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Designing Games for Stealth Health & Healthy Lifestyle Education

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Abstract: Mobile games can be highly accessible and effective tools in educating and promoting children's health education, given the significant increase in their popularity. In this paper, we describe our experience in designing mobile games for enhancing children's knowledge of healthy diet and lifestyle. We discuss design strategies for embedding lifestyle educational content and engagement with healthcare providers into three distinct mobile games. Our findings show that the children found the games engaging and enjoyed interacting with them. This work makes an important contribution to the field of games for health. It aims to adopt a 'stealth health' approach to engaging people in their own health care management by leveraging a technology that is currently used and accepted by the target population.

Keywords: Game design, mobile game, lifestyle, games for health, stealth health

1. Introduction

The prevalence of type 2 diabetes (T2D) in New Zealand has been increasing at an alarming rate, and it is a public health priority that needs to be addressed. T2D is a leading cause of death for New Zealanders, including Maori (indigenous population of NZ) (Health, n.d.). The disease is associated with other comorbidity including renal failure, lower limb amputation, avoidable vision loss and blindness and heart disease; it is also a major contributor to the inequalities in life expectancy (Ministry of Health, 2008).

Existing research evidence provides support for the use of videogames to promote health-related behaviours (Baghaei et al., 2016). Adopting a healthy lifestyle can reduce the chance of children developing T2D. A randomized controlled trial, which provided information and behaviour change support/strategies in the form of a videogame, helped increase fruit and vegetable consumption by 0.67 servings per day ($p<0.018$) in children aged 10–12 years (Baranowski, et al., 2011). A systematic review of 14 randomised controlled trials of interactive multimedia interventions to promote communication of dietetic messages with overweight pre-adolescent children demonstrated potential to improve children's health-related self-efficacy, which could in turn enable them to become more competent on complex topics such as dietary behaviour change discussions (Raaff, Glazebrook, & Wharrad, 2014). It also highlighted potential of multimedia interventions to support communication between young children and health professionals.

In recent years, designing, developing and playing games with smartphones and tablets have become increasingly popular both in research and industry. The popularity and ubiquitous use of smartphones and tablet computers offers considerable potential to deliver interventions that would support communication between young people and health professionals. For example, smartphone-based games could be played while waiting in outpatient clinics or between visits with healthcare professionals (Greysen et al., 2014).

According to Kirriemuir (2002), there are two key themes common to the development of games for education: (1) the desire to harness the motivational power of games to "make learning fun"; and (2) a belief that "learning through doing" in the form of games offers a powerful learning

experience. It has been proposed that the real educational value of a computer game should be exemplified by its ability to create a playful learning experience for children through experimentation, progressive exploration, trial and error, imagination, role play, and simulation. Therefore, a game designed to satisfy these criteria might provide a useful platform for education. Based on this understanding, learning in a computer game should be purposely structured through a series of exploration tasks so that children can discover essential diabetes knowledge in a progressive and experimental manner. Driven by an initiative from the Adult & Pediatric Diabetes Psychology Service of New Zealand, research was undertaken to design and develop effective approaches for lifestyle education and enhancing children's engagement with healthcare provider. In this paper, we describe the process of designing several health educational prototype mobile games for increasing children's knowledge of healthy diet and lifestyle and to encourage them to engage with their healthcare provider on a regular basis.

2. Game Design for Lifestyle Education

The aim of our project was to determine how to use video games to enhance children's knowledge of healthy lifestyle and their engagement with healthcare providers. The research questions we investigated in this paper was whether participants enjoyed playing the games and had a positive perception.

2.1 Design Strategies

The key concept that is frequently utilized to explain the level of engagement in a computer game is that of "flow", first introduced by Csikszentmihalyi (1990). Many researchers consider flow as the state of intensive involvement. It is widely believed that flow is the key to the success of an educational game. According to Malone (1980), several conditions are likely to induce the flow state. Among them, three conditions are of particular importance for designing diabetes education games (Chen, Baghaei, & Sarrafzadeh, 2011):

- C1: The game should be designed so that it has levels of difficulty that can be adjusted to match the children's current diabetes knowledge.
- C2: The game should provide output to children that gives feedback on how well they performed on a particular activity and how to improve their performance. In this, the activity should be designed so that reasoning behind children's decision making in the game mimics the situation often presented when managing their diabetic condition in real life.
- C3: In game activities should include a variety of challenges that includes a message about different aspects of diabetes management, each with increasing level of complexity, so that children can learn a wider range of information about managing their condition.

