The Impact of Educational Computer Games and Simulations on Student Learning and Achievement

Literature Review

In the early 1970s, when computers could be commercially purchased, they could be found in use in educational institutions. With the rapid rate of computer use in schools and the advancement of technology, computer games and simulations have become very popular and are widely used as an enhancement to the curriculum. Findings reviewed will show that computer games and simulations are widely used and the popularity of the games is increasing as well. The purpose of this review is to examine the impact and effectiveness of computer games and simulations on student learning and achievement.

When computer games are mentioned, they are typically thought of as PC games or console games. A computer game can be defined as a game that provides visual information to one or more players, accept input from the player(s), and use a set of programmed rules. Unlike more traditional games, the rules are not described in an instruction manual; they are programmed into the code. The sensory interface and story adds emotional appeal, as well. Games should be thought of as a family of related items; they are not all alike—they are not designed for the same audiences, nor do they incorporate the same features of game play. Among the common categories of games are: adventure games, where the player moves through a virtual world; puzzle games, role-playing games, where the player assumes the role of a person or creature; strategy games, such as The Sims; where a player’s strategy drives the game; sports games, such as golf or football (Oblinger 2006).

Simulations, in contrast to computer games, according to Gredler (2004) are open-ended evolving situations with many interacting variables. The goal for all participants is to each take a particular role, address the issues, threats, or problems that arise in the situation, and experience
the effects of their decisions. The situation can take different directions, depending on the actions and reactions of the participants. That is, a simulation is an evolving case study of a particular social or physical reality in which the participants take on bona fide roles with well-defined responsibilities and constraints. Randel, Morris, Wetzel, and Whitehill, (1992) define a computer simulation as model a process or mechanism determined by a specific algorithm. They usually incorporate a system to model complex processes that range from routine to extreme situations. Simulations are usually more economical and/or safe than the actual environment. The aim of simulations is to enable students to make decisions and solve problems by emphasizing the relationship of varying and interacting inputs to targeted outcomes. Garris, Ahlers, and Driskell (2002) viewed a simulation as a representation of some real-world system that can also take on some aspects of reality for participants or users.

There has been great dispute among educators as to whether computers games and simulations impact student achievement. Research dating right back to the early 1980s has consistently shown that playing computer games produces reductions in reaction times, improved hand-eye coordination and raises players’ self-esteem. What’s more, curiosity, fun and the nature of the challenge also appear to add to a game’s educational potential (Griffith, 1997). Games as Oblinger , (2006), states can seem non-educational; they are typically associated with play and childhood. Even the name implies that games are the opposite of work. Assertions that games must be used to make learning “fun” ignore the fact that students who are deeply engaged in learning consider it both fun and hard work. Most of us begin a discussion of games with some discomfort and with an incomplete experience base. For many educators, the term “game” conjures up a mental image of playing cards or a game like Jeopardy. These “casual games” are brief (five minutes to two hours) and simplistic. Today’s games are complex, take up to 100
hours, require collaboration with others, and involve developing values, insights, and new knowledge. They are immersive virtual worlds that are augmented by a more complex external environment that involves communities of practice, the buying and selling of game items, blogs, and developer communities. In many ways, games have become complex learning systems. Several studies have shown how that using computer games and simulations in classroom have some effect on learning and achievement (Demarest 2000).

