Chapter XVI
COTS Computer Game Effectiveness

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ABSTRACT

This chapter looks at the effectiveness of commercially available educational computer games. It defines what a game is from game theory and what an intelligent tutoring system is, suggests some concepts from these areas to use for game development, and reflects on some surveys of commercial off-the-shelf (COTS) educational software, including computer games. Two effectiveness studies conducted at John Jay High School, and the results of the studies are presented on the educational computer game Math Blaster Algebra. *One of the studies showed a positive learning increase from using* Math Blaster Algebra. *Both studies showed no negative impacts on scores and grades with more time playing the game. With lessons learned from game theory, the intelligent computer-based training field, and these effectiveness studies, educational computer gaming can continue to grow, be effective, and be accepted into educational systems.*

INTRODUCTION

For centuries, people have played games. Some of the games have been educational. In recent history, games have been made available electronically, on separate handheld devices and on computers, either on standalone computers, networked machines, or over the Internet.

There have been a number of books about computer games and learning, including those by Gee (2003), Michael and Chen (2006), and Pensky (2001), but no effectiveness studies have been made available to the public on these commercial off-the-shelf educational computer games. Many educational software title materials say that they help in learning, but do not show any empirical tests.

This book discusses the effectiveness of educational electronic games. The objective of this chapter is to present results of some surveys of commercial off-the-shelf (COTS) educational computer games, to report on effectiveness studies on one of the COTS games, and to discuss a possibility for improving the effectiveness of learning for students who play these games. The effectiveness study procedures are presented of *Math Blaster Algebra* with some Algebra 1 students at John Jay High School. The statistically significant results are shown in detail. Hopefully, others will become more interested in making good games and performing effectiveness studies on games by improving on the methods and procedures presented here.

BACKGROUND

Every game has at least one player, often two, and even more. Single-player games are often called puzzles. Every game has a goal or outcome that a player or set of players is working to achieve. Sometimes the goal is just to score points or collect objects, and sometimes when the goal is met, the game is over. Every game has rules that the players play by, even if the rules are not well defined or change during game play. In every game, players are making moves where they select actions from a set of possible actions. The moves may be turn-based or simultaneous with other players. In addition to these characteristics of a game, every educational game has an objective to teach or practice some kind of knowledge or skill.

The following sections outline some background areas of work that may be useful in the development of educational computer games so that the games can be more effective for teaching and learning. Some concepts are presented from game theory and intelligent tutoring systems that include concepts from artificial intelligence and instructional design theory. These two topics are referred to in the last sections of this chapter to potentially improve the learning effectiveness of educational computer games. There is also a summary of surveys that have been done on commercially available educational software that were used to help select *Math Blaster Algebra* for the studies.

GAME THEORY

The study of games began to be formalized with the mathematical field of game theory (Osborne & Rubinstein, 1994). Players in a game are contenders that can be human, machine, nature, or other entities. The players control some piece of a situation in a game. Games with many players are called n-person or multiplayer. A strategy is a set of rules that a player uses to play the game. A move by a player is given by the player's strategy. A move determines the next state of the game. Players are contending for various payoffs that are the results or consequences for the players at the end of the game. A player may get a reward or have to give up something.

One way to define a game is by the rules of the game, including the relationships between players, who moves when, what information is