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ABSTRACT

There are a variety of fitness technologies such as activity trackers, exergames and mobile applications available to promote physical activity. Based on our previous research, we found that children prefer having social interaction, a narrative and flexibility while interacting with such technologies. Other research has shown that persuasive displays encouraged adults towards physical activity. In this research, we present the initial results from a user study conducted on 16 children (ages 6-11) who used the Kidfit suite, a collection of mobile applications that combine and utilize the elements found from previous research to promote activity in children.

CCS CONCEPTS

• **Social and professional topics** → **Children**; • **Human-centered computing** → Participatory design.

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INTRODUCTION

A wide variety of wearable fitness technologies are available for both adults and children including standalone fitness trackers (e.g., FitBit, Jawbone), smartwatches and mobile phone fitness applications that track activity via accelerometers or GPS. Exergames and mobile fitness applications like Nike Fitness app, PokemonGo, BunnyBolt [5], and Fish'n'Steps [6] also intend to promote activity in their users. While there are plenty of such applications available for adults, fewer of them are designed to cater the needs of children. The mobile fitness applications for children employs elements of narrative, social interaction and more to promote activity in children and have found promising results . But none of the applications mentioned above combine the elements of fun for children into one single package. In this work we present the results from children's interaction with Kidfit Suite, a collection of mobile applications, which combines the elements of fun for children as found in prior research and confirmed in our previous studies.

RELATED WORK

Some examples of mobile fitness apps for children include Bunnybolt, FitQuestLite, NFL Play 60 and Virtual Walk. These apps employ different elements of narrative and/or gamifications to motivate children to be active. Narratives are engaging for children and can help promote physical activity by means of playful narration. FitQuestLite [2] is a narrative based application where users' activity helps a baby squirrel safely reach the tree house. Other research utilize the fact that children engage in activities that focus more in recreation than education by providing a responsive and persuasive experience with interactive audio that adjusts the tempo of the music according to the activity of the child [4]. The applications mentioned above use gamification, short sessions of activity, persuasive displays and narratives to engage children in physical activity.

In previous research [8] , we conducted 5 sessions of 25 minutes each with 7 children (ages 6-11) where they played on 3 mobile fitness applications - Zombies Run!, Virtual Walk and NFL Play 60. From these sessions, we learned that children enjoyed having a narrative, social interaction with their peers and some kind of flexibility while engaging in childhood play. Others research [3] found that a



Figure 1: Grow the Garden (GtG) game won screen.

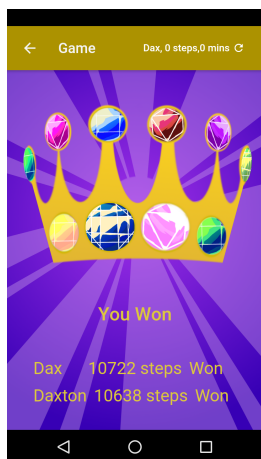


Figure 2: Capture the Crown (CtC) game won screen.

persuasive display such as a garden with flowers was able to motivate adult participants towards activity.

The activity guidelines for children suggests 60 minutes of activity each day [9]. However, from our research session, we also observed that children preferred activity being measured in terms of steps instead of activity minutes. The preference towards activity measurement in steps could be partially attributed to the fact that children tend to follow adults who measure their activity in terms of steps. Another reason for using steps as an activity measure in our research was the limitation of Fitbit activity trackers to measure active minutes if the difference is less than 10 minutes [1]. Using all the lessons learned from previous research, we developed a collection of applications [that we integrated into the Kidfit Suite] which utilizes persuasive displays and elements of social interaction along with synchronous and asynchronous play to promote physical activity in children.

KIDFIT SUITE

KidFit Suite is a collection of mobile applications and back-end API’s that fetch fitness data from the FitBit server and present it to the user in gaming applications. The applications we focus on from KidFit Suite in this paper are *Grow The Garden* and *Capture the Crown* (see Figures 1 and 2). These gaming applications leverage children’s affinity towards technology and mediums of social interaction and temporal flexibility to engage users into physical activity. Temporal flexibility refers to the ability to play short and long games achieved via synchronous and asynchronous method of play. It employs the elements of fun with fitness, flexibility while playing the game, social interaction with peers, narrative and persuasive displays to motivate children towards physical activity. These applications are targeted towards children in the age-range 6-11 yrs.

