Conceptual Model for the Design of a Serious Video Game Promoting Self-Management among Youth with Type 1 Diabetes

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Abstract

Video games are a popular form of entertainment. Serious video games for health attempt to use entertainment to promote health behavior change. When designed within a framework informed by behavioral science and supported by commercial game-design principles, serious video games for health have the potential to be an effective method for promoting self-management behaviors among youth with diabetes. This article presents a conceptual model of how this may be achieved. It concludes by identifying research needed to refine our knowledge regarding how to develop effective serious video games for health.

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Background

The incidence of diabetes among youth is increasing.[1,2] Adolescents appear to be at greatest risk.[3,4] This is of particular concern because diabetes is a chronic disease requiring a high degree of adherence to the medical treatment plan through self-management,[5] which may be difficult for youth of this age.[6] Thus, finding ways to help adolescents engage in self-management is critical.

Video games have the potential to be an effective medium for promoting self-management. Video games, as well as the technology required to play them, are readily available. A survey[7] with 8–18-year-olds revealed that many lived in homes with a computer (86%) and a video game console (83%). Many also had a handheld video game player (55%), cell phone (39%), and laptop computer (12%), all of which are devices on which video games can be played.[7] Thus video games would be both a convenient and an accessible channel for promoting self-management.

Video games appeal to both boys and girls. In a survey[8] with 12–17-year-olds, 97% reported playing video games (99% boys; 94% girls), thus dispelling the myth that video games are played primarily by teenage boys. They also reported playing video games fairly often, with 31% playing daily and 21% playing three to five times a week. Further, 94% of parents reported being present when video games were purchased,[9] and most parents (63%) reported positive attitudes toward their children playing video games,[9] suggesting that parents may be receptive to video games designed to promote self-management behaviors.

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Video games have successfully encouraged adherence[10] and self-management behaviors among youth with chronic diseases.[11] Thus video games hold promise as a channel for promoting self-management among youth with diabetes. The purpose of this article is to present a conceptual model of how video games may achieve this goal.

Serious Video Game Design Principles

Video games are experiential, creating a platform for active learning.[12,13] Rather than a didactic presentation requiring memorization or assimilation of out-of-context facts, video games promote "situated learning"[14] in which players discover and learn through exploration and experimentation.[15] Through gameplay, players "vicariously" experience desirable and undesirable consequences without putting themselves in harm's way.[16] By helping players see the "big picture,"[17] video games help players make meaningful connections between events (i.e., skipping a meal, becoming hypoglycemic, and experiencing trembling or weakness, as compared to eating regularly, maintaining glycemic control, and feeling energetic), thereby increasing the likelihood that knowledge and skills attained in the game world will be retained and applied in the real world.[13]

In a video game, entertainment and learning are tightly bound. Learning, particularly when it is meaningful to the player, is fun.[17] Gameplay features that contribute to both learning and entertainment include active involvement; solving problems that are difficult, but not impossible; and feedback that provides evidence of progress, even in the face of failed attempts.[17] Video games contribute to the development of expertise through repeated attempts to overcome barriers and make it to the next level of gameplay.[17] A compelling story,[18] challenge,[19] interactivity,[19] and immediate feedback[19] contribute to entertainment value. These features create an immersive[20] experience where players become part of the action, and their actions have effects in the game world. This immersive experience, if used properly, can provide a powerful behavioral change platform for serious video games (i.e., video games designed to achieve change[18]).

Conceptual Model for the Design of a Serious Video Game

Rather than designing video games to directly impact a targeted behavior (e.g., self-management), behavioral scientists design video games to target factors (i.e., mediating variables) that influence a specific behavior.[21] The logical sequence is that the video game is designed to influence mediating variables, changes in mediating variables

influence behavior, and changes in behavior influence health outcomes. Mediating variables come from theory.[22] Social cognitive[23] and self-determination[24] theories provide key mediating variables on which to focus a serious video game promoting self-management: knowledge,[23] skills,[23] self-efficacy,[23] and motivation.[24]

Using the mediating variable approach and the traditional input–process–output framework as guides, a conceptual model for the design of a serious video game[18] promoting self-management to youth with type 1 diabetes is presented in **Figure 1**. A serious video game attempts to achieve a balance between "fun-ness" (entertainment) and "seriousness" (behavior change).[25] Behavioral features must be seamlessly integrated into the entertainment components to create an immersive[20] experience that entertains while promoting the acquisition of knowledge, skills, confidence, and motivation needed to self-manage. Each of these mediating variables is briefly discussed here. A brief example of how to design a serious video game to target these variables is presented.

