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STATEMENT

Are Serious Games a Good Strategy for Pharmacy Education?

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Serious gaming is the use of game principles for the purposes of learning, skill acquisition, and training. Higher education is beginning to incorporate serious gaming into curricula, and health professions education is the most common area for serious game use. Advantages of serious gaming in pharmacy education include authentic, situated learning without risk of patient consequences, collaborative learning, ability to challenge students of all performance levels, high student motivation with increased time on task, immediate feedback, ability to learn from mistakes without becoming discouraged, and potential for behavior and attitude change. Development of quality games for pharmacy education requires content expertise as well as expertise in the science and design of gaming. When well done, serious gaming provides a valuable additional tool for pharmacy education.

Keywords: serious gaming, educational technology, gamification of learning

INTRODUCTION

The 2013-2014 Academic Affairs Committee recommended that AACP develop serious games that can be used in pharmacy education, that promote faculty and student innovation in designing and or implementing serious games to prepare future health care leaders, and that compile and make available a list of existing serious games potentially useful in pharmacy and patient education.[1] In addition, the committee suggested that colleges and schools of pharmacy should encourage faculty members and students to use serious games for learning and professional development when appropriate. "Gamification" of learning is a relatively new concept to pharmacy educators and may require further discussion to elucidate the educational value of serious games that prompted the committee to promote using them throughout the academy.

The term "serious gaming" might seem to be an oxymoron. As Jane McGonigal states in *Reality is Broken*, the word "game" often has an unfavorable connotation.[2] Consider the phrases, "gaming the system," "don't play games with me" or calling a person who is disingenuous a "player." We tend to assume that anything associated with the word "game" is frivolous. Serious gaming, however, is a well-accepted term among global corporate entities and organizations who have adopted this strategy for training in the workplace, recruiting new talent, and improving communication.[3]

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Serious gaming can be defined as the use of game principles for the purposes of learning, skill acquisition, and training. It should not be confused with "edutainment," which by definition is lacking in interactivity and is based on a "skill and drill" format, in which the learner practices repetitive skills or memorizes facts.[4] Serious games can be mistakenly equated with simulations, when in reality, simulations are just one game genre, along with puzzles, strategy games, role-playing, etc.[5]

Another definition of serious gaming is "the voluntary attempt to overcome unnecessary obstacles."[6] Good game play is hard work. The learner should be performing at the maximum of his or her skill level and may be exerting significant cognitive effort. This is analogous to "practicing at the top of your license." Somewhat surprisingly, winning is not an essential element of many of the best games, in which the learner is constantly pushed to higher and higher levels of achievement without the possibility of actually "winning."

Military and emergency service organizations were early adopters of this educational strategy. One distinct advantage of gaming is the ability to establish a virtually real environment for learning in which the consequences of mistakes are minimized. In 1999, responding to pressure for fiscal efficiency, the Army formed the MOVES Institute to conduct basic and applied research in modeling, virtual environments, and simulation. Recognizing that videogame technology provides processing and graphics capabilities, the Army funded the University of Southern California's Institute for Creative Technologies to create a collaboration between entertainment software technology and military simulation, training, operations,

and research. The resulting multiplayer online game, America's Army, was developed as a recruitment tool for the army and as a simulated rehearsal environment for military training and operations.[7]

While the Department of Defense has yet to publish scholarly research regarding America's Army, there are some indications that it could be an effective educational tool. The Army reports a few instances of America's Army players utilizing the medic skills they learned in the virtual medical training classes to aid victims in emergency situations. In one incident, a 28-year-old man witnessed an accident and used medic skills to control bleeding in a seriously injured victim until paramedics arrived.[8]

Project Lead the Way (PLTW) and the Ohio Department of Education partnered with the US Army and the America's Army team to provide the game platform to enhance PLTW's engineering curriculum used in 3000 middle and high schools. The applications incorporate math skills and other elements of science, technology, and engineering.[9]

