Designing Mobile Games for Improving Self-esteem in Children with ADHD

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Abstract: There is a growing number of children with Attention Deficit Hyperactivity Disorder (ADHD). Research has shown that these children process information quite differently from others. A lot of ADHD diagnosed children (especially Inattentive type ADHD) are more of a visual learner, easily distracted, struggle to follow instructions, are easily forgetful and more importantly have low self-esteem. Parents are often overwhelmed by the amount of information they receive on how to handle their child's symptoms and learning style. In this project, we propose a novel way to increase the self-esteem of ADHD diagnosed children through use of computer games. We came up with a set of design principles that can be applied to any game to make it suitable for ADHD children, especially with the aim of increasing their self-esteem. Our game design was applied to an existing open source mobile game (GLtron). The results of a pilot study showed that users enjoyed playing the game and found it valuable for increasing players' self-esteem.

Keywords: Game design, self-esteem, engagement, attention deficit disorder, hyperactivity.

1   Introduction

The term ADHD is applied to anyone that meets the Diagnostic and Statistical Manual of Mental Disorders (DSMV) test criteria [8, 10, 24], and stands for Attention Deficit Hyperactivity Disorder. A growing number of children are diagnosed with ADHD. They are affected by a range of problematic behaviors such as distractibility, hyperactivity, difficulty to stay focused or following orders. They sometimes present aggressive behavior, social isolation and defiance to teachers and parents. If a child is diagnosed with ADHD it does not mean that he/she has all these symptoms ([10], [11]). Nylund mentions in his book "Treating Huckleberry Finn" [16] that the traditional ways of teaching do not work very well on ADHD diagnosed children. They need a more dynamic way of interaction, which could help them maintain their focus.

Treatments range from stimulant medication to cognitive behaviour therapy to behavioural strategies. Parents are often overwhelmed by the amount of information they receive on how to handle their child's symptoms and learning style. Research has shown the standard parenting skills do not work with ADHD child, as they process information quite differently from other children [1, 10, 13, 24]. For example, they are more visual learners than verbal learners. A lot of ADHD diagnosed children (especially Inattentive type ADHD) are easily distracted, struggle to follow instructions, are easily forgetful and more importantly have low self-esteem [8, 10, 13, 24]. What they need is short and concise verbal instructions and immediate feedback as well as constant positive feedback, even if they only get it partially correct.

In this project, we proposed a novel way to increase the self-esteem of ADHD diagnosed children through use of computer games. Previous research [12] has shown that educational videogames, if successfully implemented, can provide users with academic success, cognitive abilities (stimulation of different abilities like creativity), motivation, and attention and concentration. With the help of our external partner, who is a registered Clinical Psychologist and the Co-Director of the BrightMind Labs, we came up with a set of design principles that can be applied to any game to make it suitable for ADHD children, especially with the aim of increasing their self-esteem as a result of playing the game. We refer to our design approach as *BRIGHT* (the letters are taken from the keywords for this project).

There have been some studies on health-related games mainly for encouraging physical activities, stroke rehabilitation and diabetes, brain training, ADHD diagnosis and helping ADHD diagnosed children solve social problems ([2], [4], [5], [7], [18], [19], [20], [25]), but we are not aware of any game designs targeted specifically for improving self-esteem in children with ADHD.

This paper presents the steps towards the development of our proposed game design with a particular focus on improving self-esteem. It then follows by discussion of how these principles were applied to an open source Android-based mobile game. A preliminary evaluation of the game will also be reported. We believe our research paves the way for the systematic design and development of fully-fledged computer games dedicated to improving self-esteem in children with ADHD.

2 *BRIGHT* Design Approach

According to Kirriemuir [14], there are two key themes common to the development of games for education: (1) the desire to harness the motivational power of games in order to "make learning fun"; and (2) a belief that "learning through doing" in the form of games offers a powerful learning experience. The first theme is broadly criticised in the literature. As pointed out by Rieber et al. [17], games should not be treated simply as educational "sugar coating", making the hard work of learning easier to "swallow". Instead we have to consider both the motivational and cognitive power of games [22].

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, and imagination. Therefore, a game designed to satisfy these criteria might stand for an ideal platform for education and cognitive development. It is, therefore, clear that learning in a computer game should be purposely structured through a series of exploration tasks so that children can discover essential skills in a progressive and experimental manner. This leads to our main research question: how can we improve self-esteem in children with ADHD though playing computer games?

