Mobile Solutions for Prevention in HealthCare: the PEGASO Project

Maria Renata Guarneri, Politecnico di Milano

10–12 May 2017 MALTA
OUTLOOK

- The PEGASO Project: Setting the scene
- The PEGASO Project: goals and motivation
- The PEGASO System and its components
- The gaming approach in PEGASO Evaluation
- Conclusions and future work
PREVENTION: FOCUS ON OBESITY

- Worldwide obesity has more than doubled since 1980.
- In 2014, more than 1.9 billion adults, 18 years and older, were overweight. Of these over 600 million were obese.
- 39% of adults aged 18 years and over were overweight in 2014, and 13% were obese.
- Most of the world's population live in countries where overweight and obesity kills more people than underweight.
- 41 million children under the age of 5 were overweight or obese in 2014.
- Obesity is preventable.
• The number of overweight or obese infants and young children (aged 0 to 5 years) increased from 32 million globally in 1990 to 42 million in 2013.

• The vast majority of overweight or obese children live in developing countries, where the rate of increase has been more than 30% higher than that of developed countries.

• If current trends continue the number of overweight or obese infants and young children globally will increase to 70 million by 2025.

• Without intervention, obese infants and young children will likely continue to be obese during childhood, adolescence and adulthood.

• Obesity in childhood is associated with a wide range of serious health complications and an increased risk of premature onset of illnesses, including diabetes and heart disease.
PEGASO FIT FOR FUTURE IN A NUTSHELL

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. A behaviour change platform targetting teenagers in preventing obesity and related comorbidities

• **Smartphone** as central element and agent for behaviour change
• Additional **sensors** with a modular approach
• **Games, Gamification** and **Cloud** based service offering
Development of a multi-dimensional and cross-disciplinary ICT system that includes game mechanics to influence behaviours in order to fight and **prevent overweight and obesity in the younger population** by **encouraging** them to become **co-producers of their wellness and take an active role in improving it** by:

**GENERATING SELF-AWARENESS**
acknowledgement of risks associated to unhealthy behaviours

**ENHANCING AND SUSTAINING MOTIVATION**
to take care of their health with a short/medium/long term perspective

**CHANGING BEHAVIOUR**
towards a healthy lifestyle based on healthy diet and adequate physical activity
A COMPASS TO GUIDE TOWARDS A HEALTHY LIFESTYLE

A positive message and tool dedicated to teenagers, to improve their lifestyle according to 4 dimensions:

- move → active lifestyle
- play → engagement
- eat → good nutrition
- share → social approach
THE PEGASO SYSTEM: ARCHITECTURE AND FUNCTIONALITIES
THE PEGASO SYSTEM: ARCHITECTURE AND FUNCTIONALITIES

• **Individual & Environmental Monitoring** – Environmental, behavioural and physiological analysis of young users, through a high level-monitoring platform including wearable sensors and mobile phone.

• **Feedback System** - Providing a feedback in terms of “health status” and changes, required actions to undertake and so on. Personalized feedback on lifestyle (in terms of diet and/or physical activity), thus promoting the active involvement of adolescents in changing their behaviours.

• **Social connectivity and engagement** – A social network where the user can share experiences with a community of peers concerning physical activity, food consumptions and everyday habits through different gaming strategies.
INDIVIDUAL & ENVIRONMENTAL MONITORING:
The PEGASO Virtual Individual Model

- A conceptual framework of basic relations between the individual's status and behaviours in different domains, which are considered to dynamically concur to health
THE PEGASO SENSOR SYSTEM

Garments: 3.rd generation, signal reliability, up to >50 washings stability;

- WES (body datalogger): CE Mark.
- WWAT (bracelet): CE Mark.

HumanAPI has been adopted as third party sensors integration tool.
PEGASO BEHAVIOUR RECOGNITION

• The PEGASO Behaviour Recognition System (BRS) is composed of two main blocks: the short-term analysis and the long-term analysis. These two blocks are accompanied by a backend system, which relies on a repository of semantically annotated data.

