A Field Study: Evaluating Gamification Approaches for Promoting Physical Activity with Motivational Models of Behavior Changes

Xin Tong(✉), Diane Gromala, Chris D. Shaw, and Amber Choo

Simon Fraser University, Surrey, Canada
{tongxint,gromala,shaw,achoo}@sfu.ca

Abstract. Wearable trackers and mobile applications can facilitate self-reflection of doing physical activity. The gamification process incorporates game design elements with persuasive systems in order to encourage more physical activity. However, few gamification strategies have been rigorously evaluated; these investigations showed that using the same gamification mechanism to promote physical activity could have contradictory effects. Therefore, I developed FitPet, a virtual pet-keeping mobile game for encouraging activity. I evaluated its effectiveness, and compared it with the goal-setting and social community strategies in a six-week field study. The findings revealed social interaction were the most effective intervention. Contrary to prior research, goal-setting was not perceived as an effective way to provide motivation compared to social interaction overall. Although FitPet was not able to promote significantly higher activity, participants showed great interests in this approach and provided design insights for future research: implementing social components and more challenging gameplay.

Keywords: Gamification · Motivation · Physical activity · Serious game · Social interaction

1 Introduction

Tools such as mobile devices and wearable technologies have been shown to help people manage their health and wellness. Of particular interest are technologies that are designed for activity tracking and promoting behaviour changes in everyday life. These technologies hold the potential to assist with counteracting the lack of regular physical activity by motivating people to develop and maintain a more active and healthier lifestyle.

Numerous persuasive systems aimed at promoting physical activity have been developed and researched in recent years. These systems capture and measure activity-related parameters and present the measured data to the user in various ways. In particular, mobile and wearable technologies can offer a host of sensing technology and data visualization tools, which allow for captured and quantified data to be stored, analyzed and communicated. Furthermore, researchers and commercial companies alike have been developing various systems designed to promote physical activity.

M. Kurosu (Ed.): HCI 2016, Part III, LNCS 9733, pp. 417–424, 2016.
DOI: 10.1007/978-3-319-39513-5_39

Individual behaviour change, including physical activity, has become a subject of active investigation in the areas of cognitive science and clinical psychology. One of the most accepted theoretical models from psychology community of how changes happen is the Transtheoretical Model (TTM) introduced by James Prochaska [1]. TTM argues that individuals change their behaviour gradually, by advancing along a series of steps. These steps vary from pre-contemplation in which individuals have not realized the need for change, to termination in which the new behaviour has become so habitual that there is no longer any danger of relapse.

In the light of the criticism toward gamification and a relative lack of rigorous studies evaluating its effectiveness, in this paper, we set out to evaluate people's acceptance of gamified strategies, motivation models and behavior changes. Through the six-week field study, we tested three gamification approaches and evaluated participants' motivation changes.

2 Related Work

Digital technology is increasingly being adopted to promote physical activity and reduce sedentary behaviour in the general population. It offers a practical way to motivate self-managed physical activity. However, for any behaviour change technology to be effective, the strategies that promote change need to be examined along with reasons that undermine to behaviour changes.

In the past decade, a number of innovative health-related programs designed to promote an increase in physical activity introduced novel technologies to reduce the cost of continuous involvement of clinical personnel required to promote and maintain healthy behaviours in patients. Many of these include techniques that transform physical exercise into engaging the individual or social games that often mix real and virtual environments [2]. In an alternative approach, pedometers – small electronic devices that monitor individual step counts, have been used as a ubiquitous and unobtrusive motivational technique available anytime and anywhere [3–5].

Some of these "quantified systems" provide numerical numbers for self-knowledge and self-reflection, which has been termed as "personal informatics". Such quantified systems can facilitate the collection and storage of personal information. It is believed that self-reflection leads individual to reconsider and possibly change their attitudes towards lifestyle changes. However, there are other systems that present physical activity data using game-based mechanics, defined as gamification. This approach has been assumed to be more fun and enjoyable, thus motivating users or players to become more physically active.