Computer games and simulations in the classroom serve many purposes. Participating with this software, students become engaged. How often have we heard students say, “I’m bored or “I need to be able to see what it looks like”? By using simulated software, students become more motivated and connected to the learning. Most of the research discusses how fun it is to play computer games, but according to Oblinger, (2006), when a person enters a game, he or she must immediately recall prior learning, decide what new information is needed, and apply it to the new situation. Those who play computer games are often required to read and seek out new information to master the game. Furthermore, knowing what information or techniques to apply in which situations enables greater success, specifically, problem solving. This often involves collective action through communities (Gredler 1998). Being able to see the connection and transfer existing learning to a unique situation is part of game play. Furthermore, in order to use computer games and simulations, students must have clear, specific goals about their learning. By focusing on the tasks that are to be learned, students become more enthralled with the lesson when they can associate it as being a fun task. When working with new information, games and simulations steer students by accenting important features; therefore, making sure that students stay on task or stick the objective.
Educators prefer games and simulations because they enhance non-traditional learning. Students can use simulated software for complex situations, and get immediate visual stimulation. For example, Civilization and Rise of Nations are true representations of simulations. With these simulations, the player is actually inside the world (virtual world) of the game not outside. The player, in reality, has a surrogate in the game, most likely a virtual character. The player can control the character. For instance, in Rise of Nations the player can manage soldiers, citizens, and building. In The Sims, the player can control an entire family. The player can interact solely with the simulation. Sandford, Facer, Ulicsack, Rudd, (2006) says the player discovers or forms goals within the simulation, goals that the player attributes to his or her surrogate in the world. In order to reach these goals, the player must recognize problems and solve them from within the inside of the simulated world. This essentially means that the player must figure out the rule system (patterns) that comprises the simulation. The player must discover what is possible and impossible within the simulation in order to solve problems and carry out goals. Achieving these goals constitutes the win state for the player. Khan (2002) explains how in an adventure games (AG) environment, the player can experience a role or roles in a near real-life setting and at the same time learn about the setting itself. Played at expert level the game can support the development of intuitive skills at coping in that environment:

As mentioned earlier, technology is forever changing and advancing. The use of computer games give chances for new and emerging technologies. Many handheld technologies are use in many classes. The rapid technological development of handheld consoles such as the Game Boy Advance has encouraged speculation about developing educational software to support blended learning. This blended learning might include classroom-based learning linked to learning online and/or outdoor activities such as museum visits and field trips (Mitchell,
Savill-Smith, 2000). Khan (2002) discussed that emergents in artificial intelligence (AI) include attempts to employ game environments in intelligent tutor systems (ITS – is software that was originally developed to respond to learner needs, providing effective coaching). As can be quoted by Khan:

Advances in game AI, better human–computer interface, speech recognition, sound compression schemes and stunning graphics capabilities have provided ITS (with) everything required in an interactive, adaptive and intelligent learning tool. Evolution of new modes of learning is bound to revolutionize the ways in which we teach and learn today.

Much research on games and simulations for learning focuses on mathematics and English language arts. These content areas are a critical focus for the No Child Left Behind Legislation and areas where there is a well-established research base on student learning. At the elementary level, students can be seen using handheld computer games for math, vocabulary and reading. During the PreK-2 grades, drill and practice and game software can help students acquire and reinforce basic number facts. Software such as Reader Rabbit and Math Blaster is highly used. (Dynarki, Honey, Levin, 2002). At the 3rd-5th grade level, students are building on their basic skills to engage in additive and multiplicative reasoning, they are exploring notions of equivalence, and working to establish computational fluency. They may begin exploring concepts of probability. Fractions, ratios, proportions are concepts that students are expected to master. Drill and practice and game software can again be used to consolidate students’ computational skills. During middle school students are expected to master the concepts associated with geometry and algebra. Voyager Middle School Mathematics is an example of a technology-rich mathematics program that has students role-play professionals such as
architects, population biologists and computer scientists who use mathematics to solve real-world problems (Dynarski, et. al 2002).

Simulations and games have been used in several ways for learning. Computer games have been highly effective in raising achievement levels of both children and adults in areas such as math and language, where specific objectives can easily be stated (Randel et al. 1992). Information-processing educational game components that have been designed to imitate popular computer games have been found to help poor readers to make significant learning gains, with the greatest improvement shown by the poorest readers and resource-deprived learners (Mitchell, Savill-Smith 2000). Computer games and simulations are highly prevalent in career technology and technical preparatory classes. Simulations are used for real-life scenarios in business, health-career, family and consumer science, and trade and industrial course. Moreover, games and simulations are used for computer assisted learning for special needs students. The research shows that there are several benefits of computer-assisted programs for programs of exceptional needs. Games and simulations have been used in comprehensive programs to help develop social skills in children and adolescents who are severely retarded or who have severe developmental problems like autism (Griffiths, 1997). Using games tend to boost the ego and have a calming effect on these children.