The **social aspect** of the applications lets children challenge their peers or play in teams towards a common goal without having to be at the same location. The **temporal aspect** lets a user decide whether they want to play a short quick session, or a rather longer session (a few hours) which will provides them the flexibility to play as and when they are available. In order to play these games, the user would first create a game by selecting players from a list of players (participants in this study) and giving a name to their game. If the user decided not to name their game, the app would give them a default name. Upon creating a game, invitations are sent to all those who were selected to be in a game and they can choose to accept or decline it. Only after all the players who are invited have accepted/declined the invite can a game start. Only the child who created the game had the authority to remove certain players if they did not want to wait for them. However, the game required at least 2 members to play, so if all the members were deleted from the game, the game could not be played. Once the game starts the user can see the steps achieved in the game and the time remaining for the game to end.

Table 1: Parents and children feedback on the fitness games they played.

P8	I like the idea of it being fitness based and incorporate it into technology because that’s just what kids are doing these days. And. I like the challenge. The challenges and then the ability to play with other kids and have two choices They can choose how many. And so they just really feel in control of it and it’s theirs
P16	They were fun games cute ideas and they were. Motivating and perfect for kids at their age I think.
P1	The games provided motivation for her for steps and then also motivation to interact with other people on physical activity and it also had a um. It was an opportunity to interact with her peers on um on her physical activity.
P9	I liked that she was more active the second time and she was curious about the kids she was playing with. So I think it motivates or encourages more friendships too. She understood had the phone and the Fitbit work. Together. So that was learning
C15	I like them. they are fun and its fun to be just competitive and not have to be in the presence of another person.
C3	Well I like that it let you be active at the same time have something to do with electronics.
C1	There should be more games like this. because I would like playing more games and see how much steps I can get to add up play against more people

Grow the Garden (GtG): application encourages users to get more and more activity which will help them to grow a garden of flowers on the screens of their mobile phones similar to what was found by [3] (see Figure 1). The users can choose to challenge their peers in a competition or play as a team, where based on the number of user, the application provides with a target of steps or activity minutes to achieve. As the total activity by all the players increase, flowers starts showing up on the screen one by one notifying the user of the progress so far. The game can be played with temporal flexibility of playing a short active game or a long game with intermittent activity.

Capture the Crown (CtC): Similar to GtG, this game uses persuasive display where gems show up on the crown as in-game user activity increases (see Figure 2). The users can play as team or a competition and have the flexibility to play a longer or shorter game.

METHOD

In order to investigate these physical activity apps we conducted a study with 16 children (ages 6-11). Th participation in the study was voluntary and children were recruited via social media posts and word of mouth. The study consisted of two one-week sessions where children wore a Fitbit for the first week, and in the second week, they wore a Fitbit and played the games. The children were given the trackers and the mobile phones to use at their homes at their own comfort. The first week of the study is used as a baseline to understand user activity in general and then compared with the activity from the second week to analyze the change in activity levels. At the end of the two weeks, interviews were conducted with both parents and children. The primary interests of the study were to evaluate *asynchronous versus synchronous* and *competitive versus collaborative* experiences while using the apps.

The children were divided into two groups (addressed as Group 1 Group 2 respectively) with 8 children each. Group 1 played GtG as a synchronous or short game where each game lasted for a random time between 25 to 45 minutes and CtC as asynchronous play where the total time in a game was a random time between 25 to 45 minutes times the number of players. The longer play allowed for more asynchronous engagement. In Group 2, GtG was played asynchronously (longer) and CtC was synchronous (short duration games). In both groups and games, children had the flexibility to challenge other players (for a competitive style game) or play in a team (in a collaborative style game). While in a competitive game, the child with maximum in-game activity won, in a team game, based on the duration of play, the physical activity needed to win a team game varied. Short synchronous games required a target activity of 2,000 steps per child and long asynchronous games required a target activity of 4,000 steps per child.

