Games and Gamification for Healthy Behaviours: The Experience of PEGASO Fit 4 Future

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Abstract. Challenging teenagers in the context of their own areas of interest, Pegaso Fit 4 Future - aims to promote sustainable behaviours geared towards achieving healthy lifestyles. Behaviour-change techniques are applied as a preventative measure to accomplish positive behaviour change outcomes. Pegaso Fit 4 Future is a EU funded project whose objective is the development of a behaviour change platform targeting teenagers in preventing obesity and related comorbidities. The overall approach is based on three main elements: a Smartphone as central element and agent for behaviour change (through a set of coordinated apps); a sensors system for self-monitoring; games and gamified approach to support user engagement and awareness. The paper describes the project focusing on the gaming aspects. Games have been identified as key element in the PEGASO strategy since its conception. After the initial requirements definition phase, a threefold approach to gaming has been adopted in order to address in an integrated strategy the following dimensions of behaviour change: motivational, social and educational aspects. This paper describes this aspect with three different mini-game developed under the project.

Keywords: Gamification · PEGASO · Health game · Behaviour change · Nutrition

1 Introduction

Funded under the umbrella of the 7th Framework Programme of the European Union, the project PEGASO Fit 4 Future [2,3] has the objective of promoting healthy behaviours and lifestyles in the teenagers population. Objective of the project is the development of a behaviour change system based on a mobile/smartphone platform, integrating a wearable sensing system in a cloud based architecture. In view of such ambitious objectives and the specific target addressed, games - as a way to attract and involve teenagers - have been in the radar of PEGASO since its conception. The specific strategy has evolved with the progress of the project and currently we are working with a multifaceted approach to gaming. This paper provides a recap on the main goals and motivations of the project, a description of the approach to gaming, detailing on some specific aspects and games currently under development. In particular section two

K. Giokas et al. (Eds.): eHealth 2016, LNICST 181, pp. 100–109, 2017.
DOI: 10.1007/978-3-319-49655-9_14

describes the goals and the rationale behind the project, section three provides an overview of the gaming approach within the behavior change theory adopted and section four provides more detailed information on the educational mini-games, which have been designed and developed by the Politecnico di Milano. Section five provides an overview of the validation and evaluation approach of the overall PEGASO system. Finally section six provides some conclusions and highlights on future work.

2 The PEGASO Goals and Motivations

Challenging teenagers in their own fields and areas of interest, PEGASO Fit 4 Future - aims at promoting a sustainable change towards healthy lifestyles, with an holistic and multidisciplinary approach. Pivotal elements of the PEGASO strategy are:

1. Developing self-awareness
2. Enhancing and sustaining motivation
3. Promoting behavioural change towards a healthy lifestyle

On the technology level, PEGASO is a multi-dimensional and cross-disciplinary ICT-based system that exploiting sophisticated and engaging game mechanics. This will motivate behavioural changes towards healthy lifestyles thus preventing overweight and obesity in the younger population.

Childhood obesity, defined as a body mass index higher than 30 kg/m2 has more than doubled in children and quadrupled in adolescents in the past 30 years [1]. Over 60% of children who are overweight before puberty will be overweight in early adulthood. Childhood obesity is a serious problem because it is not only a predisposition to many other childhood diseases but also to premature death. Moreover, childhood obesity is strongly associated with other conditions like breathing difficulties, hypertension, type 2 diabetes, orthopaedic complications, and mental disorders. However, overweight and obese children not only experience an increased risk of the aforementioned diseases; they are also vulnerable for academic underachievement, social isolation and lowered self-esteem due high body weight and negative self-image. In this situation, a tool for behavioural change for a better healthy lifestyle becomes mandatory. The framework of PEGASO is developed along three main dimensions:

1. **Individual and Environmental Monitoring** - a high level-monitoring platform including wearable sensors, for the acquisition of physical, behavioural and emotional attitude of adolescent.
2. **Feedback System** - providing feedback in terms of "health status" changes, requiring actions to undertake and so on, proposing personalized healthy options for alternative lifestyles.
3. **Social connectivity and engagement** - sharing experiences in a community of peers through different gaming strategies.