• The **Short-term analysis** main objective is to assess user’s daily habits to be able to provide feedback to the Companion and the gamification system. It processes user data coming from disparate sources in order to analyse which factors may have a negative impact on health and suggest corrective interventions.

• The **Long-term analysis** is built upon weekly and monthly data stored in the semantic repository and it is used to evaluate trends in behaviours and to assess changes. It has been deployed in a cloud environment.

• The information from the short-term to the long-term block flows through the semantic repository, which acts as a database and constitutes part of the BRS backend.

@eHealthWeekEU #eHealthWeek
THE FEEDBACK SYSTEM: PEGASO COMPANION

• The PEGASO Health Companion represents the guidance system and is the main interface between the user and the PEGASO system.
• The PEGASO Health Companion is a Personal Digital “Friend” acting as a daily-life guide for Coaching, Caring for, and Empowering teenagers in their activities toward healthy habits. Main attributes of the PEGASO Companion are:
  – **Digital**: The Companion exists in the smartphone,
  – **Personal**: The Companion is customised to the single user,
  – **Friend**: The Companion would establish an affective relationship with the user,
  – **Daily-life guide**: The Companion accompanies the users (coaching, caring and empowering) during their daily activities,
  – **Toward healthy habits**: supporting behaviour change to promote healthy lifestyles is the main goal of the Companion and PEGASO project in general with special focus on obesity prevention.
THE PEGASO COMPANION

PEGASO Companion: It is the teen’s assistant/avatar/friend/mirror:

Motivational component of the platform: entertains and engages the player, captures information of lifestyles and encourage positive changes, promoting healthy habits (nutritional knowledge, physical activity, services)

PEGASO Game: Personal, Social and educational serious game
DASHBOARD

DISPOSITIU CONNECTAT
Hola, com estàs?

ENTRENADOR PEGASO
Hola, com estàs?

Here are your targets:
Steps: 6000 passes
Activity: 30 min
Sleep: 420 min

NÚMERO DE PASSES
429
PASSES

ACTIVITAT FÍSICA
0:2' MINUTS

ESTIL DE VIDA DIARI
PASSIU

TRANSPORT A L'ESCOLA
PASSIU

SLEEP
7:39'

© HIMSS Europe GmbH
E-DIARY

Choose from these foods what to eat in your next meal. Tip: best is eating some of every food group.

- Fruits
- Water
- Vegetables
- Milk & Yogurt
- Pasta/Rice/Potato

@eHealthWeekEU #eHealthWeek
CHALLENGES

Individual challenges

Walk
- You have 24H to reach the chosen number of steps.
  - 6,000 steps: 10FC ACCEPTED
  - 7,000 steps: 15FC LOCKED
  - 9,000 steps: 20FC LOCKED
  - 12,000 steps: 30FC LOCKED

Move
- You have 24H to reach the chosen number of minutes of moderate or high physical activity.
  - 30' of exercise: 10FC ACCEPTED

Competitive challenges

Walk more than your friend
- You will challenge a friend to do more steps than you.
  - YOU: ACCEPTED
  - ANTONY CART: WAITING

@eHealthWeekEU #eHealthWeek
PEGASO HEALTHLINK

Connection with Regional Health Networks and Integration with the regional health IT systems; Preparation of Report template for the GPs

Lombardy ReportAPP

Catalan Web portal and Web app

© HIMSS Europe GmbH
THE FEEDBACK SYSTEM: TARGET BEHAVIOURS

The rationale for the selection of behaviours relevant for obesity prevention in adolescents.

