All fun and games? Exploring the positive effects educational video games can have on medical learners

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Abstract

Video games have transcended from being a simple pastime to a cultural phenomenon. With recent advances in computer processing and storage technology, this type of interactive media can provide a fun experience to children and adults alike. In the last decade, video games have found their way into medical education. Due to their intrinsic immersiveness, sensorimotor stimulation, and lifelike simulation capacities, medical-based games have become a popular medium for educational developers to create products that help elevate traditional pedagogical methods (*i.e.*, didactic lecture-style learning). This commentary will discuss the positive aspects of medical video games and provide specific examples of how they have benefited medical education for both novice and expert learners.

Introduction

On November 29th, 1972, the American home computer company Atari released the first commercially successful video game, Pong. Pong's concept was simple: two players would each control a single white line to rebound a small pixelated ball back and forth on a two-dimensional plane, somewhat similar to the eponymous real-life sport of "ping-pong." Since Pong's international success, video games have transcended from once a frivolous pastime to now a cultural phenomenon. Much of the success of video games can be attributed to advancements in the portability of computer technology, which allowed the transition from stagnant arcade machines to more convenient devices such as Nintendo's Gameboy or more recent Switch products. Furthermore, with the pervasiveness of cell phone use in North America, the ability to access these games has never been easier.

It is the consensus in developed countries that electronic device usage and access among healthcare professionals are high. It is estimated that at least 80% of American physicians use portable electronic devices, such as smartphones and laptop computers, while usage among Canadian medical students is estimated to be approximately 98%.[1,2] While the topic of smartphone usage in actual medical practice is currently under debate, the potential utility that these portable devices carry as educational tools has been generally well approved.[3-5] Educational video games are often stigmatized, especially by students, as being unappealing because of their inherent emphasis on education rather than being traditionally "fun." However, as a result of technological and pedagogical innovation, some medically relevant video games have been shown to be appealing and clinically relevant to students and practicing physicians alike. This commentary will discuss the benefits of medical video game-based education tools and provide specific examples of successfully implemented medical video games.

Case-based immersion

A major reason why video games have become such a popular form of interactive media among creative developers is because of their ability to provide player immersion. This is especially true in role-playing games, where a player assumes the role of a fictional character and must make decisions that ultimately affect the progress of a narrative story. Similar to the rise of video games has been the popularization of case-based learning (CBL) in medical school curricula, which is based off the seminal problem-based learning method developed at McMaster University.[6] CBL, analogous to role-playing video games, involves the immersion of medical students into the role of a practicing physician who must employ effective clinical decision-making to treat a patient and understand their underlying disease. Because of this immersion, CBL has proven to be an effective means of educating medical students and preparing them for the wards in their senior years.[7] Several game developers have used the intrinsic similarities between CBL and role-playing games to create educational products that similarly immerse medical learners. Medical Joyworks, an e-learning company founded in 2010, has been particularly successful at creating a CBL-style mobile video game called Clinical Sense. With over one million downloads on the Google Play Store, Clinical Sense places the player in the perspective of a physician who must correctly choose the proper interaction with a virtual patient to progress the story. Other developers have created immersive narrative video games to teach learners how to utilize appropriate heuristics (cognitive pattern recognition processes). In collaboration with a company called Schell Games, researchers of a 2017 study found that a narrative video game called Night Shift (Figure 1) on Apple iPads proved to be a superior method of training emergency medicine physicians to rapidly identify moderate to severe patients requiring triage compared to traditional didactic lecturing.[8] Following a gaming session lasting at least one hour, the video game-trained physicians were significantly less likely to under-triage, both immediately following and at six months after playing the game.

Sensorimotor development

Popular video games like League of Legends are fast-paced team games that require effective communication and a strong selective attention span. In fact, such games have been shown to train mental acuity and increase a player's visual selective attention, reading accuracy, and cognitive flexibility.[9-11] In addition to these cognitive benefits, video games have been shown to increase fine motor skills. Perhaps consequential to using rigorous handheld controls, which train hand-eye coordination and physical dexterity, video games confer an increase in sensorimotor learning, which enhances the ability to learn the dynamics of unfamiliar sensorimotor tasks.[12]

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Figure 1 | Adapted from Moham *et al.* (2017), illustrating a conversation between an attending and the department chair regarding an incorrect triage. During this conversation, the chair provides criticism on their performance, and the player must choose how to respond to this criticism. The player can either choose to accept responsibility for their error or provide rationale for the decision made.