PEGASO considers three levels of engagement towards empowerment of teenagers in developing virtuous behaviours: awareness of risks, motivation, affective learning and finally behaviour change.

Develop Awareness: Teenagers need to be aware of what they are doing; what is right and what is wrong for their healthy living. Some of them are unconsciously and automatically acting, and often under estimate or have no clear notion about information they receive. Monitoring lifestyle of teens activity, collecting parameters and integrating their own data will enable self-awareness on their current situation. Through developing self-awareness and self-reflection, teens can frame the problem or the opportunity area to act upon or intervene.

Create Motivation: It is important to motivate teenagers to change their behaviour and sustain motivation in the long-term. This goal is quite challenging, since motivation depends on many factors as well as emotions, psychological environment and personality. The use of games and, even more, the provision of services and opportunities for health with a gamified approach of reality, can support this level of engagement.

Enable Behaviour Change: Once teenagers have awareness and motivation, it is important to support the behaviour change process and reinforce acquired virtuous behaviours. The turn from old unhealthy behaviours into new healthier ones has to be monitored on a longer period.

In order to create prevention, it is important to change or stop old unhealthy habits and develop new healthier ones. In this respect, PEGASO takes a holistic approach involving the teenagers environment and specifically the families, by means of an education process empowered by training that will be provided on location (schools) and on line. The expert team will give feedbacks to the users allowing them to change their behaviour on a long-term basis. The overall system takes advantage of gaming strategies to persuade users to change their behaviour.

3 Gaming Approach in PEGASO

The main element of PEGASO Fit 4 Future interface towards the teenagers is the PEGASO Companion [4]. The Companion is the main interface between the user and the PEGASO system and plays the major role of unifying the user experience within PEGASO. The Companion is the management center of the PEGASO service system and, via the Companion, teenagers seamlessly can access the different apps. The Companion allows PEGASO to appear as a single, modular application. The overall gaming system in PEGASO is managed via the Companion and is based on a three-fold approach, leveraging:

The PEGASO game: A 3D serious game aimed at increasing nutritional awareness and promoting physical activity, providing the motivational component [5,6]. The PEGASO game is developed under the responsibility of the PEGASO partners imaginary srl (Italy) and University of Coventry.

The PEGASO serious game performs a central role as a motivational component of the system. It offers capabilities to entertain and engage the player, whilst the PEGASO sensors system captures information on lifestyle and encourage positive changes. There are two central behavioural mechanisms within the game. The first is an "energy bar", consumed by the player's actions in the game, and replenished by achieving behavioural goals set and monitored according to the behavioural theories of self-determination and nudging [7]. Secondly, the game implements "research" mechanics that require the player to apply and develop their nutritional knowledge of various food sources. Each of the two mechanisms leads to a different scenario for positive lifestyle change involving the game. The first scenario is that the player wishes to replenish them in-game energy to boost her/his abilities and expedite their progress within the game; the second one is that in attempting to complete research tasks successfully and efficiently, the player is required to develop and apply her/his knowledge about nutrition (prior researches show a strong link between lifestyle choices and in-game practices, and in particular there is a correlation between healthier lifestyle and game [8].

The PEGASO gamified approach: Linking **real world** activity with online and gaming applications, providing the social component.

Gamification and serious game are concepts integrated in PEGASO with the aim of enhancing the effect of the behaviour change techniques. Simply stated, these approaches, if correctly designed, can increase the user motivation in doing healthy tasks (or, equivalently, demotivating unhealthy behaviours). Gamification techniques in PEGASO leverage the concept of controlled or extrinsic motivation.

Controlled motivation *reflects engaging in behaviors for externally referenced reasons such as to gain rewards or perceived approval from others or to avoid punishment or feelings of guilt. Individuals engaging in behavior for controlled reasons feel a sense of obligation and pressure when engaging in the behavior and are only likely to persist with the behaviors as long as the external contingency is present. If the reinforcing agent is removed, action is likely to desist. Individuals who are control-motivated are therefore less likely to be self-regulated.* Therefore, controlled motivation, also called *extrinsic motivation* [9], involves doing something for external rewards, like money, services, praise or something else that is tangible. The drawback of this typology of reward is that extrinsically motivated people do not have to like the behaviour that the system is encouraging but the outcome. In the PEGASO context, this means that teenagers may not enjoy eating healthy food or doing sport, they are motivated to continue doing so because of the promise of a reward at the end of the process. And if at a certain point in time the reward is removed, the user will stop the desired behaviour. However, jointly with intrinsic motivation, which may be developed through the development of awareness about the different lifestyles and behaviours, linking individual choices with rewards in the social sphere has the potential of reinforcing motivation. Further through gamification techniques it is possible to develop

a positive social ecosystem that will influence the behaviour of the individual and of the group is part of.