Table 2: Parents and children responses to who would they like to play such games with

P7	I think we’d like to try again. maybe when you can play with family members or I would like to see it with Christopher (sibling)
P8	Yes. Me and my sister kind of gravitate to the same thing so she might join in with me if I brought it up to her. Normally I don’t play any games on my phone or anything like that but if it’s towards health or bettering yourself or anything like that that’s that always interests me.
P15	Oh I think yeah. I think having like an indoor especially in the winter something to get everyone active. I think that would be really fun. It would be fun if they could play like with cousins and stuff. I think it’s you’d feel really silly running around your living room but with a game in your hand you don’t feel as silly. So it’s a good exercise for them and they would they would like it because they got really excited when people were playing

INITIAL FINDINGS

In this section we present some initial findings from the analysis from the analysis of the data from the study. The idea of combining physical fitness with childhood play and technology was well received. Participants felt encouraged and motivated and they preferred playing with the people they know.

Liked the concept: Participants expressed acceptance and general liking towards the concept of bringing technology with physical activity. Both parents and children liked the visual motivation brought by flowers and gems on the crown (see Table 1) and all of them said they would like to play more such games in the future, particularly if they could play with friends and family.

Impact on activity: Out of the 16 children, 8 children showed an increase in average number of steps or active minutes over the second week, however none of them were able to get 60 minutes of activity as reported by Fitbit. Half of the children had 10,000 or more average steps during the second week of the study. 13 (81.25%) of the parents and 11 (68.75%) children reported that their activity increased while playing the games than in general (see Table 3).

Social connection: A total of 14 and 54 games were played by children Group 1 and Group 2 respectively. This uneven distribution in the participation in games could be due to the fact that all the 8 children in the first group have never met or known each other before while 6 children from the second group were either siblings or neighbours. As children were more socially connected and were well aware of the availability of participants, this could have led to more games being played by group 2. In fact all parents and children – those from both groups – reported that they would want to play with their friends and family in future (see Table 2). Since children in Group 1 were not acquainted they faced more issues starting the games as they had to wait for other players to accept the game request.

Collaboration and Competition: The data shows that children preferred playing short synchronous games such that 66% (45 of 68) games played were synchronous. Children preferred playing team games compared to challenges as indicated from the data and confirmed by interview responses. In fact one of the children noted that “you always win in teams”.

This suggests that children were motivated by winning and as all children win or lose together in teams hence seem to prefer collaboration over competition. In terms of visual appeal, CtC was preferred over GtG in the ratio 10:6. Though not designed intentionally nor asked specifically, CtC was reported to be more gender neutral while GtG was assumed to be designed for girls. Children’s preference to social interaction and effect on their physical activity was also confirmed by [7]. We anticipate that the detailed analysis of data will further help us understand the key elements that can affect children’s engagement with these apps and the affect it had on their physical activity.

Limitations and Next Steps: The Kidfit API’s can only fetch the updated data from the Fitbit server once its has been synced with the app. This presented the users with an overhead of syncing

Table 3: Parents and children responses how was their activity when they were using the apps different from their activity in general

P14	She kind of forgot about the fitbit and she was more active I think than without it, she has been wearing a fitness tracker for a year or so and the new fitbit got her more excited because it had more interactive things on it. Screen has a lot more exciting things than her other tracker. She was more active with the phone and the games. She would get up early for school and check her phone for games with her friends that also went to school early in the morning and so she would start games in the morning when she wouldn't usually be active so that added to her activity level
C3	More active. Because like I'd see how much time I had and my plan to go take a run around the block or something.
C2	I liked how instead of just running around in circles trying to get steps, you would actually have to play to get a reward or something

data on Fitbit app. As part of future work, we will work on utilizing the built-in step counter in phones to avoid the dependence on Fitbit. Children and parents also reported some issues related to logging into the system as emails and passwords are hard to remember by such young children. The next step would be to simplify logging in to make the user experience better.

CONCLUSIONS & FUTURE WORK

Although these findings are preliminary, some of our initial findings are promising, we have shared some initial findings including: the likings towards persuasive display and idea of combining technology with fitness, the affinity of playing with friends and family and the preference towards collaborative games. We hope that a detailed analysis of the data from this research will help identify the impacts of social interaction, temporal duration of games (in relation to synchronous or asynchronous play) and the role of persuasive displays in promoting children's physical activity. This research shares initial steps towards a deeper understanding on how to encourage children to engage in physical activity via fitness games.

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