Serious Games Used in Higher Education and Health Professions

Higher education is beginning to incorporate serious gaming into curricula. The Learning Lab at the University of Pennsylvania's Wharton School has more than 10 years of experience in developing games to teach business and economics and to heighten student engagement. One example is The Tragedy of the Tuna, based on a 1968 paper called the "Tragedy of the Commons."[10] The objective of the game is to learn the value of preserving resources for the future. Each student or group represents a country's tuna fishing fleet, and they each determine fleet size and deployment as they compete for the shared fish population. When all groups have made the necessary decisions, the game calculates catches, costs, and profits and adjusts the world tuna population accordingly. The Wharton School recently released 2 web-based simulations on the Harvard Business Publishing for Educators website. In *Negotiation Simulation: OPEQ*, students function as oil ministers, setting the production level for their respective countries and competing for profits within an oligopoly, thereby learning negotiations and microeconomics. In *Entrepreneurship Simulation: The Startup Game,* students role-play as founders, investors, and early employees of new companies. This game introduces concepts related to success of startup companies and allows students to experience the uncertainty of starting a new company.

The value of serious gaming in the health professions has also been recognized and health professions education is the most popular subject area for learning games.[5,11] Examples of serious games within health professions education and professional development include those to increase medical resident engagement in simulation training and to improve anti-microbial prescribing behaviors.[12,13] Published research in this area is still sparse, but several new studies of serious gaming within the health fields are underway including games targeted at HIV prevention education, cancer risk perception, laparoscopic surgery, and dental pain distraction.[14] Knight et al's experimental study regarding serious games for teaching conducted by yielded primarily positive results.[15] In a controlled trial evaluating the effectiveness of teaching major incident triage through serious games, learners (n=47) randomized to a gaming cohort scored significantly higher than learners in the traditional instruction group (n=44) in tagging accuracy and step accuracy ($p<0.05$). There was no significant difference in time to triage all casualties.[15] Schonauer et al's preliminary evaluation of serious gaming targeted at rehabilitation of chronic pain patients revealed limited, but positive results.[16] Researchers examined the effects of patients playing serious games designed to improve reaching ability and range of motion. The game used Microsoft Kinect for movement tracking. Over a period of 4 weeks, the 6 pain patients in the study reduced their average scores of pain intensity from 62 to 52 (maximum score of 100). Their sum pain disability index score dropped slightly from 30 to 28 (maximum score of 70). Walking distance of 3 patients remained stable and increased for 3 other patients.[16]

Many physicians are touting the potential of serious games to improve medical education, and perhaps the most intriguing use of gaming in the health professions is to improve health outcomes and provide therapy to patients. For example, mental health patients are using games to confront phobias, burn patients are using therapeutic games to relieve pain, and war veterans with post-traumatic stress disorder are being treated with games.[17]

Essential Elements of Serious Games

Well-constructed games have a specific structure with defining traits:[2] The traits are: (1) goals are the specific outcomes learners must achieve provide purpose to the game and focus the learner's attention. Goals change at different game levels, thus motivating the learner to continue playing higher levels;[18] (2) rules provide limits to the learner's path to the goal. Often, the rules prevent the learner from taking the easiest, most obvious path to the goal. This creates the need for learners to think creatively and construct a novel strategy to achieve the goal. The rules are an essential game element in that learners must master the rules to accomplish their goals. Common ground rules are necessary for learners to work together in the game; (3) feedback informs the learners how they are

progressing toward the goal. This may include an update on what has been achieved and what remains to be achieved. In a well-constructed game, feedback is clear and immediate and often provides motivation to the learner; (4) voluntary participation – typically, each learner accepts the game elements and is free to enter or leave the game when they choose. Because a good game is engaging and increases time-on-task, the learner will seek to repeat game levels to master the necessary skills and achieve the next, more challenging level. When used in a required educational exercise, participation is not voluntary. However, if well-constructed, the student is likely to become engaged in the game and will choose to spend time beyond that required by the instructor; (5) a game must have "flow." In other words, the skill of the game player must grow in direct proportion to the difficulty level of the game. If the player has greater skill than required in the game, the player becomes bored. If the challenge of the game level is too great, the player becomes discouraged or anxious. With appropriate flow, the player is constantly challenged at an appropriate level and keeps progressing through increasingly difficult game levels.

