PEGASO Companion: A Mobile App to Promote Healthy Lifestyles Among Adolescents

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Abstract. Promoting healthy lifestyles can be a successful weapon in counter-fighting the epidemics of overweight and obesity. The PEGASO project aims at encouraging adolescents to become co-creators of their own health. In particular, it aims at creating an ecosystem where adolescents are motivated and supported in adopting healthy lifestyles. In this ecosystem, the PEGASO Companion, a smartphone app, plays the role of universal access to healthy services and providing personalised mechanisms to support behaviour change.

Keywords: Obesity prevention · Persuasive technology · Gamification · Behaviour change

1 Introduction

In the last few years, obesity became epidemic and a general alarm has been issued worldwide. Although many organisations, research institutes and governments took action to solve this problem, no country to date has reversed its obesity epidemic [10]. In this scenario, prevention in healthcare plays a crucial role: the aim of each national healthcare system should be shifting from the concept of "cure" to "care" emphasising also the reciprocal nature of the interaction between the environment and the individual [8]. This requires new regulatory actions from governments, to be coordinated with increased efforts from industry and civil society in order to create a new complex and multifactorial process in which technological factors, organisational strategies, and human dimensions can find the correct balance to enable the population to adopt healthy lifestyles [8].

The PEGASO project aims at developing an ecosystem where users are encouraged and facilitated in adopting healthy lifestyles through the coordinated actions of policy makers, schools, healthcare providers and other stakeholders (such as companies and

associations). In this ecosystem, the multi-dimensional and cross-disciplinary ICT system plays a key role. This system includes game mechanisms, multimedia services and social activities to influence users' behaviours in order to fight and prevent over-weight and obesity in the younger population by encouraging them to become co-producers of their wellness and take an active role in improving it. This complex system communicates with the young users through a smartphone application called Companion, which is able to monitor the user's lifestyle in order to empower and support him/her in improving his/her wellbeing through motivational mechanisms and tailored interventions.

In this paper, the PEGASO Companion is introduced in the frame of the vision for the application of artificial intelligence in the future of healthcare. After presenting this vision, the paper follows describing the current development of a first version of the PEGASO Companion in the frame of the current European project: in particular, the architecture, the user experience design and scientific grounding are presented and briefly discussed.

2 The Companion Vision

In the frame of the PEGASO project, the smartphone will embody the Companion to guide the user's lifestyle. However, the PEGASO Companion vision is not linked to a unique physical device but it is conceived as a ubiquitous artificial intelligence, which changes form over time to accompany the user throughout her/his life adapting to her/his evolving needs and desires [4]. The Companion will understand the user's personality and will establish with her/him a long-lasting affective relationship. The Companion will participate to the whole user's life in order to become a real life companion. Different ages and stages of maturity have different requirements and the Companion has to be able to continuously adapt to novel needs and propose appropriate activities.

Although the Companion vision comprehends a large picture depicting a future artificial intelligence being able to accompany the user's whole life, in the frame of the PEGASO project, the system has been conceived to be focused on just the adolescence. Indeed, the World Health Organization reported that over 60% of children who are overweight before puberty will be overweight in early adulthood. This implies that the adolescence is a crucial period for choices concerning the lifestyle. PEGASO aims at developing a whole ecosystem that would be able to motivate teenagers to learn and to apply a healthy life-style effortlessly in order to prevent obesity in adulthood.

3 Architecture

Many entities compose the PEGASO guidance and support system. Figure 1 presents the relationship between the different entities from a functional perspective to provide a preview of the elements that will be addressed in this document. This figure abstracts from the actual technological implementation.
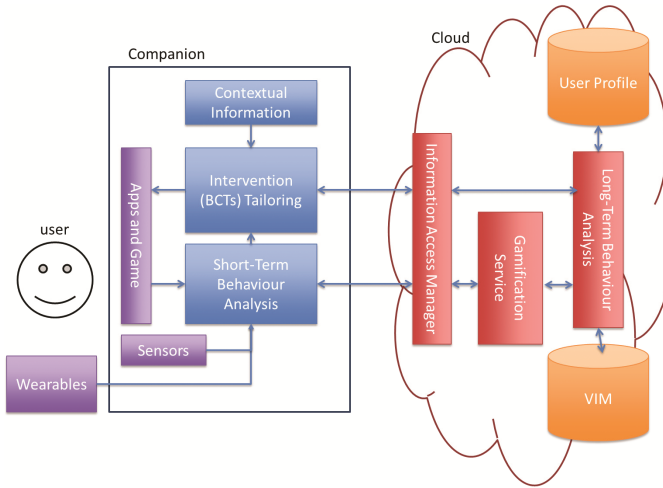
Fig. 1. Relation among the entities composing the PEGASO guidance and supporting system. (Color figure online)

The user interacts with the system via wearable sensors, sensors embedded in the smartphone, multiple apps and a serious game (in purple in Fig. 1). Such interactions allow the system to tailor the Virtual Individual Model (VIM) to the user (the VIM concept and the tailoring approach are detailed in [2, 3]). The VIM, together with the user profile, allows the long-term behaviour analysis module to suggest a healthy target behaviour and to assess the user adherence to the selected target behaviour. At the same time, the long-term module will specify to the gamification service, which personalised rewards should be created and evaluated (red blocks in Fig. 1). Then, inside the user's smartphone, contextual information, together with the events detected in the short-term behaviour analysis module, the output from the cloud long-term module and the gamification service will allow creating tailored interventions (blue blocks in Fig. 1). Such interventions will be operationalised via functions inside the app and the PEGASO serious game. All these modules are embedded in a container mobile app called Health Companion.