Knowledge Provides the Foundation for Change

Knowledge is the basic information one needs to perform a behavior or to self-regulate.[23] It is the "what," "when," and "how" of behavioral performance.[26] Two types of knowledge are necessary for self-management: behavior specific and self-regulatory. For example, attempting to monitor blood glucose without knowing appropriate ranges (behavior-specific knowledge) or the steps involved in solving problems (self-regulatory knowledge) would make self-management difficult, if not impossible. Together, these types of knowledge provide the foundation for self-management.

Skills Enable One to Act on Knowledge

Behavior-specific skills are those specifically related to the targeted behavior. To self-manage type 1 diabetes, being able to accurately test blood glucose, interpret the results, and respond accordingly are important skills. Self-regulatory skills are also important to effective self-management. Three key self-regulatory skills that should be emphasized in a video game promoting self-management are briefly described here.

Goal Setting

Goals are a statement of intention and give focus and direction to change efforts.[27] They provide a standard, or benchmark, against which goal attainment can be assessed.[28] Specific, proximal, and moderately difficult (i.e., attainable with effort) goals are more likely to be
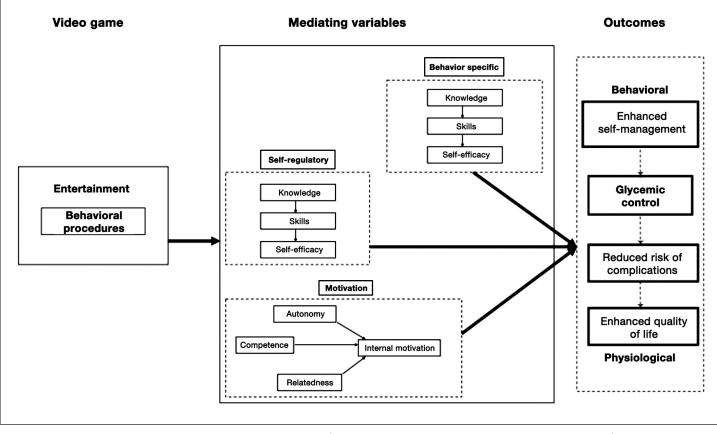
Figure 1. A cognitive, motivational, and self-regulatory model for the design of video games promoting self-management behaviors to adolescents with type 1 diabetes.

attained.[27] For example, a goal that meets these criteria is "check my blood glucose within 15 min of waking up each morning this week."

Goal Monitoring
Keeping a record of goal attainment provides information about goal progress and supports and reinforces behavior change.[23] Writing down blood glucose each time it is assessed provides a record of progress toward the goal of maintaining blood glucose levels within a certain range.

Problem Solving
Goal attainment and behavioral performance are often derailed by barriers (i.e., problems).[29] Problem solving identifies strategies to overcome actual or perceived barriers.[30] For example, problem-solving skills can help an adolescent choose an appropriate meal when faced with the problem of eating at an unfamiliar restaurant.

Self-Efficacy Is Confidence in One's Ability to Be Successful

Self-efficacy is confidence in one's ability to successfully perform a task or behavior.[23] It influences task selection,

persistence in the face of difficulty, and effort exerted to attain a goal, all of which affect behavior.[23] Self-efficacy is influenced in two primary ways: personal success and observing others, i.e., models, successfully perform the behavior.[23] Personal success has the greatest effect on self-efficacy (i.e., monitoring blood glucose for a week, correctly responding to abnormal values, feeling better, and experiencing satisfaction at a job well done); however, observing others perform a task or behavior and receive feedback is the most common way in which individuals learn a new behavior[23] (i.e., observing a video game character engage in a sequence of actions, feel better, and experience satisfaction). Key model attributes include perceived similarity and competence.[31,32] Perceived trustworthiness, attractiveness, and likeability are also important attributes.[33]