Gamification has the potential to engage people at an emotional level, which is considered to be far more powerful than typical transactional engagement strategies [6]. The gamification techniques – points, virtual rewards, levelling up, badges, peer obligation, social currency, missions and challenges – are part of the new area of gamification, with early signs of great potential for lifestyle improvements [7]. Concluded from the definition and applications of gamification, gamification is not about applying technology to old engagement models. Rather, gamification is thought to create entirely new

engagement models, targeting new communities of people and motivating them to achieve goals they may not even know they have.

Gamification approaches have become popular in recent years [6] and are utilized as a design trend in applications for promoting healthy behavior changes. Nevertheless, many researchers have also criticized gamification mechanics. Furthermore, current research has not covered or evaluated most gamification techniques yet. Therefore, it remains unclear whether certain gamification approaches are effective in the context of physical activity.

Therefore, the major research question of this research is: will certain gamification approaches, including goal setting, social interaction, and a game-based virtual pet-keeping mobile application, be effective for promoting more physical activity? If there is an effective gamification method, how can that strategy provide motivation and why? Besides, I also wanted to figure out the design challenges and opportunities for developing such research prototype and persuasive technologies for encouraging motivation for lifestyle behavioral changes.

3 FitPet Game Design and Gamification Approaches Overview

3.1 FitBit Website Community and Mobile Challenge

Social Interaction Type One: Online Website Community: Fig. 2 (the second image) introduces the layout of Website Community. At the top of this image is a leaderboard which visualizes all group members' step data into bar charts and ranks each member from the most to the least with the member's name and the step number. Members may post their questions in the Discussion area and add friends with others.

Social Interaction Type Two: Challenges on Mobile Phones: Fig. 2 (the third image) demonstrates what the Mobile Challenges look like in a mobile App and how the communication and interactions among members can be. Four types of Mobile Challenges are included. *Daily Showdown* is a one-day competition, and *Weekend Warrior* takes effect only during the weekend, whereas *Workweek Hustle* is effective for competition during the five weekdays. *Goal Day* is about how many participants can reach their daily steps goal. For all challenges, the one who has the most steps will win the competition. After a Mobile Challenge starts, participants can chat with each other, cheer-up or nudge each other. The system will send notifications to the main screen once there are major changes happening, such as "Tom just surpassed you!", "You just have 1000 steps more than Jerry!", or "You rank first currently."

3.2 FitPet Mobile Game

Therefore, in *FitPet*, goal-setting is the key to designing and playing this virtual pet-keeping game. The relationship between goal-setting and virtual creature's wellness and evolvement is the core mechanics that incorporate the users' daily physical activity goal into the wellbeing of their virtual pet. The tight connection is designed for player engagement so that during the 'user-pet interaction', users will grow emotional attachment to their virtual pet. *FitPet* also asks its users to break larger goals (like a long-term

fitness or activity goal) into smaller practical challenges – a daily steps goal. This is to encourage players to stay motivated through the growth progress of their virtual pet and engages them *emotionally* to achieve their best to attend to the virtual pet.

In order to motivate users to engage with the pet more frequently, and grow an emotional attachment to the pet, individual's daily progress towards their goals was mapped to the development of the virtual pet in two ways. Firstly, the daily step count

Fig. 1. Flow chart of FitPet mobile game

Fig. 2. The three gamification approaches for each study group: control group (left, goal-setting task), social group (middle, goal-setting task and Website Community as well as Mobile Challenges), and FitPet group (right, goal-setting and the mobile game)

can be converted to game coins, and then the users can use their coins to play with their pets, feed their pets, and provide medical help when the pet is sick. Secondly, the growth level of this virtual pet is related to the accumulated total steps and the users' daily step goal. The general idea of this mobile application is to take care of the pets by taking care of the player himself. Figure 1 shows the flow chart of *FitPet* mobile App.