4   User Experience

PEGASO is composed of multiple applications and services. Most of them are related to one or multiple target behaviours that have been selected by the user with the help of the system. However, the PEGASO Companion is the main interface between the user and the PEGASO system and plays a major role in PEGASO. In fact, the role of the Companion is to unify the user experience within PEGASO. Via the Companion, the user will have the possibility to access seamlessly the different apps, which for the user will appear as a unique, modular application. Therefore, in this paper we focus on the action mechanisms present in the Companion taking into account the functionalities of

the other applications as extension of the Companion itself. Consider the eDiary app as example: the eDiary is a mobile application having the specific task of dealing with the nutrition target behaviours, acquiring data and providing feedback to the user. Such an application is integrated in the Companion and, therefore, extends its functions with the possibility to present to the user the feedback about her/his behaviour.

Neglecting the underlying technological implementation, from the user perspective the Companion can be structured as follow: a main app called Companion provides the Main User Interface (UI) (Fig. 2). Being the Companion the entry point for the user inside the PEGASO universe, the Main Companion UI includes the elements that glue together the different Companion facets and allows the user to access the different apps and functionalities (as depicted Fig. 3). The Main Companion UI is composed by the following elements:

- News stream. This UI is the main channel of communication between PEGASO and the final user. At the same time, this UI allows receiving information and updates from the other users inside the PEGASO ecosystem, and from the user's friends in particular.
- Friend UI. This UI allows the user to add friends and accept friendship requests.
- App launcher. This UI allows launching the other PEGASO functions (such as applications).
- User profile. This UI presents the profile to the user showing personal information, the FitCoins balance, the level and badges.
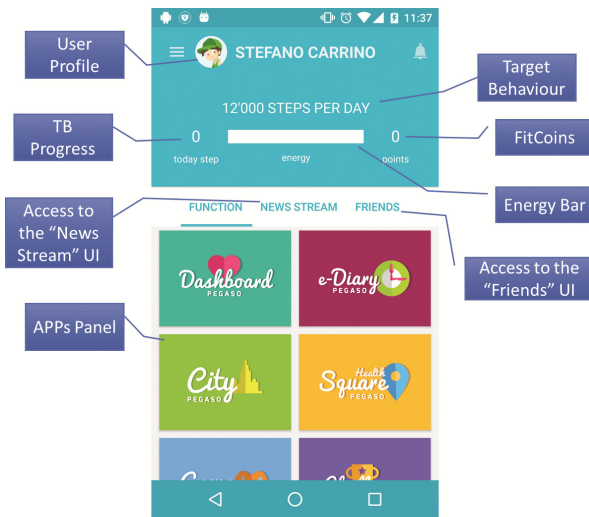

Fig. 2. Companion main User Interface.

Fig. 3. The PEGASO mobile ecosystem.

Another important aspect of the Companion is that it integrates different services for Gamification (connected to a rewarding system with access to services provided by other stakeholders), and a tailored messaging system, which allows personalising the communication with the user according to her/his characteristics and preferences.

Moreover, as already mentioned, the Companion provides the possibility to access all the PEGASO services from a single point of access. In practical terms, this main access is represented by the "Function" tab, which contains all the Apps Panels, which are buttons that allow launching the associated services or applications.

The Companion applications integrated in the current version of the Companion are the eDiary, the Challenges, the Dashboard, the PEGASO City, the Mobile Serious Game, and the Report App. These apps are introduced in the next paragraph.

The **eDiary** is a new kind of food record application for smartphone explicitly designed for teenagers and able to monitor their dietary behaviours (Fig. 3b). It also is able to provide an immediate educational feedback based on dietary data patterns introduced by the users.

The **Challenges** app is another component of the PEGASO Companion allowing users to challenge themselves and the other users (Fig. 3c). Its objective is to motivate the user to achieve her/his target behaviour exploiting goal fixing and social elements.

The main goal of the PEGASO **Dashboard** is to present to the user visual feedback and suggestions about target behaviours related to physical activity, sedentariness and

sleep (Fig. 3f). In addition, the Dashboard is the sensors mate app: it allows connecting with and managing wearable sensors and fitness trackers.

The PEGASO **City** creates the bridge between the digital world of the PEGASO system with the physical world (Fig. 3e). This app has a twofold role inside the PEGASO Health Companion: firstly, PEGASO City helps teenagers to find places that are part of the PEGASO Stakeholders' Ecosystem, and that provide them opportunities to act healthy and progress towards the reach of their target behaviour. Secondly, through the empowerment provided by the integration of a reviewing system and sharing functions, the application provides the teenagers a set of possible interactions and actions that contribute to the gamification process and the rewarding system.