To apply the educational features into the game, we used design strategies proposed in our previous work (Baghaei et al., 2011, 2016). The first design strategy was Structure Enhancement (SE), which means that the educational content should enhance the structure of the game and not weaken it. For instance, the addition of educational elements into the game should prompt design for a new series of difficulty levels so that children can gain knowledge progressively as they advance through the stages of the game. The second strategy was Feedback Enhancement (FE). With this strategy, the educational features must provide a knowledge-rich visual feedback that are triggered by specific in game situation. Feedback can be provided in various forms, such as message boxes and on-screen performance indicators. For example, a warning message can be shown to the user or have the performance indicator flash red when their in-game character chooses to eat unhealthy food. The final strategy is referred to as the Challenge Enhancement (CE). Our previous study suggested that challenge induced proactive knowledge discovery and encouraged engaged learning. Hence, CE recommends that educational features in a game should provide users with a range of challenges as they play the game. Using a stage-based game, simple educational features can be used for the early stages of the game, while complex features are reserved for more advanced stages of the game.

When designing an enjoyable educational game, it was also noted one of the most important aspect to consider was player's perception on the game. We used four heuristics used to measure

player's perception on the game in the design and development of the games: Usability, Educability, Mobility, and Playability (Baghaei et al, 2016). These heuristics has worked well as a measurement of participant's experience of the game for the past diabetes educational game based on Mario Brothers, hence we continued to keep these heuristics in mind when designing the video games for this study.

2.2 Modifications of Ari & Friends

When choosing the game design, we initially chose to use the Mario Brothers game as a template for several reasons (Baghaei et al., 2016). Overall, we considered the Mario Brothers game well suited to provide a lasting and fun learning experience. Based on these strategies, additional features were added to the original open source Mario Brothers game to create 'Ari & Friends'. In this game, in addition to the original storyline where the main character has to explore various stages to find and rescue a princess, players are presented with an additional challenge where Ari is presumed to be suffering from T2D. As a result, players must solve health problems caused by the condition, such as the necessity to maintain therapeutic blood sugar levels. While exploring dungeons, players need to carefully consider the actions they take, as movements such as jumping, running and picking or eating food items will affect their blood sugar level, which are reflected in an indicator bar on the screen (Figure 1).

In the game, players are encouraged to eat healthy food to maintain energy and to keep active by exploring the terrain. It was expected that children would be able to make the connection and learn the skills to keep themselves healthy by choosing a healthy diet, being physically active, and maintain their blood sugar level. To encourage children to approach health care professionals when they needed assistance, a new character "doctor" was introduced to this version of the game. When players reach a checkpoint, they would encounter the doctor who asked health related questions. Players were rewarded with physical immunity against enemies and free adjustment to their blood sugar level if required. All modifications were consistent with the SE, FE and CE design strategies. An example of the use of these strategies: As with the initial version of Ari & Friends, the main challenge was to maintain Ari's blood sugar level throughout every stage of the game. Players were required to keep a close eye on the indicator and maintain levels within predefined limits. If the blood sugar was low, players were required to use their remaining energy to find and eat a food item. If it was too high, they were required to undertake activities and exercise such as running and jumping. With these modifications, players were now required to explore the terrain to find food items and carefully choose which food to consume. This approach with SE strategy as the need to make correct food choices and being mindful of blood sugar level provides fine-grained challenges through every stage of the game.