Motivation Determines If a Behavior Will Be Performed

According to self-determination theory,[24] behavior is driven by three basic needs: competence (ability to successfully perform a behavior—influenced by repetition and specific, positively framed feedback), autonomy (having choice

and control over behavior), and relatedness (connecting the behavior to important others or personal ideals). Creating a learning environment that promotes high levels of basic need satisfaction enhances the likelihood a behavior will become internalized and integrated into one's sense of self (i.e., "I am a person with diabetes who self-manages"), thus increasing the likelihood it will be maintained over time.[24]

Constructing a Self-Management Video Game

Storyline, characters, gameplay, and behavioral procedures are the mechanisms through which mediating variables are influenced in a serious video game.[25] Formative work must be conducted prior to constructing the video game to ensure that the characters and storyline, including situations in which characters find themselves, problems encountered, and solutions, are realistic and appeal to the intended audience,[34] such as adolescents with type 1 diabetes. Characters should include both protagonists, who serve as models, and antagonists, who attempt to impede the protagonists, thus adding tension and conflict and therefore interest to the storyline.[18,25] Ideally, protagonists should represent adolescents with various degrees of self-management and should also represent family structures, fears, concerns, and behavioral issues with which adolescents with type 1 diabetes are likely to identify. They can also include key individuals in an adolescent's life, such as friends, siblings, and relatives. Formative work with adolescents who have type 1 diabetes should be used to guide character selection and development.

Behavior change components, such as goal setting and goal review, should be embedded in the gameplay and help advance the storyline but should first be tested with members of the intended audience to assess comprehension and appeal.[35] For example, players could set goals to monitor blood glucose in the "real world" and report it in the game world. Their self-management (or lack thereof) could have a direct effect on a character in the game world, i.e., the character becomes lethargic or experiences irritability from being in poor control.

Character modeling and dialogue can convey knowledge, demonstrate skills, and enhance self-efficacy. Modeling a coping style[31,32] in which characters model imperfect performance initially but persevere and gradually improve through personal effort and skill refinement, emphasizing the importance of using strategies,[31,36] and

verbalizing and/or demonstrating how to use the strategies[31,36] would enhance knowledge, refine skills, and enhance both self-efficacy and competence. An example of how to achieve this in a video game would be to have an "expert" character (i.e., one who self-manages and is in control) guide other characters in the game who are attempting to self-manage. Providing encouragement, feedback, and demonstrating how to use skills and strategies to self-manage would serve as a model for the player.

Providing choice, connecting goals to personal values, providing immediate performance-related feedback, and structuring the game in levels with challenges that gradually increase in difficulty would enhance competence, self-efficacy, and internal motivation. Enabling the player to make choices for the characters and then observing consequences of appropriate and inappropriate choices could help the player see the big picture and develop an understanding of the short- and longer-term effects of these choices on self and others.

Parents could also be included in a video game designed to promote adolescent self-management. Creating a game with multiple players where parents and adolescents work together to win the game, assume the role of the other, or play separate games specifically targeted to their particular roles in self-management could provide an avenue for reducing family conflict often found in families in which there is an adolescent with type 1 diabetes.[37]

Future Research Directions

Research is critical to expanding the knowledge base on how to create effective serious video games that entertain while promoting lasting change. In addition to testing the efficacy of the conceptual model presented here to promote self-management among adolescents with type 1 diabetes, areas in which to focus research efforts include the role of story in creating an immersive experience, identifying the ideal genre for serious video games, and how to best structure the video game to promote lasting change. More should be learned about the design of multiplayer experiences (e.g., peer group competition or parent–child cooperation) to capitalize on the apparently strong desire to play video games in social circumstances. Whether to design completely separate video games or to incorporate video game experiences into existing social Web sites is also an important area of investigation.

Conclusion

Serious video games offer promise as an engaging and entertaining method for promoting self-management among youth with diabetes, particularly when guided by a conceptual model informed by behavioral theory. Future research is needed to test the efficacy of this approach, as well as its effectiveness under real-world conditions.

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