The PEGASO partners responsible for the overall approach to gamifications are mainly Neosperience (Italy) and the University of Applied Science of Western Switzerland (HES-SO). Linked to the overall ecosystem sustaining the positive behavioural changes, gamification is also a key element of the definition of the PEGASO value network and the potential business model.

The PEGASO minigames: Addressing specific aspects of healthy behaviour, providing the educational component. The minigames are small games that have very specific goals, that can be completed in a short timespan and that provide information in a playful manner. The main goal is to develop awareness and encourage healthy behavior developing the intrinsic (autonomous) motivation. **Autonomous motivation** *is defined as engaging in a behavior because it is perceived to be consistent with intrinsic goals or outcomes and emanates from the self. In other words, the behavior is self-determined. Individuals engaging in behaviors feel a sense of choice, personal endorsement, interest, and satisfaction and, as a consequence, are likely to persist with the behavior. The behavior is consistent with, and supports, the individuals innate needs for autonomy, the need to feel like a personal agent in ones environment, competence, and the need to experience a sense of control and efficacy in ones actions. Individuals acting for autonomous reasons are more likely to initiate and persist with a behavior without any external reinforcement and contingency. Autonomously motivated individuals are, therefore, more likely to be effective in self-regulation of behavior.* Intrinsic motivation fosters behaviours that result in internal rewards (such as satisfaction, positive feelings and happiness). When people are intrinsically motivated, they have a sincere desire for the activity and behaviour change techniques have mainly to work as facilitators for the target behaviours. The PEGASO minigames are the results of work conducted by Politecnico di Milano (Italy) and are further described in more details.

4 Current Work on Educational Games and Mini-Games

PEGASO system includes mini-games related to different and specific aspects of healthy behavior in order to provide an educational media which involve teenagers in the educational process. We focus onto three aspects of health: Food diversification; Food related to energy intake; Food myths and legends. We developed three mini-games, one for each of these aspects: the Food Quiz, the Calories Quiz and the Food Pyramid.

4.1 The Pegaso Food Quiz

The Pegaso Food Quiz is inspired by very popular games on mobile platform like Trivia Crack or Quizoid. It tries to mix the popularity of these game with food education in order to eliminate false information and myths that our society creates around physical activity and food. As visible in Fig. 1, the game is very

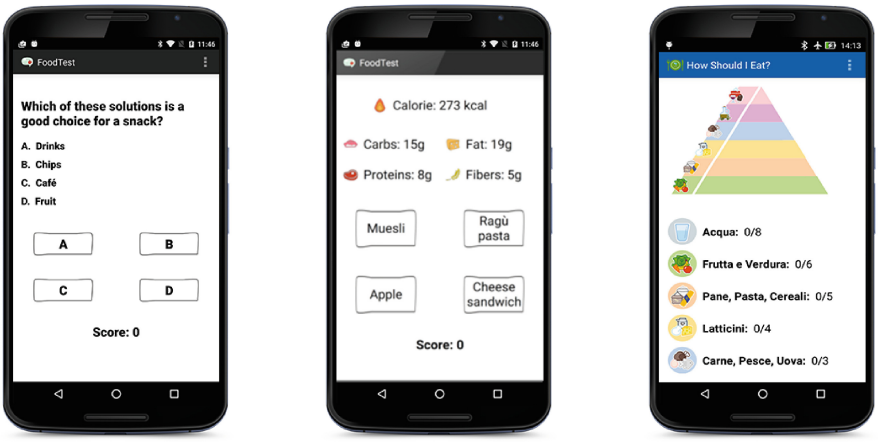

Fig. 1. The three Pegaso mini-games: from left the "Food Quiz" for food diversification, the "Calories Quiz" for food related to energy intake, and How Should I Eat? for Food diversification.