2.3 Designing 3D Diabetes Educational Game

Using the same design principles and strategies, we also developed a 3D education game targeting a similar demographic. Similar to Ari & Friends, the 3D Zombie game intended to teach children about healthy lifestyles and management of T2DM, and to encourage them to engage with their healthcare provider on a regular basis. While the educational messages were similar, the game design was markedly different. 3D Zombie game had mechanics like Microsoft Minecraft, a game that is vastly popular among our target demographic. This provided an advantage of a shorter learning curve required to play the educational game. For the development process, we decided to use the Unity Game Engine to facilitate the rapid development of a fully 3D immersive world. The game was a mission-based

Figure 1. Ari & Friends Game Screen with Indicator Bar.

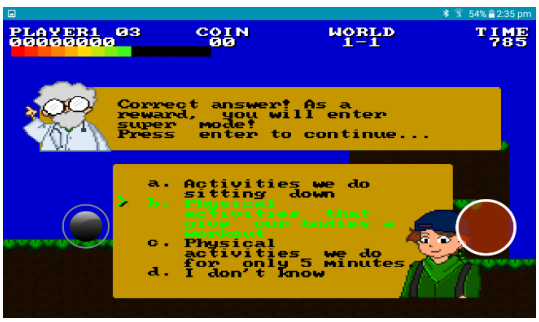

Figure 2. Option Text Turns Green indicating Correct Answer.

role-playing game where players roamed a post-apocalyptic world overridden by zombies. Users played as a main character with T2D. Players were given tasks to complete in order to advance to the next level; each task related to a particular aspect of diabetes management. Players were required to find hidden healthcare providers (e.g., doctors or nurses) that could offer instructions or tips on how to solve a task and advance to the next level. If players ignored or ran away from a healthcare provider, they lost points, experienced changes in blood sugar level, or their movement speed slowed down (Figure 3).

Figure 3. Screenshot of the Zombie 3D Game; the player wakes up in the hospital and must save others by following instructions of health care providers.

The player's main task was to save a person from turning into a zombie by completing healthcare provider's instructions. At the end of each level, a quiz session was triggered to assess player's knowledge and to collect data. The session comprised questions related to the tasks on each level, which made each task a learning goal and highlighted the need to complete every available task to advance to the next level. Similar to Ari & Friends game, one of the main challenges in the game was maintaining therapeutic blood sugar level. Because of the main character's condition, blood sugar level had a major impact on the character's performance. Different types of food items were scattered throughout the terrain; each resulted in different effects when consumed (i.e. speed increase) and affected blood sugar level differently. We initially included guns as a potential weapon for players to use against zombies. However, it was decided to forego the guns after talking to our potential participants and further consideration about our target age group. In the place of guns, we added a shield feature so that the players could defend themselves against zombies and sugary food items. We conducted a pilot study (n=10) during which we decided this game, with the current implementation, was not suitable to be played on a tablet or a mobile device and was aimed more for PC players. The game also had some performance issues. We decided not to go ahead with it, despite the visual appeal.

2.4 Designing Diabetic Jumper

Diabetic Jumper was a 2D game with the mechanism based on another popular video game, Doodle Jump (https://en.wikipedia.org/wiki/Doodle_Jump). The goal of this educational game was to improve children's health literacy and knowledge about diabetes management, and to give positive reinforcement for children to engage with their healthcare provider on a more regular basis. The players must jump on platforms to reach the finish line of each level to advance to the next stage. Players navigate the avatar's movement trajectory by tilting their devices left or right. There were several playable characters within the game. Characters were drawn as imaginary non-human avatars with bodies that has a condition similar to somebody with type 2 diabetes, so they must strive to maintain therapeutic blood sugar level. The game was comprised of six stages with increasing complexity. After some feedback from the pilot study, different game elements were introduced in this game in addition to blood sugar level, such as body weight and sleep level that needs to be maintained in the more advanced stages. This provided fine-grained challenges to the existing game structure, following the SE design strategy. In their journey to the top, they will encounter different items of various types, each type has different characteristics affecting either blood sugar, body weight, or sleepiness. In the later version of the game, items can also have other interesting effects, such as gradually increasing weight, gradually decreasing blood sugar level, and instant death.

Figure 4. Some of the Additional Features of the Game.