Even though games and simulations can be beneficial in the classroom, there are teacher concerns when using the software. When determining what games and simulations should be integrated there are several questions that many educators asked: 1) How should games and simulations be integrated into traditional instruction? 2) What is the manageability of the technology software for several students when they are doing several different tasks? 3) How will testing be structured? To integrated games and simulations with the traditional teaching
strategies, games do not have to be used in their entirety in order to support educational goals and stimulate student motivation – in some cases; certain elements of games can be extracted and used productively in isolation from the game as a whole. Educators should allow sufficient time for both them and their students to become familiar with the game – this may be more time than initially expected. Teachers should ensure that they are clear about the learning objectives they are intending to achieve over the course of a scheme of work, and identify the precise role to be played by using the game in achieving these. After determining this, teachers will be able to determine how testing will be structured or determined. (Kirriemur, MacFarlane 2004).

Since the curriculum is driven by standards with No Child Left Behind (NCLB), educators should be mindful when purchasing games and simulations. Games should afford purposeful interactivity ‘to do with learning objectives or providing the learner with opportunities for understanding through collaboration, investigation or experience’, while the design of learning tasks should encourage ‘both individual accountability and productive interdependence’. Educators should look for software that acknowledges the role of the teacher and should facilitate the teacher’s meaningful intervention (Becta 2001). Although teachers lack the production resources of commercial developers and may lack sophisticated programming and design skills, many do, however:

…possess three qualities that will permit them to fill the instructional niches that are too small for the commercial producers: experience with students, knowledge of curricula, and desire to expand and apply their professional skills. Thus, teachers who invest the time in developing the necessary skills can focus on the design of instructional games, as well as other computer-based instructional support materials, that reflect the specific
interests and instructional needs of the children in their classrooms and schools (Kelly & O’Kelly 1994).

Another issue for teachers is the lack of experience and desire to use and play computer games, use of simulations and the skill level of the instructor. Teachers, says Griffith (1997) need to continually to work at updating their skills and knowledge to operate and use computer gaming and software. This is in addition to their need to be current with curriculum content and pedagogy. It is, therefore, important that they be supported very carefully in practical and motivating ways.

It was found that there are several advantages and disadvantages of using computer games and simulations in an educational setting. It is frequently argued that computer games are valuable tools in enhancing learning. They are seen as a means of encouraging learners who may lack interest or confidence (Kirriemur 2004) and of enhancing their self-esteem and flickers creativity. Frequent gaming increases other desires for other computer educational tasks that may benefit school performance. The Pillay (2003) study found signs that:

…playing recreational computer games may influence children’s performance on subsequent computer-based educational tasks. However, the extent of this influence depended on the types of games played during the learning phase. Linear cause-and-effect games tended to encourage means–end analysis strategy, whereas adventure games encouraged inferential and proactive thinking.

Additionally, simulation games enable engagement in learning activities otherwise too costly to resource or too dangerous, difficult or impractical to implement in the non-directed time-consuming activities such as playing computer games and completing simulations classroom (Greitzer, Kuchar, Huston 2007).
Studies have shown that games and simulations cannot replace traditional learning. The impact of frequent gaming on academic shows a disadvantage with at risk students. When using games frequently, at risk students are less positive about school. This ties in with other indications that teacher-defined at risk students display strong preferences for non-directed time-consuming activities such as watching television and playing computer games (Bruno 1995). Also, students may become frustrated with simulations because inadequate structured simulations do not provide feedback causes students become overwhelmed. Computer games and simulations can be difficult to fit in the curriculum.

According to the literature, it can be determined that the use of computer games and simulations impact and enhance student learning. However, it does not show a direct correlation on the increase student achievement. Computer games and simulations are used as a primary goal to increase and supplement student learning. Therefore, there is definitely an educational impact. Computer simulations and gaming technology brings new challenges to education. With the current curricula and No Child Left Behind, it has been shown that there should be careful consideration when incorporating games and simulation so that the use of this emerging technology does not displace other more effective techniques. Nevertheless, simulations and computer-based games have advantages that are not prevalent in other learning strategies. For example, the ability to choose different solutions or answers to a difficult problem and then see the effect those decisions have on a fictional game allows students to experiment with problem-solving. Games and simulations have great positive potential in addition to their entertainment value. Success has been seen when games and simulations are specifically created to address a precise situation and problem, or teach a specific skill. However, whether games and simulations really make a difference in achievement remains an important question. What is also apparent,
though, from the literature is that the gaming and instructional simulation enhances instruction, and, as a result, impact learning.
References