To address this research question, the nature of computer games needs to be carefully examined. The key concept that is frequently utilised to explain the level of engagement in a computer game is that of "flow", first introduced by Csikszentmihalyi [6]. 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 [23]. According to Malone [15], several conditions are likely to induce the flow state. Among them, a few conditions are of particular importance for designing educational games:

C1.   The activities in a game should be structured so that the level of difficulty of the game can be adjusted to match children's knowledge.

C2.   The activities in a game should provide concrete feedback to children so that they can tell how well they perform and perhaps what they need to do to perform better. In particular, the performance of the game should be closely related to children's current state of knowledge of the domain.

C3.   The activities in a game should present a variety of challenges such that children can obtain increasingly complex information about different aspects of domain they are learning.

It can be argued based on Malone's conditions that instead of aiming for a gaming experience that superficially conceals the educational purpose behind fun activities, a careful design of the structure of the game is highly desirable. Specifically, the game structure should contribute to the flow and subsequently the creation of an active learning and visually stimulating environment.

Among all types of games, it appears that simulation and role play games are most likely to satisfy these requirements. In fact, learning through direct experience, which is enabled by simulation and role play, has been consistently demonstrated to be more effective and enjoyable than learning through information communicated as facts. Although simulation and role play games may be suitable, we argue that other types of games can, when designed according to sound principles, lead to a positive outcome for children with ADHD symptoms.

Based on what we found in ADHD literature, our earlier work in this area [21] and our experience in dealing with such children, we present *BRIGHT* – a set of generic design principles aimed to increase self-esteem in ADHD children as a result of playing computer games:

- Positive Feedback (PF): Provide constant positive feedback and recognize the effort, when the player is doing a good job and is gaining new scores – this is particularly important for improving self-esteem.
- Clear instructions (CI): Give them clear instructions from the beginning as to what they are required to do.
- Specific Goals (SG): Give them specific goals, e.g. to achieve a certain score in order to finish a specific level.
- Encourage them to Think Straight (TS): Our aim here is to encourage the players to slow down, analyse the situation and create a strategy rather than rushing to reach the final goal. Children with ADHD are usually impatient [10, 11, 13] and because of the hyperactivity they are always rushing. TS design principle focuses on improving this behavior.
- Encourage them to organise themselves (OG): the objective here is to help the players create the habit of planning ahead. We believe this is effective, as the majority of children with ADHD are disorganised [13] and planning ahead helps them address this issue.

To evaluate the proposed design empirically, we had to identify an appropriate game and modify it using the proposed design strategies discussed earlier. Guided by Malone's conditions, efforts were made to compare and select suitable games as the basis for our quest towards tackling the research question. Many open-source games were studied and GLtron (http://en.wikipedia.org/wiki/GLtron) was finally selected. The game consists of controlling a motorcycle on a large and limited square area by turning it to the left or to the right. During the motorcycle movement, each player creates a wall following its path and this wall blocks the way of other players on the scene. The goal of the game is to be the last player riding. Cycles can be boosted with a limited turbo. There are various gameplay styles, including switching the gameplay from "booster" to "wall accel." to "both". "Booster" has an extra button for boosting, in addition to the standard left, right, glance left, glance right buttons, while "Wall ride" increases a player's light cycle's speed automatically depending on how close they are to an opponent's wall. "Both" incorporates both options for increasing the player's light cycle's speed. There are several arena sizes that can be selected, from "tiny" (which is best for two players on normal speed) to "vast".

GLtron is an action-packed game with good visualisations and enjoys a good match with Malone's conditions: the level of difficulty of the game can be adjusted (C1), feedback is constantly provided to show players how well they are doing (C2) and the game becomes more challenging as they keep playing (C3). We felt it would be an engaging and fast-moving game for children and a good fit to start off with. The game is released under the GNU General Public License.

The changes were made to the mobile (Android) version of GLTron as a proof of concept. Screenshots of the modified game are shown in Figure 1 along with a positive feedback message on the second screen shown to the player.

3 Applying *BRIGHT* Approach to GLtron

Driven by the five design strategies, namely PF, CI, SG, TS and OG, modifications were made to the GLtron game (see Figure 1). At the beginning of the game, the instructions are clearly explained (following CI principle). The player would be given a clear goal - that is to be the last one riding if they want to win the game (SG). The number of players are shown on the screen at all times. The game will gradually become more challenging in the following ways, if they win in less than t(s) seconds:

1) the number of artificial players will automatically increase and the updated number gets displayed on the screen
2) the speed will also increase and an updated speed will be shown to the player

