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Serious Games: A Concise Overview on What They Are and Their Potential Applications to Healthcare

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Abstract

Younger generations are extensive users of digital devices; these technologies have always existed and have always been a part of their lives. Video games are a big part of their digital experience. User-centered design is an approach to designing systems informed by scientific knowledge of how people think, act, and coordinate to accomplish their goals. There is an emerging field of intervention research looking into using these techniques to produce video games that can be applied to healthcare. Games with the purpose of improving an individual's knowledge, skills, or attitudes in the "real" world are called "Serious Games". Before doctors and patients can consider using Serious Games as a useful solution for a health care-related problem, it is important that they first are aware of them, have a basic understanding of what they are, and what, if any, claims on their effectiveness exist. In order to bridge that gap, we have produced this concise overview to introduce physicians to the subject at hand.

Keywords:

Serious games, games for health, patient education, user-centered design, mhealth, behavioral health, medical education.

Introduction

Younger generations are extensive users of digital devices[1] to the extent of being designated by some as ''digital natives''[2,3]. For them, these technologies have always existed and have always been a part of their lives[4]. Video games are a big part of their digital experience. Already in 2004, the average video game player was aged 30 years old and had played computer games for almost 10 years[5]. The average child aged 8–10 years old spent 65 minutes per day playing video games; 52 minutes/day among youth aged 10–14 years and 33 minutes/day among teenagers aged 15–18 years[1]. Today, most of these stats have remained the same or increased in number[6]. Video games reach a large and diverse audience who expect extended contact; suggesting games can attract and maintain attention, a key component for effective behavior change[7].

User-centered design (UCD) is an approach to designing systems informed by scientific knowledge of how people think, act, and coordinate to accomplish their goals[8]. UCD design practices employ both formative and summative practices in order to achieve systematic discovery of useful functions grounded in an understanding of the work domain. The user experience of video games has itself become a substantial topic of human computer interaction, with researchers developing models and methods as well as heuristics for the usability or playability of games[9–11]. There is an emerging field of intervention research looking into using these techniques to produce video games that can be applied to healthcare. Games with the purpose of improving an individual's knowledge, skills, or attitudes in the "real" world are called "Serious Games"[12]. Serious Games applied to medical or health-related purposes are growing rapidly in number and in types of applications; however, physicians might not be aware of such developments.

Before doctors and patients can consider using Serious Games as a useful solution for a health care-related problem, it is important that they first: are aware of them, have a basic understanding of what they are, and what, if any, claims on their effectiveness exist. In order to bridge that gap we have produced this concise overview to introduce physicians to the subject at hand. We will first explain what Serious Games are and how they are fundamentally different from entertainment games. Secondly, we will provide a theoretical framework to understand why games and gaming can be appealing. Thirdly, we will dissect and elaborate on the elements and principles that make up Serious Games. Fourthly, we will summarize some examples and success cases of serious game design used to promote skill acquisition or modify behavior in other health and educational domains. Finally, we discuss and provide recommendations for future intervention research regarding the use of Serious Games to aid and promote health care.

Definitions

Humanity has played games since prior to written history[13], suggesting that playing games meets enduring psychological needs[14]. A game is a physical and mental contest with a goal or objective, played according to a framework, or rules, that determines what a player can and cannot do inside a game world[15].

A video game is any game played on a digital device and encompasses a wide range of games played at arcades, over the Internet on personal computers, or on dedicated game consoles (e.g., Nintendo Wii, Sony PlayStation, or Microsoft Xbox) or handheld units (e.g., Smartphones, Nintendo Game Boy, Sony PSP). To win the game, video games challenge players to use the information they obtain as they navigate the game world[16,17] thereby providing an interesting education and training modality[18].

The emerging genre of "serious video games" or "Serious Games" employs the medium's rich, role-playing, story-based

environments to teach, train, and change knowledge, attitudes, and behavior[19]. Serious Games are often referred to as games for health when they target health behaviors[20]. Unlike regular video games, Serious Games have the dual goal of entertaining, while promoting behavior change[12,21]. Achieving the proper balance between "fun-ness" (ie, components that entertain) and "serious-ness" (ie, the components that promote behavior change) is both essential and difficult to attain [12].

The Theory Behind Serious Games

Games are played primarily for entertainment or "fun,"[22] but what constitutes "fun" is not well understood. Serious game design draws from a large body of empirical research suggesting that learning is maximized when it is occurs in relevant contexts that engage learners[23]. They employ principles of video game design to create enjoyable and immersive environments but, importantly, they are also grounded in theories of learning and development[24]. Serious Games focus on providing feedback related to achieving long-term goals and enhancing intrinsic motivation for learning by providing players with information about their progress toward incremental and primary learning goals[25].

Reviewing the literature on the subject, we find that there are several theories and models used to explain the appeal of games. Next we will present a small selection of theoretical models that often show up in literature regarding Serious Games.

Self-determination theory (SDT) is a macro-theory of human motivation that has been applied to identifying which factors sustain individuals' motivation within video games[26]. SDT postulates that the more often basic psychological needs for autonomy, competence, and relatedness are satisfied within a game context, making both the experience more enjoyable and the motivation more sustainable[27]. When considering games as a set of behavior changes, Social Cognitive Theory (SCT) is another commonly cited theory[7]. SCT proposes that behavior change is a function of enhanced skills and confidence (self-efficacy) in doing the new behavior[7], while modeling[7] and feedback[28] are keystones for learning skills. A comprehensive model of learning for behavior change in video games is based on SCT and the elaboration likelihood model[29] and includes the following steps: attention, retention, production, and motivation.