Studies have shown that video games aid in the development of dexterous skills that are translatable to surgical operating rooms. In 2007, a study by Rosser *et al.* evaluated a group of surgical residents for their laparoscopic skills and suturing capabilities. The study found that participants who reported previous video game play exceeding 3 hours per week achieved a 27% faster completion time and did so with 37% fewer errors than their non-video game playing colleagues. They also found that those who were better at video games performed better in their laparoscopic and suturing demonstrations, concluding that there was a positive correlation between skillful video game play and increased manual dexterity.[13] Further studies have confirmed this positive association and have attributed it to an increase in psychomotor skills, even going as far as to evaluate which video game consoles have the most skill translation.[14-16] Practically, video game use has clinical significance as well. In 2018, an article published by the British Broadcasting Corporation interviewed a group of 33 surgeons and reported that video games have improved their quality of training and practice, strengthening factors such as concentration, reaction time, and hand-eye coordination, all of which would be important when focusing on a screen during laparoscopic surgeries.[17]

High-quality simulation

Early video game home entertainment systems, such as the popular Super Nintendo Entertainment System in the early 1990s, had relatively low micro processing power resulting in graphically limited games that required around 0.23 megabytes to 4 megabytes of storage.[18] Today, the average smartphone game on the Apple iOS store is 67.7 megabytes, and more graphically intensive games, like God of War on the PlayStation 4, require around 45 gigabytes. Because of these processing and storage achievements, medical educational video game developers have been able to create products that are so graphically powerful that they border on realistic medical simulation. One particular developer who has demonstrated great success in medical video game simulation is Sam Glassenberg, founder and CEO of Level Ex.[19] Level Ex is a software development company that creates mobile games specifically targeted towards physicians. Coming from a family of physicians, Glassenberg was considered the "black sheep" of the family because he was part of the LucasArts team creating Star Wars video games and later the DirectX team for Microsoft. Glassenberg first noticed the potential of using video games as an educational tool when he created a mobile video game for his grandfather, an anesthesiologist, who needed to teach residents how to perform a bronchoscopy. Since the success of its first game, Level Ex has produced multiple graphically intensive mobile video games that teach learners how to perform challenging real-life medical procedures. In March 2019, Level Ex released a game called Cardio Ex that teaches players how to perform difficult interventional cardiology procedures

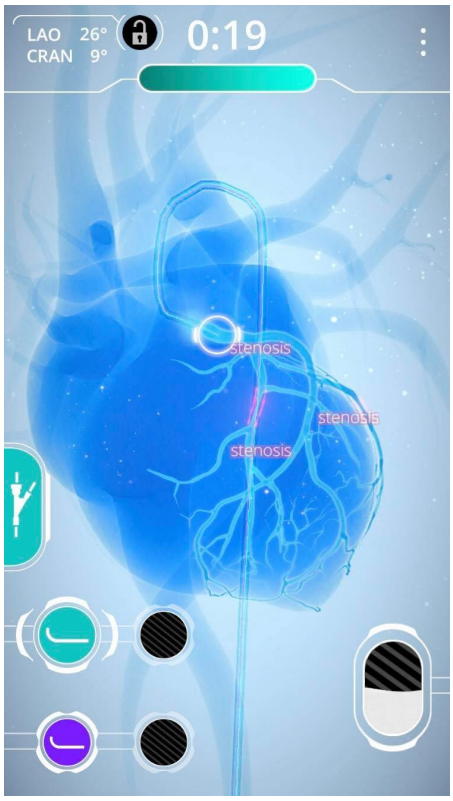

Figure 2 | A screenshot illustrating gameplay of Cardio Ex, made by developers Level Ex. The objective of this level (Level 1-4 "Lesion Legend"), is to guide a drug-eluting stent to the site of the lesion and repair the stenotic coronary arteries.

(Figure 2). Players have the ability to manipulate a fluoroscopy-based three-dimensional representation of the heart and are equipped with a host of tools like non-compliant/semi-compliant balloons, drug-eluting stents, polytetrafluoroethylene stents, aspiration catheters, and atherectomy drills. In the United States, the simulation and educational aspects of Cardio Ex are considered so powerful by the Accreditation Council for Continuing Medical Education that cardiologists who play the game are awarded Continuing Medical Education (CME) credits for reaching specific milestones.[20] Currently, Level Ex has four games targeted towards cardiologists, pulmonologists, gastroenterologists, and anesthesiologists that can award CME credits, with more games currently in development.

Conclusion

As medical students who have played video games for nearly their whole lives, it is the authors' belief that educational medical video games present a unique opportunity for learners. In addition to being fun and engaging, the underlying aspects of video games like interactive storytelling, graphical realism, and sensorimotor stimulation, warrant increased consideration from curriculum developers. These benefits are not exclusive to medical students, as evidenced by the provision of CME credits and increase in surgical performance when playing these games. Furthermore, as computer technology becomes more powerful and portable, the educational potential of video games will undoubtedly continue to improve. Whether you are a first-year medical student looking to develop your clinical decision-making skills or a seasoned cardiologist looking to expand your surgical horizons, there is likely a video game waiting for you to try.

Conflict of interest

The authors have declared no conflict of interest.

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