The players are encouraged to think of a new strategy as the game gets more challenging (TS & OG). Positive feedback in various format is constantly provided when the player has achieved something and a difficult obstacle is overcome (PF). We believe this will directly affect their self-esteem. Some of the example feedback messages given in different scenarios are:

Fig. 1. Modified version of GLtron for mobile devices

- Every 15 seconds give them one of these messages (picked randomly):
    - *Well done !*
    - *Keep up the attention, <<player's name>> !!*
    - *Good focus, <<player's name>> !!*
    - *keep going !!*
    - *Nearly there !*
    - *Well done at keeping alert, <<player's name>> !!*
    - *Great job !*

- Every time another car crashes:
    - *Well done !*
    - *keep up the attention, <<player's name>> !!*
    - *Good focus <<player's name>> !!*
    - *Well done at keeping alert, <<player's name>> !!*

- After every 15 minutes of playing, if they have won at least once, give them this message:
    - *Well done <<player's name>>, very good focus! Show this to your teacher!*

- Each time they win, change the default message of "you won" to:
    - *Well done <<player's name>>, you won! You have a very good focus.*

The modifications made aims to show ADHD diagnosed children that they can achieve their goal, when they are focused. To find out how and for how long they interact with the game, children need to login with their user name in order to play the *BRIGHT* version of the game. Many game-playing activities, such as player's name, start and finish time & date, score, speed, change in speed, level size, number of players, change in number of players, number & type of messages they get on the screen, each time they win or lose, length of play will be logged on the tablets in addition to timestamp for each entry. The log will help us find out whether children's self-confidence will improve after playing the game for some time.

4   Preliminary Evaluation

We carried out a pilot study with the *BRIGHT* version of GLtron in March 2015. 36 users (17 males & 19 females, aged 20-29) took part in our study by playing the game for 30 minutes and filling out a user questionnaire at the end. The results are shown in Table 1.

Overall the game was well received. 81% of participants believed that the game has merit in increasing confidence in children who have low self-esteem. 79% thought our version of GLtron kept players motivated and 76% (of those who had played the original version) said they would spend more time playing the modified version of the game and/or would allow their children to spend more time playing it compared with the original version. We received very positive comments, for example: "*I believe the game can help children concentrate*", "*innovative approach*", "*I can see a lot of potential in improving one's confidence*", "*enjoyed playing it*". Some suggestions were also made for further improvement. Some users asked us to award them using points in the game in addition to providing positive feedback during the session. One user thought it might be a bit too challenging for younger children to win and another one suggested some of the feedback messages to be shortened, as they might influence the player's experience otherwise. A user

asked for more improvement in visual effects and sounds and a few others asked for it to be personalised to the players, as some are more experienced than others.

Table 1. Subjective Evaluation

Question	Yes, very easy or high merit	Yes, easy or some merit	Neither Yes or No	No, difficult or little merit
Were the game controls easy to use?	58%	26%	12%	4%
Did you have fun playing the game?	51%	29%	13%	7%
Do you think the game has merit in increasing children's self-esteem?	66%	15%	14%	5%
Did you get well through a challenge?	34%	29%	21%	16%
Were the messages given to you, while you were playing, made you focused more in winning the game?	31%	42%	27%	0.00%

5   Conclusions & Future Work

In this paper, we presented the initial steps towards development of *BRIGHT*, a novel game design for increasing self-esteem in children with ADHD. We applied the design to GLtron, an open source mobile game, and presented the results of an initial pilot study. The results showed that the players liked the idea, enjoyed playing the game and believed it adds value.

We plan to address the feedback received from the initial study and evaluate the effectiveness of the proposed design on mobile platforms with ADHD-diagnosed children aged between 6-11. Three acceptance indicators will be measured: the increase in self-confidence as a result of playing, engagement with the game and the player's enjoyment. These will be measured during and after playing the original and *BRIGHT* versions of the games for a week. We hypothesise that the *BRIGHT* version will increase their self-esteem, engagement with the game and enjoyment. Considering Gardner's seven types of intelligence [9], making *BRIGHT* games personalised to the players' skills will be our next goal. We aim to present players with different challenges, e.g. linguistic, mathematical, spatial, kinesthetic, musical, interpersonal and intrapersonal, to find out which type(s) of intelligence they belong to and what their preferred way of learning is. The information gathered in this phase of the project should also help parents and educators develop children in areas they are good at. We also plan to conduct a longitudinal user study for a period of

3—6 months to examine whether using *BRIGHT* games can lead to long-term behavioural changes. We believe our research paves the way for the systematic design and development of full-fledged computer games dedicated to improving self-esteem in children with ADHD.

Acknowledgements

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