THEORETICAL FOUNDATION FOR GAMING IN HIGHER EDUCATION

There are a variety of reasons why well-designed serious games are appropriate for use in higher education. Although learners typically enjoy serious games over traditional lectures,[19] serious games are effective not because they are games, but because of the cognitive and psychological processes involved when learners play them.[20] Even though high quality research regarding specific effects of game-based learning is somewhat limited,[5] the learning principles that well-designed games use are supported by a breadth of cognitive science research studies.[21]

Many of the cognitive processes used while playing games (eg, self-regulation, motivation, and higher-order processing) are necessary components of learning processes.[5,22,23] Metacognition is another important element of well-designed games. Effective educational games require learners to be aware of and reflect upon the knowledge and actions taken during the game.[24] Furthermore, game-based education supports learning in ways that are situation-based, problem-centered, and provide context for interactive decision-making, all features associated with effective learning design.[25,26] These authentic, situated learning contexts afford greater content mastery than traditional classroom learning.[4,27,28]

One of the criticisms of the mass educational model in today's society is that the teaching focus is on the "average" student, a disservice both to higher performing students, who don't get challenged, and to lower performing students, who get left behind.[29,30] Good games operate at the outer edges of learners' competence, challenging them at a level at which they can be successful. This "just barely out of reach" phenomenon is a key psychological factor with regard to motivation.[21] The motivational effect is one of the most widely touted benefits of gamification of learning.[31]

Many woes of traditional education link back to student motivation (or lack thereof) to engage in learning activities.[32] The gaming approach to learning is more motivational than a nongaming approach and more effective in promoting knowledge retention.[21] Time on task is one of the more significant predictors of student learning, yet students often are not motivated enough to invest sufficient time in learning activities. The ability to motivate and thereby increase time on task is a hallmark of serious games.[33] Well-designed serious games provide learning material in a way that entices students to stay engaged. This "immersion effect" of serious games fosters environments in which learners spend concentrated attention on the task at hand.[33] Serious gaming assists educators at any level in designing learning activities that engage students. Effective games have holding power that capture users' attention and entice them to continue playing.[33]

Designing and implementing highly motivating, serious game experiences is not a simple task, and game dimensions are an important element for learning effectiveness.[31,34] Designers recognize that motivation to stay immersed in a gaming environment results from a careful and highly-calibrated balance of challenges and rewards. One of the key psychological components of effective game design is that concrete challenges are matched to learner skill levels and increase in difficulty as skills are mastered. Moderate challenges just out of a learner's reach provides the motivation to stay engaged with the activity.[35] The cognitive reward (ie, gratification) only comes when a learner's skill has been assessed and deemed sufficient to advance to the next stage or challenge.[36] Games have a significant feature not commonly found in humans: infinite patience. No matter how many times the learner needs to repeat the game level, the game never becomes impatient. When the human teacher loses patience, the learner may be intimidated or quit trying to learn.[33]

As opposed to the vast majority of traditional educational methods, students participating in game-based learning environments receive dynamic and immediate feedback regarding their skills, knowledge, strategies, etc. A related, but often unmentioned, attribute of gaming in terms of the educational process is that of creating fun failure.[24] Although most educators will readily admit that failure and the response to failure are crucial elements of learning, the educational system does not support that effectively. In most educational settings, the stakes for

failure are high with long delays in feedback.[35] This situation induces students to avoid taking risks, seeking only to determine what the instructor "wants to hear." Couple that issue with infrequent and/or delayed feedback and the chances of any real learning is reduced. Well-designed games, however, involve repeated experimentation with rapid feedback. In this setting, failure is not only acceptable, it is expected. The crucial element of adaptive feedback permits one to learn from the previous failure,[23,36] and learning from mistakes is powerful.[37] Games use scaffolding in which cues, prompts, hints, or partial solutions are provided to learners to keep them progressing until they have sufficient skill to create their own path through the game.[33] Games create an environment where effort and persistence are rewarded, allowing the learner to view failure less negatively and more as an opportunity for further learning.[35]

