StepCity: A Preliminary Investigation Of A Personal Informatics-Based Social Game On Behavior Change

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Abstract
Encouraging physical activity is an important public health issue. In this study, we set out to see if a game could be used to motivate people to be more active. We recruited 74 subjects to wear Fitbits – a personal activity monitoring device that tracked the number of steps taken in a day – and compared step totals in three experimental conditions: a control, a social interaction experience, and a social game we developed called StepCity. We found that for newer Fitbit users, the game led to users taking more steps than they did in a control condition. In this poster, we present the details of our system and the results of a controlled experiment.

Author Keywords
Fitbit; exercise; games; gamification; serious games; games with a purpose

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
A Fitbit is a wireless activity tracker that tracks a user's steps (along with other information, depending on the

model of the device). A user wears it and the data automatically syncs with the Fitbit service website via a USB device or Bluetooth connection to a user's computing device.

Games can be highly motivating [5], as can social interaction (discussed further in the section on related work). We became interested in understanding the connection between social interaction, social games, and motivation for physical activity as monitored by a Fitbit. Specifically, we set out to answer two related research questions:

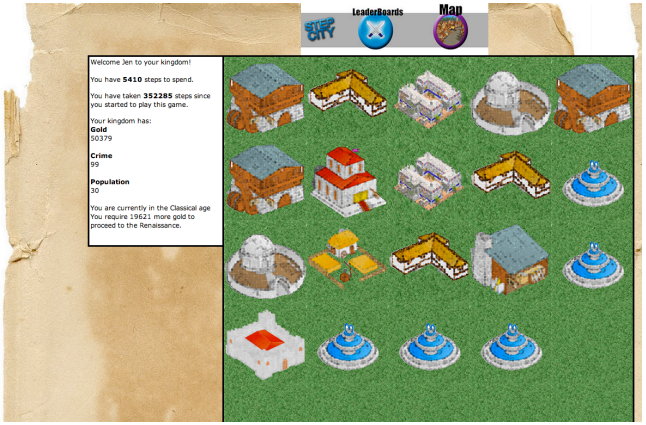

Figure 1 - The social game, StepCity, developed as part of this project.

RQ1: Will a social game that uses Fitbit steps as a type of currency encourage users to take more steps than they would otherwise?

RQ2: Will a simple social interaction experience encourage users to take more steps than they would otherwise?

To answer these questions, we ran a controlled study with 74 subjects. They wore Fitbits for 30 days under three conditions: a control, a social interaction experience, and a social game that used Fitbit steps as currency.

This paper presents our game design (see Figure 1) and social interfaces. We studied the impact of these types of interactions with a within-subjects experiment. We found that among certain groups, the social game was related to significantly higher step totals than the control.

Related Work

The relationship between social interaction, games, and health has received quite a bit of attention in the literature.

Consolvo et al. [3] developed an early mobile phone application that encouraged physical activity by sharing step count with friends. Ali-Hasan et al. [1] developed a prototype social app to accompany a pedometer, like a Fitbit. Lin et al. [6] developed a game in which the number of steps taken by a player contributes to the health of a virtual fish in a shared tank with other players. Their initial results showed social interaction made users feel more accountable about their exercise and awareness of others' actions helped motivate them.

A full working social application integrated with a pedometer was studied in Foster et al. [4]. In a study of 10 subjects, they found significant increases in subjects' step totals when social interaction was present over when it was not.

Xu et al. [10] probed the issue of social motivation for health more deeply. They found that in a health-based game, different use motivations could be distinguished, and this affected participation. We use insights from this work, dividing our subjects into groups based on their existing experiences of using Fitbits.

Mueller et al. [9] studied games that required physical exertion and the role of social interaction in this environment. They found the inverse effect as well: physical play can encourage social interaction through the game.

Beyond games and looking at social interaction more generally, Ma et al. [7] analyzed a popular weight and exercise-oriented social network. They found correlations between user's weight loss and the number of friends they had on the network, indicating social interaction can be important to working toward health and fitness goals.

This work all suggests that there is promise to look at the interplay between social gaming, social interaction, and physical activity measured by Fitbits.

Experimental Setup

Platform

To answer the research questions described above, we built an experimental web app. The site was built on top of WordPress and subjects were able to sync data from their Fitbit accounts with our site.

The app contained three major features: a user profile and data sync section, social interaction with other users, and a social game. Details of the social features are described with the experimental conditions below.

Conditions

We created three conditions that made different features available to users at different times.

1. Control: Subjects would wear their Fitbits as usual, with no additional interaction.
2. Social Interaction: We built a simple social experience where users could add friends in our system, see the steps logged each time one of their friends' synced their Fitbit with our system, and send messages to friends through the system. Users were able to browse their friend lists and friends' updates, comment on activities, and manage a simple profile.

   Fitbit currently has a social networking component on their website. Our intention was not to replicate the sophisticated social experience they had there, but rather to create a simple way for subjects in this experiment to have interaction with one another and share their experiences.

3. Social Game: We designed a game that treated Fitbit steps as currency. The game is shown in Figure 1 and is discussed more in depth below.

Game Design

In the web-based game, named StepCity, players connect their Fitbit accounts to the game. When the players log in to the game, their account is synchronized with the game through the Fitbit API and the number of steps taken since the last synchronization is added to the available currency. Players are able to buy buildings to place in their city that produce gold and increase population. Most buildings have the side effect that they create crime for the city. Cheaper buildings produce more crime while more expensive ones produce none. The players are

able to move through various "ages" and are ranked in a leaderboard page by gold, population, and crime.