The SE, FE and CE design strategies were used in the design process of the game. Pickable item types started with modest variation in earlier stages with types of healthy or unhealthy food, water, and exercise items. As the player unlocks more advanced stages, item types will have more variation, gradually adding more situational problems for the players to solve, such as drowsiness that begins from the medium difficulty stages and passing food carts with junk food that will kill the players instantly in more advanced stages. This way, children can first learn how to maintain the condition by using simple food choices and exercise, then learn how to maintain increasingly complex conditions and learn how to make more complex decision making as work their way up to later stages. This aligns with the CE design strategy where challenges are structured so that children can discover and learn educational content in a progressive manner. To give positive reinforcement on engaging with healthcare professional, we introduced checkpoints in each stage where the character can rest and answer quizzes given by a nurse character. The quiz screen displays a question with multiple answer choices.

The game followed the FE design principle by giving clear visual feedback after the player has given an answer. The choice will be highlighted in green for correct answer and red for incorrect answer. Further information related to each question will be displayed regardless of correct or incorrect answer. However, players are rewarded with point bonuses and free stats adjustment (blood sugar level, weight level, and sleep level when applicable) if they answer correctly. Visual feedback are also given in the form of explicit colour change in the indicator bars of blood sugar level, weight, and sleep level when they enter unsafe or critical level, and green in therapeutic level. When an indicator enters an unsafe level, a warning message will pop up, warning the user and giving instructions on how to bring it back to therapeutic levels. In addition to the gameplay, the application has features such as level selection, game settings, help, and personal high scores (Figure 4) to improve Usability and Playability.

3. Pilot Study

A series of co-design user-panel workshops with young people aged 9-15 years were conducted. During these workshops, young people played the prototype games and then provided user feedback directly to the designers and developers. These interactive sessions allowed users to highlight factors that facilitated or inhibited game use. They also provided detailed input into possible changes to improve the games. Based on feedback, the game developers revised the game and the process was repeated until we had a working version of the game to pilot test. In total, three user panels were conducted over a period of 12 months. Further, having revised the games we beta-tested with 10 participants aged 9-15 years over one week. After one week, all participants said that they played the games regularly over the course of 7 days. After allowing some time for the participants to experience the gameplay of all three games, we questioned the participants on their preference between the three games and what they thought about the games. The majority of the participants voted for the Diabetic Jumper as their preferred game, with only one participant reporting they preferred the 3D game. Participants stated the game controls were difficult to use on a tablet and would prefer to play it on a PC.

The visualisation of the bubble for choosing items in Diabetic Jumper was well received by the participants. During the session, participants also made some suggestions on how to improve the game both in terms of engagement and educational value, e.g. adding themes such as Halloween, Christmas, School party with different food items and backgrounds, introducing factors that immediately kill the player such as a fast food restaurant, including exercise bubble and pillow for sleep, making the levels more challenging as the players progress through the game. As a result of the Beta testing, we decided to use two of the games only (Diabetic Jumper and Ari & Friends), which were tested in a small pilot study of potential end-users.

4. Conclusion and Future Work

This project proposed novel design ideas for delivering healthy lifestyle education and interactions with health care professionals. Using co-design principles, we designed and developed three prototype serious mobile games for health targeting children. We further developed expertise and skills in the use of co-design methodology applied to the design and development of serious games for health. These methods can also be applied to other health conditions. The games are currently suitable for Android devices and aim to promote knowledge about healthy lifestyles and to engage young people to discuss their health condition with their healthcare provider or other similar person. It is possible these games could be used in a clinic or general practice setting to encourage young people to discuss their health condition. Initial findings showed that the children found the games engaging and enjoyed interacting with them. Future research is required to test the potential of these games in a primary care setting and examine whether children's knowledge of healthy lifestyle will enhance as a result of engaging with these games over a period of time.

This work makes an important contribution to the field of serious games for stealth health and healthy lifestyle education. Our approach aims to adopt a 'stealth health' approach to engaging people in their own health care management by leveraging a technology that is currently used and accepted by the target population.

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