simple; ten multiple choice questions are shown to the player who has to choose the correct answer out of four possibilities. At the end of the ten questions, the game shows the score and the possibility to insert it in a global leader-board. All the questions and leader-board are stored in a cloud-based repository in order to facilitate the insertion of new questions and take a global leader-board. The questions in the game concern many different aspects of health, food and activity. Here are two examples of question with the right answer underlined:

– *All these nutrients are essential for strong bones except ... Calcium - Magnesium - Vitamin D -Sodium.*
– *How many servings of fruits and vegetables should consume per day? zero - four - five - two.*

4.2 The Pegaso Calories Quiz

As the first one, this second mini-game follows the strategy of quiz to teach players the energy content of the different foods. In order to test different user interface, in this second mini-game the graphic is completely different and it is based on Marije Vogelzang food design [11]. The UI (User Interface) is very simple but clear, and the food icon design by Marije Vogelzang help teenagers to easily understand the gameplay. The game shows the amount of calories, fats, carbs, fibers and proteins included in a meal, and the player has to select the correct answer between four different dishes. As for the PEGASO Food Quiz, the score depends on the number of correct answer and it is stored in a global leader-board. The gameplay of this game allows to teach teenagers the food diversification and the content provided by each dish in order to explain the correct association between diet and daily activity. We used different user interfaces in order to test the pleasantness of the two different quiz games.

4.3 How Should I Eat?

The food diversification is one of the main aspects of a correct diet and is the foundation of the Mediterranean Diet. The diversification consists of consuming diversified foods during the span of a week and, at the same time, covering the correct needs for water, carbohydrates, fats, proteins and sugar. A graphical expression for this diversification is the food pyramid [10]. It consists of a triangle having at the basis the foods must be eaten in greater quantities during the day (or the week), such as fruits and vegetables, and at the top foods that should be consumed rarely because they are rich in fat and sugar (fried and sweets). "How should i Eat?" is a physical interaction game based on the Mediterranean diet pyramid. It is not a usual mobile game, but it makes use of devices and objects to involve the player and make the gaming experience more tangible. The game is inspired by Disney Infinity [12] and Tiggly Shapes [13] which use physical object to interact with the mobile phone or tablet. How should i Eat? uses the so called BLE Beacons; they are small devices with Bluetooth® Low Power and iBeacon [14] service which allow measuring approximately the distance between the same and the smartphone/tablet. In this way, the smartphone/tablet is able to trigger action depending on the beacon distance.

We created a table with 35 different dishes and drinks (Fig. 2); each of these is composed by a cardboard disc which includes a beacon specially programmed with the name of the dish/drink. On the mobile device screen a Food Pyramid is shown. The players choose a series of food they usually eat during a day and approach them to the smartphone/tablet. The mobile device automatically recognizes the selected beacons, visualizes the dishes/drinks on the screen (Fig. 2) and insert the relative content in the food pyramid. After the completion of a typical daily food intake, the pyramid can be saved in order to compare it with other pyramids of different players.

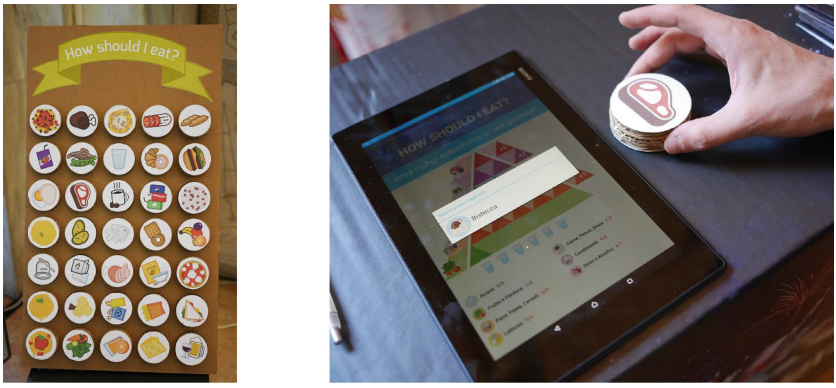

Fig. 2. How should I Eat? Cardboard and an example of use for the iBeacon

5 Evaluation of the PEGASO System

Games and gamification have been identified as key elements of the PEGASO approach since its conception and constitute the main factor for the engagement strategy. The overall system, which includes also a wearable sensors system, for monitoring of current behaviour, and a recommendation system - leveraging the concept of target behaviour and gentle push - will be evaluated by means of three pilot experiments in three countries (Italy, Spain and United Kingdom) enrolling about 400 students in high-schools.

