and have neglected other types. We contend that a comprehensive taxonomy of learning outcomes will not only reveal in which situations serious games improve learning, but also uncover dimensions of learning that have been neglected thus far in reviews.

In the remainder of this chapter we first define games. Next, we present a taxonomy of learning outcomes. For each learning outcome we then review relevant studies and draw some conclusions. Finally, we present some directions for future research and draw a final conclusion.

WHAT ARE GAMES?

A serious game is a computer based game with a primary purpose other than entertainment, ranging from anywhere between advertisements to military training exercises (Michael & Chen, 2005). Naturally in this review we will concern ourselves mainly with games that aim at the aforementioned learning outcomes. Many definitions exist that describe a game (cf. Garris, Ahlers & Driskell, 2002; Vogel et al., 2006), but mostly a definition along the following lines is chosen: that it is goal-directed, a competitive activity (against the computer, another player, or oneself) and conducted within a framework of agreed rules (Lindley, 2004). In addition, games constantly provide feedback to enable players to monitor their progress towards the goal (Prensky, 2001).

A TAXONOMY OF LEARNING OUTCOMES IN SERIOUS GAMES

There are many classifications of learning outcomes. Traditionally, researchers have focused on the cognitive dimension of learning outcomes (Bloom, 1956; Gagné, 1977). Others have included affect-oriented objectives such as appreciation (Krathwohl, Bloom & Masia, 1964). More recent, other classifications have emerged identifying factors such as collaboration/teamwork, communication and self-regulation as potential outcomes of learning (Baker & Mayer, 1999). An interesting classification of learning outcomes has been provided by Kraiger, Ford and Salas (1993), who distinguish between cognitive outcomes (e.g., problem solving), skill-based outcomes concerning the development of technical or motor skills, and affective outcomes including attitude and motivation. Drawing from the two latter classification schemes, we propose a taxonomy consisting of four categories of learning outcomes: cognitive, motor skills, affective and communicative. Figure 1 presents an overview of these learning outcomes and their constituent parts.

Cognitive learning outcomes can be divided into knowledge and cognitive skills. Knowledge refers to encoded knowledge reflecting both text-oriented (e.g., verbal knowledge) and non