Selection of Target Behaviours concerning Diet & Physical Activity

- associated to the risk for obesity in adolescents
- detectable through sensors or mobile app interaction
- evidenced to be changeable

• Develop a quantitative scoring system of selected TBs based on obesity risk
• Provide metrics for assessing behaviour change and outcomes for PEGASO evaluation
• Create tools for behaviour assessment through machine-based reasoning

Fruit & Veg consumption
Sugar-sweetened beverage intake
Breakfast skipping
Fast-food habits
Snacking behaviour
Overall Physical Activity
Sedentary behaviour
Sleep habits
THE FEEDBACK SYSTEM: PEGASO BEHAVIOUR RECOGNITION

- Identification of behaviours and match with Target Behaviours
- Scoring system:
  - Short-term analysis,
  - Long-term analysis,
  - Overall Risk analysis
- Analysis and feedback to the user
PEGASO BEHAVIOUR RECOGNITION SYSTEM

DATA COLLECTION

- Abnormality detection
- Personalized advice

- Behavioural Feedback to User
- Behaviour change interventions

Data indicators about TARGET BEHAVIOURS:
- Fruit consumption
- Vegetables consumption
- Breakfast consumption and quality
- Sugar-sweetened beverage
- Fast food intake
- Snacking habits
- Overall Physical Activity
- Sedentariness
- Sleep habits

Short-term data analysis (24h) - Smartphone

Data Analysis: Cleaning, fusion and inference

USER «DAILY» PROFILE

LONG-TIMESCALE TREND BEHAVIOUR ANALYSIS:
- Scores and trends analysis
- Long term goals achievement/desertion/relapse detection

1 MONTH SUMMARY

Semantic repository (ontological model)

Long-term data analysis (4 weeks) - Cloud

© HIMSS Europe GmbH
Recognizing daily behaviours: The short-term analysis

Ranking behaviours and recognizing trends: The long-term analysis

Storing user data based on ontological model: The semantic repository
SOCIAL CONNECTIVITY AND ENGAGEMENT: THE GAMING APPROACH IN PEGASO

The overall gaming system in PEGASO is managed via the Companion and is based on a three-fold approach:

• **The PEGASO game:** a 3D serious game aimed at increasing nutritional awareness and promoting physical activity - motivational component

• **The PEGASO gamified approach:** linking ‘real world’ activity with online & gaming applications – social component

• **The PEGASO minigames:** addressing specific aspects of healthy behaviour – educational component
THE PEGASO GAME - MOTIVATION

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 "energy bar", consumed by the player's actions in the game, and replenished by achieving behavioural goals;
- The "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.
THE PEGASO GAME: DAYTIME SCREENSHOT
THE PEGASO GAME: NIGHTTIME SCREENSHOT
THE PEGASO GAMIFICATION: SOCIAL COMPONENT

• Gamification techniques in PEGASO leverage the concept of controlled or extrinsic motivation.
• Controlled motivation involves doing something for external rewards, like money, services, praise or something else that is tangible.
• 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.
• 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.
THE PEGASO GAMIFICATION: SOCIAL COMPONENT

• Linking individual choices with rewards in the social sphere has the potential of reinforcing motivation.
• In addition through gamification techniques it is possible to develop a positive social ecosystem that will influence the behaviour of the individual and of the group.
• 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: EDUCATION

• The PEGASO minigames are small games with very specific goals; they can be completed in a short timespan and 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 acting for autonomous reasons are more likely to initiate and persist with a behaviour without any external reinforcement and contingency.
THE PEGASO MINIGAMES: EDUCATION

- Intrinsic motivation fosters behaviours that result in internal rewards, such as satisfaction, positive feelings and happiness.
- Education and awareness are important triggers for developing autonomous motivation.
- Minigames have been embedded within the PEGASO serious game;
- Stand-alone minigames have also been developed to be played as separate elements for education and entertainment.
EMBEDDED PEGASO MINIGAMES

- **SCAVENGING**: Collect as much food as possible and match the food icons belonging to the same nutritional category.

- **RESEARCH**: Match a single food item, collected through the scavenging mini-game, to a recipe requirement.

@eHealthWeekEU #eHealthWeek
THE STAND-ALONE PEGASO MINIGAMES

• Related to different and specific aspects of healthy behavior.

• Focus on three aspects of nutrition:
  • Food diversification
  • Food related to energy intake
  • Food myths and legends
  • Food Quiz
  • Calories Quiz
  • Food Pyramid.
THE PEGASO FOOD QUIZ

- The food quiz presents 10 questions to the player.
- The questions are related to food, diet, but also physical activities and daily lifestyles.
- The players reply choosing one out of four possible answers.
- At the end of the 10 quiz, the users insert the name/nickname for the leaderboard.
THE PEGASO FOOD QUIZ

The Food Quiz aims to teach players different aspects about:

• Nutrition;
• Physical Activities;
• Debunking Urban Legends.