In addition to using serious games for their potential cognitive learning benefits, games are increasing used for behavior and attitude change. The area of health behaviors provides the most evidence to suggest that gamification works; for example, health and fitness apps, which use gaming and gaming principles, are among the most popular in the mobile computing environment.[38-40] Serious games are also successful at inducing behavioral change in various other contexts including personal health outcomes,[41] corporate sustainability,[42] and substance abuse prevention.[43] Although less of a focus, some nascent research suggests that serious games are effective at shaping attitudes.[44] Gentile et al showed that individuals who played prosocial games (games without physical aggression) displayed more positive, prosocial attitudes toward others.[45] In that study, 161 college students with a mean age of 19.2 years were randomly assigned to play specific parts of a prosocial game (eg, Chibi Robo), a violent game (eg, Ty2), or a neutral game (eg, Pure Pinball) for 20 minutes. They were then instructed to assign their partner 11 tangram puzzles to complete. They were told their partner would receive a $10 gift certificate if s/he completed at least 10. Partners could be aided in that assigners could give them easy or difficult puzzles. Those who played the prosocial game were significantly more helpful than those who played the neutral game ($p<0.05$) or the violent game ($p<0.05$). Greitemeyer et al showed that playing a prosocial game (relative to a neutral game) increased interpersonal empathy.[46] For their study, 56 students with a mean age of 29 years were randomly assigned to 2 video game conditions (prosocial vs neutral). After playing the game, they were given scenarios in which schadenfreude and empathy were assessed. Participants in the prosocial group experienced less schadenfreude ($p<0.05$) and increased empathy toward others in need ($p<0.01$) than those from the neutral group. This area of research needs further attention but offers potential for health professions educators who struggle with teaching and instilling professional attitudes such as empathy.

DEVELOPMENT OF SERIOUS GAMES

One common misconception about gamification is that any type of gaming tactic will automatically make learning more engaging. This, however, mistakes superficial gaming experiences for specifically-designed psychological experiences. Educators with little or no training in game design should not create gaming experiences because it is very easy to design bad games with little to no effect on learning.[38] In addition to education and content expertise, development of good serious games requires expertise in the science and design of gaming. When technology is involved, good games also require highly skilled technical personnel. This is evident by the recent estimation that 390 colleges, universities, and trade schools now offer curricula based in video game design.[47] While 232 of those institutions offer bachelor's degrees, 47 offer master's degrees and 4 offer doctoral degrees. The complexity of serious game development makes it unlikely that effective games can be created by a small group of individuals.[48] Often, when educators try to create games for learning they get the "worst of both worlds." These games, often referred to as edutainment, are not usually fun nor are they very good at promoting learning.[49] Creating quality serious games for health professions students is not an easy or inexpensive task. However, with cooperative efforts among groups of schools or health professions, high quality products can be produced in an affordable manner.

CONCLUSION

Research on the effects of gaming on learning is accumulating and is promising. Research regarding why gamification can be a powerful method of stimulating learning is well-documented. Serious gaming provides tremendous opportunity for scholarship of teaching and learning as pharmacy educators begin to use this educational strategy. As with any type of teaching methodology or technology, the academy should avoid trying to find a "place" for serious games in the curriculum, and instead be open to its use and when it may be the most effective method to enhance student learning. Even with all the benefits described in this paper, gamification is not a panacea for all educational woes[35] and should not be considered a replacement for other types of learning experiences. Serious gaming is one of many types of learning architectures, and, when done well, provides an valuable supplementary tool for pharmacy education.

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