4 Research Method

A six-week long between-subject field study was conducted with 23 participants (8 females and 15 males). The six-week period was divided equally into the study's three phases: pre-test observation, intervention, and post-test observation. During the intervention phase, the participants used the system and reported their experiences. This mixed-design study consisted of four quantitative questionnaires and three semi-structured interviews. Three conditions were designed to assess the engagement and effectiveness of separate gamified solutions: (1) goal-setting with *FitBit*, (2) social Website Community and Mobile Challenge condition with *FitBit* applications and (3) the *FitPet*.

Pre-test Observation (2 weeks): Before the pre-intervention stage, participants were asked to fill in a questionnaire about their daily lifestyle, physical activity level and routines, and familiarity with technologies and games. During the pre-intervention phase, the participants were given a *FitBit* wearable device worn on the wrist. The participants were asked to wear the *FitBit* as much as possible. The participants were also encouraged to maintain their regular lifestyles.

Intervention (2 weeks): During the experimental phase, the participants were randomly assigned to one of the three conditions. The control group has the FitBit data self-monitoring features and the goal-setting task. The first experimental group was also given the goal-setting task with FitBit data self-monitoring features, as well as social features (activity groups and Mobile Challenges). While the second experimental group could still wear FitBit (for capturing data), they were instructed to focus on the mobile app FitPet and not pay attention to FitBit anymore.

Post-test Observation (2 weeks): At the end of week 4 in the study, the goal-setting, social Website Community and mobile game interventions ended for the experimental groups. But the participants were asked to adopt the most helpful methods to keep themselves motivated and stay physically active.

The steps data were measured during all three phases by the *FitBit* devices and FitPet mobile App. After each session, the participants were interviewed for 20 min regarding their experience of using *FitBit* and how the intervention might impact their physical activity.

5 Results, Analysis and Evaluations

The study used a between-subjects design; a participant either belonged to the control group, the social group, or the *FitPet* group. Time was a within-subjects factor, as every participant's step was measured after each study phase. Therefore, in order to evaluate the effectiveness of the three gamified conditions, a Two-way Mixed-ANOVA test was conducted to compare before-intervention and after-intervention step changes. Independent variables were intervention conditions (goal-setting, social Website Community and *FitPet*) and time phases (pre-intervention and post-intervention). The dependent variable was the step count data collected throughout the six-week user study. To compare the effectiveness of three interventions, only steps data from before-intervention and post-intervention phases were included and analyzed.

A significant main effect of time was found, $F(2, 22) = 4.17$, $p = .02 < .05$, $r = .53$. Then to figure out where the significant differences existed, a Tuckey HSD test was run. It showed that the social group had significantly more steps than the *FitPet* group $p = .03 < .05$, and between the social group and the control group, $p = .03 < .05$. However, there was no significant difference between the *FitPet* group and the control group. Figure 3 shows steps increased during post-intervention phases compared with pre-intervention phases among three study groups.

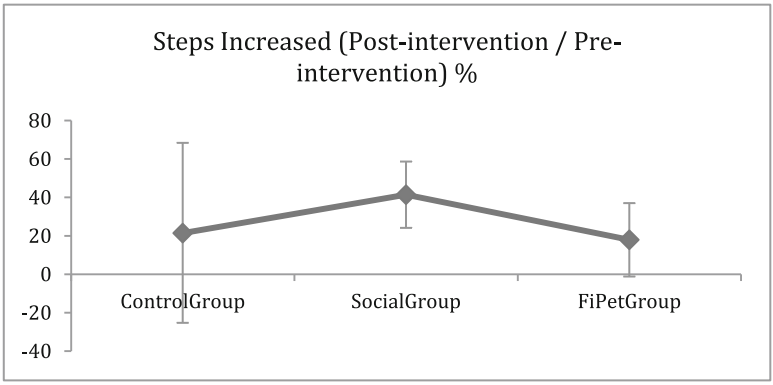

Fig. 3. Steps increased: percentages of three conditions after intervention compared to pre-intervention phase

The main effect of condition was non-significant, $F(2, 22) = 2.23$, $p = .12 > .05$, $r = .20$. This indicated that when the time at which step count was measured is ignored, the initial step level of participants in each group was not significantly different.