• In 2016 Runtastic launches the app:
• *Runtastic Health Myths & Facts* based on the same aims.

© HIMSS Europe GmbH
The Calories Quiz presents five questions to the player.

The question consists in dietary content of food (calories, carbs, fat, proteins and fibers contents) and four foods.

The players reply choosing the food that contains the cited dietary content.

At the end of the 5 quiz, the users insert the name/nickname for the leaderboard.
THE PEGASO CALORIES QUIZ

• Calories Quiz teaches players to distinguish “good and bad” food based on food content.

• Very often common dishes are considered healthy food, but really are not (e.g.: Frozen Yogurt which is very rich of sugar and preservatives).
THE PEGASO FOOD PYRAMID

Cardboard with all the selectable foods.

The player select a food tag and approaches to the tablet/smartphone.

Once completed, the device shows the balance of the daily diet.
THE PEGASO FOOD PYRAMID

- As for the Calories Quiz, the Pegaso Food Pyramid addresses the same objectives, trying to teach the player the principles of the *Mediterranean Food Pyramid*
PEGASO: EVALUATION APPROACH

Validation studies carried out in Italy, Spain and United Kingdom.

- **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;
- System’s **compliance** to Stakeholders’ needs.
PEGASO EXPECTED IMPACT

• **Enhancing self-awareness** of younger people for health issues and **promoting behavioural changes** in favour of physical activity and healthy diets

• **Preventing juvenile overweight/obesity** and reducing morbidities associated to juvenile overweight/obesity in the short time, and long term health consequences

• **Reducing medical, social and personal costs** associated to juvenile and adult overweight/obesity.
LONGER TERM PERSPECTIVES

• Development of a **multi-stakeholder multi-sectorial model** of well-being, health and social care
• Requirements for a **new organisational model** – encompassing different sectors of the PA – to develop a culture of prevention
• Development of a new organisational model based on a **mix of economic resources** coming from private and public sources
• Development and prioritisation of potential measures towards **healthcare and prevention policies** for the European healthcare sector

© HIMSS Europe GmbH
SUMMARY AND CONCLUSIONS

• There is a perceived clear need at all policy levels that healthcare needs to be addressed through prevention to ensure sustainability of the healthcare system;
• Well-being is a complex concept to which several determinants contribute at different levels in the different stages of an individual’s life;
• Well-being and the self-perception of health go beyond the dynamics of the healthcare sector only;
• PEGASO addresses prevention of obesity and overweight in teenagers with an holistic approach embracing the full ecosystem and healthcare value network as a first step towards the design of a new healthcare model.
SUMMARY AND CONCLUSIONS

• The following key issues however have to be adequately addressed and are at the centre of the PEGASO rationale:
  – Knowledge of how to stay healthy is ubiquitous; however, obesity and lifestyle-related illness are still among the top healthcare challenges in Europe.
  – Motivating individuals to change behaviour is not just a clinical issue. Successful programs include incentives along with personalised programs and, increasingly, the inclusion of behavioural science.
  – Gamification has emerged as a recognisable trend that can have a significant positive impact on all businesses and is yet to be leveraged by wellness and healthcare.
  – The strategy proposed by PEGASO, based on behaviour changes, is expected to have favourable effects in reducing the risk of overweight/obesity and associated diseases and social costs in proportion to the national prevalence of body mass excess in this age class taking advantage of the possibilities offered by innovative ICT and of teens’ affection to mobile and social network.
ACKNOWLEDGMENTS

• PEGASO has been partially funded by the European Commission: FP7-ICT-2013.5.1 - Grant Agreement n° 610727.

• The presenter would like to thank all the partners of the PEGASO consortium for their proactive collaboration in the project.
Thank you!

Maria Renata Guarneri, Politecnico di Milano

@pegasof4f

10–12 May 2017 MALTA