The primary role of the **serious game** within PEGASO is to engage and motivate users of the complete platform (Fig. 3d). An immersive game environment, in this case a post-apocalyptic world, is considered as a central component of the PEGASO game to engage the users towards gameplay. The mission of the player is to help the government finding a cure for the new 'zombie' virus [7].

The **Report** App provides the connection between the PEGASO ecosystem and the personal health folder (Fig. 3g). The connection is established via the "bridge" system, which allows extracting some significant data collected in the PEGASO ecosystem and to create a report to be shared with physicians into the personal health folder.

From an architectural point of view, the Companion is a modular application that allows other compatible applications to plug in. The Companion provides a basic set of functionalities also as a standalone entity, however with the chosen solution, the user is able to select which component is more suitable for her/him. For instance, if a user does not want to use the eDiary but she likes playing the serious game or challenging her friends, she can decide to have only these modules of the PEGASO ecosystem.

5   Scientific Grounding and Main Concepts

PEGASO has developed a conceptual framework for biological, behavioural and psychosocial characterisation of adolescents, which will allow their behaviour recognition, personalised interaction and, in specific cases, the intervention for behaviour change. More in detail, PEGASO system focuses on those behaviours, pertaining to nutrition, physical activity and sleeping habits, which have been recognised to have impact on overweight/obesity prevention, and are amenable to be changed.

Their identification is based also on their detectability using the interaction with the user through the PEGASO Companion, the eDiary, the game, and also through non-invasive devices, such as mobile embedded accelerometers, sensorised bracelet and garments, which will accompany the users during their everyday life.

On the selected target behaviours, the system of PEGASO will be able to start user-specific educative/informative interaction, in order to raise users' awareness and tailor adequate actions to change them, when appropriate. Such tailored interventions are grounded on psychological theories and frameworks: the Behaviour Change Wheel framework, the Positive psychology, the Self-Determination Theory and Gamification.

5.1 Behaviour Change Wheel

The Behaviour Change Wheel framework (BCW) is a meta-framework synthesised from 19 existing frameworks of human behaviour change [9]. At the centre of the BCW is the COM-B behaviour system involving three essential components of human behaviour: Capability, Opportunity, and Motivation around which are positioned nine intervention functions aimed at addressing deficits in one or more of these components. The strength of this framework is the easiness to design tailored interventions for a specific user associating the sources of behaviours to specific intervention functions. In particular, PEGASO will tailor the intervention using a complementary tool the COM-B questionnaire. This self-assessment questionnaire provides an indication of the user self-awareness related to a specific target behaviour for each of the three components of the COM-B behaviour system that contribute to motivate the user to adhere to the target behaviour.

5.2 Positive Psychology

Positive psychology focuses on positive subjective experience, positive personality traits, and improving quality of life to prevent the negative consequences (i.e., negative mental and physical health consequences) of living an empty and unfulfilling life [13]. At the subjective level, it is concerned with valued personal experiences: well-being, contentment, and satisfaction (in the past); hope and optimism (for the future); and flow and happiness (in the present). Finally, at the group level, it is about the civic virtues and the institutions that move individuals toward better citizenship: responsibility, altruism, civility, moderation, tolerance, and work ethic.

- Autonomy means to be the first responsible of the actions of one's one life
- Competence means to gain mastery (via experience) in a specific task.
- Relatedness refers to the innate desire for interpersonal attachments: interacting, being connected and caring for the others [1].

Motivational mechanisms argue that social-contextual events can increase the feelings of autonomy, competence and relatedness. For example, a simple badge provided when achieving a goal can affect the feeling of competence.

5.3 Self-Determination Theory

The Self-Determination Theory (SDT) is a theory of motivation concerned with supporting behaviours that are natural and intrinsic in the human being (and, therefore, self-motivated and self-determined) [5, 11]. SDT states that there are three universal, innate, psychological needs: need for autonomy, competence and psychological relatedness [12]. The satisfaction of these needs lead to an enhanced self-motivation and mental-health.

5.4 Gamification and Serious Games

The user will follow the strategies for behaviour change only if the system is successful to engage her/him. Therefore, the user motivation plays a crucial role for the functioning of PEGASO (it is not just a chance that motivation is one major component of the COM-B model). PEGASO directly tackles this aspect via the use of two different persuasive mechanisms: gamification and serious gaming. It is important to distinguish these two close approaches:

- **Gamification.** The definition of Gamification consists of the use of game design elements in non-game contexts [6].
- **Serious Game.** The Serious Game describes the design of full-fledged games for non-entertainment purposes [6].

From these definitions, we can see that the boundary between the two approaches can be blurred and the actual approach will be subjective and dependent on how the user plays or uses an application. In PEGASO, we are developing a serious game and different gamified applications that are gamified, but that are not games.

6   Conclusion

In this paper, the PEGASO project has been presented. In particular, the focus was on the role of the Companion in providing access to innovative services and for the use of personalised mechanisms to motivate teenagers to adopt healthy lifestyles in order to promote obesity prevention.

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