A Persuasive Mobile Game for Reducing Sedentary Behaviour and Promoting Physical Activity

Oladapo Oyebode*[0000-0002-5797-7790] and Rita Orji[0000-0001-6152-8034]

Faculty of Computer Science, Dalhousie University, Halifax NS B3H 4R2, Canada olapadapo.oyebode@dal.ca, rita.orji@dal.ca

Abstract. This paper presents TreeCare, a persuasive mobile game for reducing sedentary behaviour and improving physical activity among adults. The game uses the tree metaphor to create a link between a tree's health and player's physical activity level in the real-world. Each player is initially assigned an empty tree that gradually grows leaves and then fruits as the player becomes physically active (measured using step counts). The tree withers as the player reduces his/her activity level, thereby reinforcing the significance of regular physical activity and the negative effect of sedentary behaviour.

Keywords: Persuasive game, Mobile game, Physical activity, Sedentary behaviour, Persuasive strategies, Health.

1 Introduction

Research has shown that sedentary behaviour poses a cardio-metabolic health risk [1]. In other words, sedentary behaviour can cause cardio-vascular disease [2], over-weight/obesity [3], high abdominal fat [4], diabetes [5], cancer [6], and coronary heart disease [6]. There is also evidence that physical inactivity produce similar health risk as sedentary behaviour [7]. Hence, digital interventions that help individuals to increase physical activity and reduce sedentary behaviour will yield positive health outcomes.

This paper presents a persuasive mobile game, called TreeCare, for promoting physical activity (such as walking or running) and reducing sedentary behaviour among adults. The game uses the metaphor of a tree (in a garden) with green leaves and fruits to represent a player's physical activity level in the real-world (operationalized using step counts). The tree's health deteriorates (reflected by the loss of leaves/fruits) as player's activity reduces. TreeCare employs twelve widely used persuasive strategies in health games design, which are *self-monitoring, simulation, reminder, reward, reduction, praise, suggestion, recognition, competition, cooperation, personalization,* and *social comparison*. These persuasive strategies are part of the Persuasive Systems Design (PSD) framework [8].

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2 TreeCare Design and Implementation

In the TreeCare game, a flourishing tree (with green leaves and fruits) represents a player who is consistently physically active in the real-world, but an empty tree with no leaf/fruit represents low or no activity. Each player begins the game with an empty tree which, in turn, gradually grows leaves and fruits as the player becomes physically active (measured using step counts). The tree's health deteriorates (reflected by the loss of leaves/fruits) as player's activity reduces, thereby showing the negative effect of a sedentary lifestyle on an individual's health and the benefit of physical activity. The game has two modes – the "Starter" mode and "Challenger" mode – governed by rules for gaining/losing leaves and fruits.

The Starter mode involves a single player whose initial daily goal is set as 5000 steps. The daily goal can be changed by the player. For every 1000 steps achieved in a day, a green leaf appears on the player's tree. However, if the player fails to meet his/her daily goal, the tree loses the number of leaves that corresponds to the remaining steps required to meet his/her goal, based on the formula below. ceiling(n) is a function that returns the smallest whole number that is greater than or equal to n where n is a real number. For example, if a player achieves 4200 steps out of 5000 daily goal, he/she will gain 4 leaves but lose 1 leaf.

Number of leaves lost =
$$ceiling\left(\frac{daily\ goal - step\ count}{1000}\right)$$

On the other hand, the Challenger mode is a competitive mode involving multiple players. In other words, individual players compete with one another to achieve (or exceed) the minimum step count goal for a challenge. A player can view active challenges and can join any of them to compete. Also, the player can create a challenge which automatically becomes visible to other players. Every challenge has a minimum step count goal that every player is expected to meet, as well as the expiration date and time. Once a player joins a challenge, he/she will be assigned an empty tree for that challenge. For instance, a player that joins two different challenges is assigned two empty trees – one for each challenge. Thus, as the player becomes physically active (such as running or walking) in the real-world, the health of his/her trees gradually improves. Finally, every challenge has a leaderboard that ranks players in descending order of the total step counts achieved, and the top 3 players are rewarded with a trophy each when the challenge ends.

TreeCare employs twelve widely used PSD strategies in health games design, which are *self-monitoring, simulation, reminder, reward, reduction, praise, suggestion, recognition, competition, cooperation, personalization,* and *social comparison*. Table 1 shows the strategies already implemented in the current version of TreeCare, and the corresponding game elements or features.

We implemented TreeCare for Android devices using the Unity framework and Android Studio. Step counts are retrieved in real-time through phone sensors using the Google Fit APIs (i.e., Sensors API, Recording API, and History API). Figure 1 shows sample screens of the TreeCare game.

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2

Table 1. Game elements or features, descriptions, and the corresponding persuasive strategies.

Game Element	Description	Strategy
Tree (in a garden)	Tree's health is linked to player's physical activity level in the real-world	Simulation
Leaf and Fruit Counter	Counts the number of leaves and fruits on the player's tree	Self-monitoring
Steps Counter	Retrieves each player's steps in the back- ground and updates the total step counts in real-time	Self-monitoring, Personalization
Activity Chart	Displays the weekly or monthly view of daily steps achieved to enable progress tracking	Self-monitoring
Virtual Trophy	Top 3 players in a completed challenge are awarded a trophy that corresponds to their position on the leaderboard.	Reward
Streak Coin	When a daily goal is achieved, players receive a streak coin.	Reward
Steps Challenge	Players compete in a challenge which has a minimum step goal they must achieve.	Competition
Leaderboard	Ranks players in descending order of the total step counts achieved	Competition, Recognition
Congratulatory Mes- sage	Pop-up message with trophy image and confetti animation to congratulate players on their achievement	Praise
Position Tracker	Players can track their position in a chal- lenge (in real-time) without opening the leaderboard	Self-monitoring, Competition
Personal Settings	Players can customize their daily goals, reduce/increase music volume, and change profile name (or nickname).	Personalization



Fig. 1. Sample screens in TreeCare: (a) Game has two modes – Starter and Challenger; (b) A player's tree in the Starter mode; (c) Graph for tracking weekly or monthly progress; (d) Active challenges a player can join, and a button for creating a new challenge; (e) Leaderboard showing player rankings in a challenge.

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3 Conclusion

In this paper, we presented a persuasive and fun game, called TreeCare, that motivates its players to be more physically active and less sedentary. The game uses the "tree" metaphor to create a link between a tree's health and player's physical activity level in the real-world. The idea is to influence players to increase their physical activity levels (measured using step counts) to make their trees look healthy with green leaves and fruits using various persuasive strategies of the PSD framework. The tree withers as the player reduces his/her activity level, thereby reinforcing the significance of regular physical activity and the negative effect of sedentary behaviour.

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4