There was a significant Time * Group interaction effect, $F(2, 22) = 5.31$, $p = .02 < .05$, $r = .33$, indicating that the changes of step count in the groups were significantly different from each other. Specifically, there was a significant increase of steps in the social group. In the social group, the post-test step count was significantly higher than pre-test step data, $p = .03 < .05$. Also, in the post-test analysis, significant differences were found between *FitPet* group and social group. The social group had a significant

increase of steps over *FitPet* group, $p = .04 < .05$. No other differences were revealed by the tests. These findings indicate that the social group was significantly more effective than the goal-setting control group and the *FitPet* experimental group.

6 Discussion and Conclusion

From the interview results, we found that the effectiveness of goal-setting strategy relied highly on individual's personality. Social interaction and communication gamification strategy were the most effective one in terms of promoting more steps. Although the FitPet game-based approach was not successful at encouraging significantly more steps compared to the control group, participants accepted and enjoyed the generally game design idea. However, more game mechanics should be implemented in order to keep players within the flow channel of engaging with the game. The findings of the study revealed how people liked various gamification design strategies and what should be taken into specific consideration when designing for motivation and behavior change. Hopefully, these design challenges and opportunities may shed light on gamification design and provide other designers and researchers with enlightening insights.

The lessons learned from this research could inform the design of applications for promoting physical activity or behavior changes. From the analysis, we found that emotional engagement played a significant role in motivating individuals as well as to keep them checked in and to stay motivated during the study. The social aspects are evaluated as an effective strategy if used properly and under certain circumstances. For example, some social aspects can involve participants in an active and engaging way, such as socializing and having fun with each other. Conversely, the passive communication afforded in the Website Community has not proven very effective in promoting physical activity. Moreover, besides social competition, opportunities for positive collaborations should be considered as an important type of social interaction when designing for gamification. Specifically, social components should be implemented into a FitPet-like game approach, and its effectiveness should be investigated and evaluated. Furthermore, since FitPet-ish games hold the potential to engage people and we see people's enthusiasms about making achievement in a larger context than their personal-goals. More mechanics and dynamics are needed in order to enhance the level of players' awareness and engagement.

Attending to these issues will help in the ways in which ubiquitous and persuasive technologies can be used to encourage physical activity and promote healthy behavior changes. The reflections of this research and critiques of others in the same fields helped us understand: in order to be effective and efficient, the context where gamified approaches are used matters. The contexts and prerequisites of what gamification strategy should be deployed, how to use it, and when, are critical to the success of designing gamification strategies for behavior changes.

References

1. Prochaska, J.O., Velicer, W.F.: The transtheoretical model of health behavior change. Am. J. Health Promot. **12**(1), 38–48 (1997)
2. Björk, S., Holopainen, J., Ljungstrand, P., Akesson, K.-P.: Designing ubiquitous computing games – a report from a workshop exploring ubiquitous computing entertainment. Pers. Ubiquitous Comput. **6**(5–6), 443–458 (2002)
3. Tudor-Locke, C.E., Myers, A.M., Bell, R.C., Harris, S.B., Wilson Rodger, N.: Preliminary outcome evaluation of the first step program: a daily physical activity intervention for individuals with type 2 diabetes. Patient Educ. Couns. **47**(1), 23–28 (2002)
4. Chan, C.B., Ryan, D.A.J., Tudor-Locke, C.: Health benefits of a pedometer-based physical activity intervention in sedentary workers. Prev. Med. **39**(6), 1215–1222 (2004)
5. Consolvo, S., Everitt, K., dSmith, I., Landay, J.A.: Design requirements for technologies that encourage physical activity. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, New York, NY, USA, pp. 457–466 (2006)
6. Burke, B.: Gamify: how gamification motivates people to do extraordinary things. Bibliomotion (2014)
7. McCallum, S.: Gamification and serious games for personalized health. Stud. Health Technol. Inform. **177**, 85–96 (2012)