The role of play in learning is informed by Vygotsky's social constructivist theory[30,31] and the concept of ''flow'' theory in task engagement[32], related to providing achievable challenges in learning, are often used. For example, flow theory suggests that engagement in learning is highest when perceived challenges and skills are well matched[32]. Garris et al.[19] suggest that learning is enhanced when participants discover and use information rather than memorize it.

In sum, serious game design merges learning theory and empirical findings about maximizing skill learning and generalization of learning together with principles of game design to create a unique intervention tool that can target any set of cognitive, social, affective, and/or health-related skills with the goal of improving outcomes beyond the context of the game.

Dissecting Serious Games: Principles and Elements

Hunicke et al.[33] developed a game design framework called MDA (signifying Mechanics, Dynamics, and Aesthetics), to help understand games. Fundamental to this framework is the idea that games are more like artifacts than media, they need to be thought of in terms of the behavior they produce via interaction.

Jesse Schell in his book "The Art of Game Design: a book of lenses"[34] and Ralph Koster in "A Theory of Fun for Game Design"[35] point out common video game components such as immersive storylines, characters, goals directed around targeted skills, rewards and feedback about goal progress, increasing levels of difficulty, and the provision of choice. These same elements are highlighted by Baranowski et al[20] and Kapp et al.[25] in their work on Serious Games.

Storylines engage individuals by means of their empathy with the protagonist and enable individuals to experience content in meaningful contexts[20]. In a serious game, the story narrative is built to support learning of the specific educational content targeted by the intervention[36]. This ''interactive storytelling'' technology allows for players' interactions with computer-controlled characters and subsequent decisions within the game to shape the goals and outcome of the storyline[37]. Characters in these stories can be protagonists, who serve as models, and antagonists, who attempt to impede the protagonists, thus adding tension and conflict that act as the motivating factor behind the story's action and plot[12,20]. Character modeling and dialogue can convey knowledge, demonstrate skills, and enhance self-efficacy[38].

Goals in games are objectives that players need to accomplish to succeed. These changes in behavior convey a statement of intention and give focus and direction to efforts[39]. Goals provide a standard, or benchmark, against which goal attainment can be assessed[40]. Continuous feedback and rewards for progress are critical for shaping behavior in Serious Games as learners work towards achieving challenging goals. In designing rewards and feedback, both intrinsic and extrinsic motivation needs to be considered[41].

As suggested earlier, SDT states that provision of choice is one of the important tools of fostering intrinsic motivation and enjoyment in Serious Games[14,42]. In addition to providing individualized levels of difficulty, provisions of choice within a serious game can allow learners to maintain a sense of autonomy and control over their learning experience[43].

Healthcare Applications

Serious Games have been shown in a systematic review to be at least as effective as conventional tests in improving cognitive abilities in the elderly[44]. In a randomized controlled trial (RCT) they seemed more effective than conventional neuropsychological interventions when it comes to improving neuropsychological abilities of alcoholic patients[45].

There are RCTs of computer-based interventions being used to improve emotion and face identity recognition abilities in autism[46] and meta-analyses on language and social skills[47] with the goal of improving psychosocial outcomes in both mental health and developmental disorders.

Serious game-based interventions have been used in RCTs to support rehabilitation in disabled patients, showing equal effectiveness compared to conventional training programs[48].

Games have been applied to promote healthy behavior in children[49] and to educate patients[50]. Serious game-based patient education has also been shown to increase the treatment adherence among adolescents with leukemia in an RCT [51]. The characters in educational games can include mentors who facilitate learning by providing guidance in the game[36,52].

Serious Games have been shown in RCTs to add to training medical personnel[53] and reviews show improvement of understanding of geriatric principles among medical students compared to conventional training methods[54]. One strategy for personalizing training/game play is to use adaptive progressions. In other words, on a trial-by-trial basis, the level of difficulty of the training is specifically adapted to the player's in–the-moment game performance.

Conclusions and Directions for Future Research

Video games are an experiential activity, rather than a presentation requiring memorization or assimilation of out-of-context facts. Video games can promote "situated learning"[55] in which players discover and learn through exploration and experimentation[56,57]. Through gameplay, players "vicariously" experience desirable and undesirable consequences without putting themselves in harm's way[57]. When using Serious Games in health care, end users (clinicians, patients, or educators) must decide whether games are safe and effective enough to be used for their intended purposes. In order to do so, they need consistent, transparent, and reliable assessments, however, studies on Serious Games'validity and effectiveness remain scarce[53,58].

Lewis[59] and Albrecht[60] have recently published guidelines reporting standards to support clinicians and patients in distinguishing high quality mHealth apps yet these have two important shortcomings when it comes to games. First, explicit information on a serious game's content and didactic features is required, as the external purpose of a serious game is frequently less obvious to the user than in the case of mHealth apps. Second, Serious Games require additional validation steps (eg, construct and predictive validity), compared to non-interactive information platforms. Gameplay is dynamic and learning goals in gameplay are often not disclosed to the user. In fact, the user learns by playing the game, whereas discovery in itself may be part of the gameplay. Disclosing learning goals could thus be counterproductive[61].

The Dutch Society for Simulation in Healthcare (DSSH) developed a consensus-based framework[62] based on Lewis'[59] and Albrecht's[60] work. This framework could be a valid tool to assess Serious Games but further exploration is required. It should also be considered that a game's validity does not predict a game's success nor its attractiveness to the user, which also depends on its entertainment capability and distribution method[63].

There is a need for more literature on Serious Games and their potential in informatics specific areas as well.

Finally, player expectations should also be considered. When faced with regular games players simply expect to be immersed in the story or gameplay of the product. Players may have different expectations for health video games and might be more critical as to the "fun" they are having.

Serious Games' potential make them something that physicians should be aware of but their complexity and lack of valid ways of assessment can play against their widespread use. Regardless, Serious Games are a promising tool which, if properly crafted, could be used to create high-impact interventions.

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