Such evaluation will cover the overall PEGASO platform as a tool aimed to support teen-agers to get aware about their health status. The validation of the PEGASO platform will assess the following factors:

- System and Technology acceptance, usability and long-term use: these will be also a secondary assessment of motivation and engagement;
- Reliability in assessing the teen-agers lifestyles and their changes (with focus on the eating habits and on physical activities) and related efficacy on the sensors network system;
- Efficacy of the system in encouraging lifestyle change;
- Subjective assessment for awareness;
- Systems compliance to Stakeholders needs.

In order to access the efficacy of the system in encouraging lifestyle change, the consortium will use an approach based on pre post assessment of behaviour by means of questionnaires combined with the use of a control group to check efficacy beyond chance. The following existing questionnaires are planned to be used:

- Usability: System Usability Scale (SUS) [15]
- User interaction and experience: Emotional Metric Outcome (EMO) [16]
- Acceptability Technology acceptance model (TAM) [17]
- Desirability: Microsoft Desirability Toolkit [18]

Interventions designed to encourage the adoption of health-promoting behaviours involve a broad spectrum of complexity due to various factors: the number and difficulty of the behaviours required from participants, the coexistence of diverse components that may interact or act independently, the participation of multiple disciplines, and the need for flexibility in adapting to changing contexts. It is essential to gain a deep understanding of the context, which also influences the effectiveness of the intervention. The system PEGASO may be considered as a complex intervention.

The main directives for the design, implementation, and evaluation of this type of interventions were developed by the Medical Research Council (MRC). The MRC Framework [19] promotes research participation by the general public and practicing professionals, which increases the interventions acceptance and feasibility in addition to facilitating participant recruitment and follow-up. This approach also improves the validity and reliability of the assessment tools

and ensures the cultural and social relevance of the intervention. These design strengths can also help to increase the sustainability of the intervention, transfer research findings to actual practice, and increase the long-term impact of the health outcomes [20,21].

6 Conclusion

All the games were developed for Android smartphones and tablets. They have been tested on different OS version starting from Android Jelly Bean 4.3. The game are still in the first alpha release, but they have been tested by about 100 teenagers player during two main events ("Wired Next Fest 2015" and "Giovani ambascaitori del cibo @Expo 2015"). After the test all the teenagers were asked to complete a small survey in order to gather opinions regarding the gameplay, the user interface and the user experience. Results of questionnaires show an high acceptability of the games, especially for kids around 10/12 years old. As it might have been expected, the favorite game was "How should I eat?" thanks to both the engaging user interface and the interactivity provided by the ibeacons. For the two quiz games, teenagers underlined the importance to insert more questions and diversifying them inserting grouping (e.g., for Calories Quiz groups foods by Vegetarian, Vegans, Fast-food, Snacks...). Future works aim to insert other features into this game:

- Insert a check on the question already dealt by the player in order to avoid presenting the same questions in a short time;
- Insert the possibility to use a question of the game for unlocking the phone.

As described in the first part of this paper, all these games are part of the Pegaso system of apps. In order to minimize the number of apps to install, quiz games will be merged in the Pegaso Companion main app. In this process they lose their identity of mini-game, but the gamification aspects are maintained.

As indicated earlier, PEGASO is a complex system, of which the game related part constitutes a key component. Other components are the wearable sensors subsystem and the recommendation subsystem. Validation of the system and of the intervention as a whole will be performed by means of pilots involving 400 students in three European countries.

Acknowledgments. This paper is partly based on the work performed within the context of the PEGASO project. The PEGASO project is co-funded by the European Commission under the 7th Framework Programme. PEGASO is part of the cluster of projects in the ICT for health area; it has started in December 2013 and will run for 42 months. The author wishes to thank all the project partners for their contribution to the discussion.

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