The novelty of this game is that it is unlike other modern social games, such as those on the social media site Facebook, that artificially slow down players with long wait times between moves. Instead, this game is only limited by the amount of physical exercise that a player wants to undertake in order to build new items. Most of the items were priced with the idea that ten-thousand steps per day is an attainable goal by adults, meaning, the lower-cost buildings "cost" around ten-thousand steps.

Experimental Design

After subjects were recruited, they were asked to set up accounts on our experimental website and complete a survey that included:

- Basic demographic information including gender, age, and physical location
- The International Physical Activity Questionnaire (IPAQ) [2], a brief set of questions to elicit subjects' normal level of physical exertion over the previous seven days.
- A modified PACE survey [8] which elicits opinions about how much subjects enjoy physical activity through a 16 question Likert scale. The instrument is scored by averaging the participant's answers.

Then, subjects spent 10 days using their Fitbits in each of the three conditions described above, for a total of 30 days of participation. The order of the conditions was randomized to prevent order effects in the results.

During this time, subjects would come to the website and sync their data. We collected full step data for each day. Note that even if users did not sync every day, the Fitbit devices recorded the steps by day and the API allowed us to access daily step totals by date.

Subjects

Subjects were recruited through posts to mailing lists, social media, and Fitbit-oriented discussion forums. Subjects who already had Fitbits were allowed to use them, and we provided Fitbit Zips to any volunteers who wanted them.

We had a total of 74 subjects. Of those that responded to the initial survey, 44 were female and 17 were male. Participants ranged in age from 23 to 63 with an average age of 37.73 (n=63,sd=10.18).

The average 7-day physical activity reported as part of the IPAQ was 22.71 hours (n=61, sd=47.78). The average PACE score was 4.07 out of 5 (n=63, sd=.77).

Results

We collected data from 74 subjects. However, a number of participants regularly neglected to wear their Fitbits, which corrupted the data we received from them. We set a rule to drop anyone who was missing 3 or mode days of data per condition (33.33%). This eliminated 20 subjects, leaving 54 subjects for analysis.

Among these, there were 4 outliers we detected outside the interquartile range (IQR) in a boxplot. Eliminating those subjects provides a clearer picture of the data. For the 50 remaining users, the average number of steps was 96,931.38 (sd=35,116.09) in the control, 99,029.4, (sd=36,817.83) in the game, and 98,451.50 (sd= 38,263.27) in the social experience.

We then analyzed the number of steps that each person had on record with Fitbit from before the experiment began, and categorized subjects as "new" users (<100,000 lifetime steps) (n=17), active users (100,000-500,000 lifetime steps) (n=24) or enthusiasts (>500,000) steps (n=9).

Our initial research question set out to compare the relationship between the condition and the number of steps subjects took. We checked for all assumptions for a repeated measures ANOVA with between subject grouping and met those assumptions. We compared the number of steps taken by the group and condition via an ANOVA.

There was no significant difference based on the condition alone. However, there was a difference based on the condition and grouping. Enthusiasts were much more active in the control group than the other groups in other conditions.

We then removed Enthusiasts to see if there was a within subjects difference among those who were considered active or new. Statistically, we used paired t-tests, to determine if there was an increase in steps when playing the game or using the social experience over the control.

For the game, we found no significant difference over the control ($t = 1.3386$, $df = 40$, p-value = 0.09). For the social-only experience, we found no significant difference compared with the control ($t = 0.9762$, $df = 40$, p-value = 0.16).

Discussion

The main result we found in this study is that newer users – those with fewer than 500,000 lifetime steps – took more steps when using the game than they did in the control condition. *Even though this number was not significant, we interpret these results to be promising towards future research*. We removed Enthusiasts from the analysis because we believe that this group has developed a number of habits around the Fitbit and the amount of time afforded in this study was insufficient for such longtime users. The Enthusiasts may have experienced the "John Henry" effect in which participants know they are in a control group and over-compensate.

We interpret our data as the fitness-based social game motivated participants to take more steps. We believe this is causation instead of correlation. The IPAQ and PACE instruments show that although the participants may think favorably about physical activity, there was a wide variance in how much those participants actually took part in physical activity and there is little correlation between those two scores ($r=0.21$). Also, our experiment design tried to minimize the effect of the research itself by having participants take part in conditions in different sequences.

This implies that a social game can motivate users to be more physically active.

Conclusions

In this study, we conducted a controlled experiment to determine if a social game or social experience would affect the physical activity of subjects. We found that using the game correlated with subjects taking

significantly more steps over a 10 day period when compared to a control.

Our work here is a first step toward understanding the impact that social games might have on motivating users to exercise. Our results derive from the first prototype of a game and a simple social experience. We believe the results are encouraging, and that this is preliminary evidence that games can motivate users to take more steps and monitor their activity more closely. This appears to be particularly true for users who are not yet enthusiasts for personal monitoring and who need encouragement for more activity.

Future work in this area should include larger studies with a variety of deployed social interaction techniques In addition, deeper qualitative studies that analyze user motivation and how it relates to the social interactions (as in [10]) can help identify which users may be most helped by social features and how to design to support as many users as possible.

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