TeenPower: Measuring the effectiveness of an intervention program and encourage adolescents towards physical activities using gamification

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Abstract — Adolescents, reportedly, easily adopt a sedentary lifestyle and unhealthy behaviors easily carried into adulthood. Prevention is one of the few viable ways to contain the current epidemic percentages of overweight and obesity. The TeenPower Project has created an intervention program that relies on a mHealth platform to engage teenagers into embracing healthier lifestyle behaviors. Although the program is already fully deployed in some schools, further work is necessary to continue to encourage adolescents into long lasting behavioral changes. It is necessary to measure the effectiveness of this intervention program by analyzing the data generated by the adolescent’s usage of the platform. This analysis may also support the decision-making process of health professionals when planning the future of the intervention program. On another hand, gamification, the use of game-like rewards and incentives, paired with desired behaviors to increase motivations, is starting to be integrated in the mobile application as a way to engage to adolescents in the platform. This document provides an overview of the current state of the TeenPower intervention program and mHealth platform and sheds light over the new features currently being developed for future upgrades.

I. INTRODUCTION

According to the World Health Organization (WHO), over 340 million children and adolescents were overweight or obese in 2016. The prevalence of overweight and obesity among children and adolescents has risen from 4% in 1975 to 18% to just over 18% in 2016 [1]. Although obesity may be result of genetic syndromes, most cases are the result of a chronic energy imbalance caused by harmful dietary and physical activity patterns. Without treatment, these behaviors are propagated into adulthood increasing the risk of cardiovascular diseases, diabetes and hypertension (among others). Prevention is known as the only viable way to contain the epidemic percentages of overweight/obesity and nutritional surveillance data are essential to effectively design, implement and evaluate policies and strategies to combat obesity [2].

Overweight and obesity cannot be solved through individual action alone. Comprehensive responses are needed to create healthy environments that can support individuals in making healthy choices grounded on knowledge and skills related to health behaviors. Since 95% of adolescents (aged 13-17) own a smartphone or have access to one [3] and adolescents already use internet as their primary source of information, healthcare professionals should ensure the access and reliability of the information [4]. This motivated the development of an mHealth platform called “TeenPower: e-Empowering teenagers to prevent obesity”, that combines Information and Communication Technologies (ICT) with a health intervention program, hoping to empower people to make healthier choices and manage their health more effectively.

This document describes the TeenPower Intervention Program, the current state of both applications that support the intervention program, and the additional features currently under development for a future update.

II. TEENPOWER INTERVENTION PROGRAM

The TeenPower is a practice base research that networks and explores synergies between territorial partners, forming an interdisciplinary team that includes personnel from various different areas, such as: nursing, nutrition, sport, psychology, informatics, statistic, design and teaching [5]. Faced with the need for an integrated and dynamic strategy to promote salutogenic behaviors in adolescence, the team structured an intervention program by working in a constant collaborative process.

The intervention program hopes to e-empower adolescents into obesity prevention by providing them with easy access to interactive health content, self-monitoring tools and facilitated communication with health professionals. It is supported by two software applications:

- A back-office application created to support teachers and health professionals during the intervention program;
- And a mobile application created to provide adolescents health-related content and self-monitoring tools for their daily usage;

This intervention program is already fully deployed in three schools in the center of Portugal and currently possesses a target audience surpassing two hundred plus adolescents, expected to grow in the coming months with deployment in new schools.

III. TEENPOWER PLATFORM

Both applications that form the TeenPower platform are already in production and are used on a daily basis by

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adolescents or health professionals. The following section elaborates about each software solution, providing an inside look into their features and the way they were implemented.

A. Back office Application

![Backoffice Application Architecture](image)

The back-office server serves as a command center for the TeenPower platform. It can be separated in two major sections:

1) the web-based application for health professionals and teachers;
2) and the TeenPower API (Application Programming Interface) that is consumed by the mobile application;

Laravel, a Hypertext Preprocessor (PHP) framework was the elected development tool to create the web-based application and the API. The web-based application can only be accessed by the project team members and allows:

- management of user accounts;
- updates to the interactive contents presented in the mobile app (Figure 2);
- communication with team members or teenager’s trough private messages or forum discussions;
- and basic data visualization tools to analyze data generated by the mobile application (Figure 5).

In the web-based application, web pages created using Hypertext Markup Language (HTML) and Cascading Style Sheets (CSS) present the information stored in the TeenPower database. Some pages make use of Vue.js (a front-end reactive JavaScript Framework) and AJAX (Asynchronous JavaScript and XML) requests to enhance user-experience, by updating page sections without requiring the traditional reload to refresh.

On the other hand, the TeenPower API provides a set of Representational State Transfer (REST) compliant endpoints that are used by the TeenPower mobile application to retrieve and store information in the TeenPower Database, a MySQL relational database that holds all the generated data by both applications. Data exchanged in each pair of request response is encoded in JavaScript Object Notation (JSON).

Almost all endpoints are protected with authentication middleware that requires a valid OAuth2 token to be present in the request header. A valid token can be obtained by sending user credentials to the “login” endpoint, which forwards the request to an OAuth2 server created using the Laravel Passport package. If credentials are valid, an access token is generated and returned, and can later be used to access other API endpoints.

