Chapter 63
Video Gaming for STEM Education

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ABSTRACT

The focus of this chapter is how video games can be utilized for instructional purposes, specifically in the STEM areas (Science, Technology, Engineering, and Mathematics). Gaming, as an instructional tool, enables educators to create participatory learning activities, assess understanding of complex and ill-formed situations, facilitate critical thinking and problem solving capabilities, and ensure active engagement across the learning continuum for all students. How to use it effectively, however, is a topic of debate among many educational scholars.

In order to create innovative ways to teach classic concepts using video games, instructors need diverse skills: technology skills to access video games that meet the needs of today's learners for active engagement, instructional skills to integrate theory and practice, as well as adhere to the standards of academic rigor, and leadership skills to guide students to higher levels of critical and creative thinking.

Therefore, this chapter will explore the vast world of video games and the opportunities for instructors to incorporate them into lesson planning. The basis of this empirical work is to align the guiding principles of STEM with the identification of accessible games, based upon learning principles and assessment strategies. The challenge for 21st century educators will be how to bridge the gap between the traditional development of skill sets to meet workforce demands in a dynamically changing global economy that simultaneously creates employees who are capable of innovation, collaboration, and deep critical thinking.

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GAMEPLAY AND LEARNING

To this point, there have been many successful implementations of gaming for educational purposes. One example is a study by Rosser, Lynch, Haskamp, Gentile, and Yalif (2007), which was conducted at the Beth Israel Medical Center in New York for the Laparoscopic Skill and Suturing Program. The participants were introduced to Gastrointestinal and Colonoscopy procedures using a specially designed videoscopic surgical environment. The video games were Super Monkey Ball, Star Wars: Racer Revenge, and Silent Scope. Each game tested a specific skill that would be applicable surgical techniques such as depth perception, spatial awareness, task accuracy, precision, and speed. The study found a correlation between video gaming skills and laparoscopic surgical skills "those surgeons whose video gaming exceeded three hours or more per week, had 37% fewer errors and 27% faster completion in the Rosser Top Gun Laparoscopic Skills and Suturing program than did their non-gaming counterparts."

The benefits of using games in all of the STEM areas, not just science, are noted throughout the literature. Implementation of their use is evolving. Some of the hindrances to their incorporation into the total spectrum of best practices for learning are: the cost of the technology, thus insufficient hardware and software, the unwillingness of some educators to try new pedagogical techniques, and the lack of educator training. Most of the articles also point to the lack of empirical evidence to prove that the games actually do impact learning and to what extent.

In 2003, Rollings and Adams defined gameplay as "one or more causally linked series of challenges in a simulated environment" (Kiili, 2004, p. 16). It is these progressive challenges that engage the players and connect them with the game by continually testing their skills and checking for understanding and compliance of the rules before allowing them to advance. By presenting both well-defined and ill-defined scenarios, players must continually re-evaluate their strategies and test contrasting situations to progress through the game's hierarchical intricacies. It is the specific process that provides the educational bridge to learning, not only about the complexities of the game, but also contributes to the player's higher level of critical and creative thinking. It is through exploration and testing ideas in the game that provides results.

The simulations in the games create a highly interactive environment for reflective learning and processing of experiences. According to Clark and Mayer (2008), several principles would be engaged in this process: The Segmenting Principle would have the learning process broken down into phases or manageable chunks where the learners could practice independently and then interact with other players; and, the Personalization Principle would be evidenced by the conversational style that emerges in the gaming community. Mini societies emerge within the game because individual players create unspoken rules. Interestingly enough, much of the dialogue that takes place within the game has nothing to do with the dynamics of playing the game. Players were using this time to bond and form strong social networks. These social networks included players from all around the world, creating a link that fashioned intricate team building between people who would otherwise never interact.

Team building is essential to learning, as well as functioning in the workplace. We, as humans, gravitate towards a group for a sense of belonging. The act of even assigning a name to a certain group can form a sense of community. Ellis asserts, "A meta-analysis of team building research found that team building interventions tend to emphasize at least one of four possible components: goal setting, interpersonal relations, problem solving, and role clarification." All of this can be realized within the group dynamics and encouraged with specific gameplay expectations. Clark and Mayer