B. Android Mobile Application

The android application was structured with gamification in mind and the design was created in collaboration with the school of Multimedia and Arts Design. Users find themselves represented by a customizable avatar across different scenarios, each containing features like:

- Visualization of health-related contents (videos, posters and infographics);
- Self-monitoring tools to register daily habits (sleep patterns, hydration and eating habits, physical activity records such as push-ups and abdominals, steps taken, calories expended, as well as Body Mass Index (BMI) and waist circumference);
- Social interaction tools like public discussion forms and private messages;
- Positive reinforcement messages spread across the application, adjusted for sex and reference values defined by health care professionals;
Figure 3 presents the house and the map scenarios. In the house, the user can use self-monitoring tools to register not only his meals and water consumption (by clicking in himself), but also his sleep patterns (by clicking in the bed). The fridge also provides with healthy snacks, juices and shake suggestions. The TeenPower map is the central point of the application design and enables users to jump across scenarios. It also features the Library, an interactive content repository filled with a variety of videos, posters and infographics.

Figure 4 presents the park and gym scenarios. In the park, the user can see physical activity related content and also check how many steps he has taken in a day, and the calories expended doing so. This feature was added by integrating Google Fit in the application, using their services to record the user’s activity and obtain such metrics. On the other hand, the gym contains exercise related content and also self-monitoring tools to record anthropometric data and daily exercise routines. Every scenario allows the user to access the menu, from where it is possible to participate in the TeenPower discussion forums or customize the user’s profile. Private messages can also be exchanged between other adolescents or health professionals through the chat area, accessed by clicking on the letter icon. Each time a user replies on the forum or sends a private message to another user, a notification is sent using Firebase Cloud Messaging (a Firebase service that facilitates the sending of notifications to another smartphone). Notifications are only shown in-app as red and white dots above the area that contains new content.

IV. ADDITIONAL FEATURES

The fact that both applications are already in use by team members and adolescents has enabled us to identify shortcomings on the platform or lacking features in a timely manner. The following sections describes two solutions for two features that will add great value to the mHealth platform.

A. Location-Based Gamification

Gamification, the use of game-like rewards and incentives to increase motivations and sustain habits of individuals over time has been a focus of the health apps industry in recent years [6]. A gamification strategy based on participation was recently introduced to the TeenPower mobile application. Teens can accumulate points by using self-monitoring tools or by visualizing interactive health contents and their avatar also possesses progress bars for rest, hydration, hunger and physical condition that vary according to their use of the self-monitoring tools on the current day. The rest bar is dependent on the number of hours slept, the hydration bar varies according to the water consumed, the hunger bar is linked to meals inputted during the day and the physical condition bar is connected to the number of steps taken Quotas for these bars are adjusted for sex and reference values set by healthcare professionals. Although it is believed that this system (which will be further developed) will encourage users to self-monitor on a daily basis, several studies also call for the need to increase the amount of physical activity and the decrease of sedentary behavior’s [7], [8], [9].

Working with location awareness [10], a device’s ability to sense the current geographic location, could provide innovative ways to encourage adolescents towards physical activities. The potential of location awareness can already be seen not only in more business-oriented applications like those created by Foursquare [11], but also in leisure oriented games such as Pokémon Go [12] or Ingress [13]. All the applications above give a whole new meaning to the world that surrounds us, respectively, encouraging the users to track the places they have visited and help future visitors by providing feedback, or to go out and explore their surroundings while enjoying a game.

An innovative system that combines location awareness, gamification and healthcare could hold the key to increased physical activity in adolescence by giving them a reason to “go out and play”.

B. Data visualization dashboard

According to Thacker et al. [14], to measure the impact of a prevention program it is necessary to have inexpensive and practical data-gathering systems that track the methods used in the prevention program and such information should be made available quickly to prevention practitioners. As it stands, the TeenPower platform already comprises two data sources that generate great amounts of data:

- Self-monitoring tools of the mobile application, which generate great amounts of data by recording an adolescent’s daily habits;
- Newly integrated Firebase Analytics, which allows for close monitorization of the application’s state while in production and provides not only out of the box metrics for engagement measurement and crash reports, but also allows developers to create their custom metrics.
- Data gathered by the new location-based gamification system;
As presented in Figure 5, the current version of the TeenPower back-office already a simple data visualization tool. However, it lacks features such as information correlation or a user-centered design that would allow for easy visualization of key metrics.

A comprehensive study of obesity risk factors, key obesity measuring metrics, and methods to evaluate the effectiveness of a prevention program has already started and will later be used either to plan the functionalities the dashboard’s functionalities or organize data according to its importance. For this reason, a newly sketched data visualization dashboard that comprises data from both sources, would allow TeenPower team members to:

a) measure the effectiveness of the intervention program;

b) support the decision-making process when customizing the mHealth approach;

c) easily detect adolescents who are at risk and provide personalized feedback or a specialized approach.

V. CONCLUSION

The first version of the TeenPower mHealth platform is in fully working order and supporting the intervention program on schools in the center of Portugal, with a current target audience of two hundred plus adolescents that is expected to grow in the coming months. This has allowed us to identify shortcomings on the platform or lacking features in a timely manner.

Integrating Firebase Analytics and recording custom metrics will also allow us to identify areas where adolescents have expected functionalities to be, opening doors to the placement of new functionalities in the existing layouts. New features that add value to the TeenPower platform are already being developed, while at the same time the interdisciplinary team is paying close attention to new suggestions coming from adolescents. The data visualization dashboard will be particularly important to measure the outcomes of the intervention program as an easy tool that facilities data analysis will be crucial during the evaluation phase.

REFERENCES


