

# Pegaso: a Serious Game to Prevent Obesity

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**Abstract.** The problem of obesity in the world has grown considerably in recent years. Between 16% and 33% of children and adolescents are obese. Even if obesity is among one of the easiest medical conditions to recognize, it is one of the most difficult to treat. The issue of individuals' motivation to change is the most significant obstacle in promoting positive health behaviours. Games' ability to reach and engage large number of players for long periods of time provides an opportunity for them to be used as a pedagogical tool. This paper describes how serious games and 'gamified' daily life processes appear to be a suitable means for supporting persuasion towards healthful behaviour within the frame of the Pegaso project that aims to develop a multi-dimensional cross-disciplinary ICT system to prevent overweight and obesity in the younger population.

**Keywords:** serious games, obesity, adolescents, healthy nutrition, game based learning

## 1 Introduction

Obesity has become a worldwide public health problem but the most alarming fact arrives from the childhood obesity. In the past 30 years, this has more than doubled in children and tripled in adolescents [1], [2]. Further, childhood obesity is a global phenomenon affecting all socio-economic groups, irrespective of age, sex or ethnicity. Obesity is caused by many factors: genetic, psychological, environmental, socio cultural, lifestyle and person's habits. Usually adolescent obesity is determined by the co-presence of all these factors, or at least by some of them.

In this context, analysing the different roles that food and nutrition have within the adolescents' life can be really interesting [3]. Due to the cultural and social changes, parents today have less time to plan and prepare healthy meals, which results in adolescents opting for more processed and fast foods that are usually less healthy than

home-cooked meals. Furthermore, the food sold in supermarkets is processed, high in fats and is containing too much sugar.

Eating habits are also adapted to the different contexts. For instance, in contrast to the communal eating habits within a family context, teenagers' eating habit tends to be influenced by their social circles. In this case, food has become part of the identity development process, which allows teens to create or reinforce their peer relationships. It is not important what they are eating but with whom they are. In fact, the teenager's environments (family, friend, schools, etc.) reinforce lifestyle habits regarding diet and activity. For example if a parent is overweight and has poor diet and exercise habits, the child is likely to adopt the same habits.

Life style also depends on specific leisure interests, which influence the eating behaviour. For example, junk food is valued differently and is more rarely consumed by fitness-oriented individuals compared to those who spend their free time playing computer games.

Eating habits are also related to the specific gender differences. In general boys are less influenced by the social pressure about the body stereotypes than girls. Especially during adolescence girls exercise and do sports for modelling their figure. They experience their body mainly as a threat, unlike boys, in which the changing fat-muscle ratio meets the body needs [3].

Many girls encounter the natural change processes therefore with restrictive eating behaviours. These reduced-energy diets are sometimes performed as early as elementary school age. With increasing aging the older girls often leave meals (preferably breakfast), relinquish the so-called fattening foods, and other food items.

This happens also because for most of the teens and their parents it is not clear which amount of nutrients is adequate [4]. Another example portrays the trained unhealthy nutrition that has been observed in some families. In general, infants and young children are very good at listening to their bodies' signals of hunger and fullness. They stop eating as soon as their bodies tell them they had enough. But sometimes a parent or grandparents encourages children to finish everything on their plate. This forces them to ignore their fullness and to eat everything that is served to them. The way we eat when we are children may strongly affect our eating behaviours as adults. These habits may affect what we eat, when we eat, and how much we eat.

In conclusion, it is possible to argue that teens' eating habits are an expression of their lifestyle, are used for social positioning and allow teenagers to create their individual and social identity. Most of the time teenagers really don't know what they are eating and they are even not really aware of the consequences of their bad food habits. As adolescences are not easy to manage, especially by parents or other adults, it is really hard to convince and motivate them to change their life style in order to prevent obesity. In fact, the issue of individuals' motivation to change is the most significant obstacle in promoting positive health behaviours. The serious games' ability to reach and engage large number of players for extended periods of time provides an opportunity to motivate teens in terms of understanding the importance of a healthy lifestyle. As technology evolves to support an increasingly diverse range of complementary demands, various forms of technology-driven intervention have already been integrated into teaching and learning methods, including digital games. In such a con-

text, games must be able to demonstrate effective learning (to be pedagogically-driven) whilst also remaining engaging and entertaining (to be fun driven). The engaging element of game technologies has been proven effective in formal and informal learning experiences in both blended and standalone contexts [5]. Gaming literature states several positive learning outcomes of using games: the development of social skills, cognitive abilities and motivation towards learning, social and emotional development [6], strategic decision making [7], logical and critical thinking [8], problem solving and collaboration [9], as well as communication and team-building skills [10].

This paper describes which characteristics a game should have in order to prevent obesity and overweight in the younger population. In particular, in section 2 the pedagogical role of serious games will be discussed. In section 3, some serious games, developed within the Mirror project, will be presented, as an example of games able to trigger reflection in order to make users more aware about their behavior. Finally, in section 4 the main features that a game should have in order to prevent obesity will be presented and discussed.

## **2 Serious Games: a new Pedagogical Approach**

Over the past few years, with the widespread use of commercial games the domain of game-based learning has received increasing attention. However, until very recently, strategies for supporting the more efficacious methods of learning with games were uncertain. Research has shown that teachers were unsure which games to use, which context to use games and how they could be evaluated and validated.

Learning is mostly a process that leads to a change in behavior or understanding, rather than a quantitative increase in knowledge or storing information that can be reproduced. Learning is about internalization [11], i.e. about making sense or abstracting meaning, about being able to relate parts of the subject matter to each other and to the real world. Several methods and approaches exist to learning (e.g. collaborative, cooperative, contextual, inquiry-based, problem-based etc), each with its strengths and weaknesses, which make it more or less suitable for specific application settings.

Studies that compared traditional learning and game-based learning [12] found significant difference in favor of game-based learning. Studies in the US have also confirmed this finding [13]. Empirical studies reflecting the efficacy of game-based learning providing greater support for developing effective games for learning, and addressing user expectations of high fidelity games and ‘immersive experiences’ [14].

Some of the main hits of game-based learning include motivation and engagement as well as the ability to provide activity-led approaches to be modelled for individual users and user groups [15]. However, studies have opened up the importance of games as tools for supporting socially based learning, or social interactive learning [13].

The benefits of effective use of game-based learning are considerable, but as studies have shown use is often most effective with particular learners who enjoy learning with games. Therefore the optimal adoption of serious games may need to be considered to learners' specific ways of learning for achieving increase in nutritional knowledge and physical activity as means to prevent obesity.

There is a shift in the use of games to support delivery of formal and informal education. The application of pedagogically-driven digital games often seeks to capitalize on growing trends amongst a wide range of target audiences who engage with digital media recreationally. A frequent question in serious games design is how to best embed pedagogically-driven learning activities and learning content. A common argument is that this content integration must not obstruct the engaging aspects of the game [16], though in areas where the subject matter does not immediately lends itself to an entertainment gaming analogy, this may prove challenging. One solution might be to exploit a blended approach to apply extrinsic motivation on learners to play, though this can be at-odds to the frequently cited benefits of game-based approaches in stimulating intrinsic motivation. Isolating individual pedagogical elements and examining their relationship to game design is an obvious route [17], though one complicated by the reliance of these elements on other factors such as learner demographic, representational medium or learning context. Consolarium, a game-based learning (GBL) initiative of Education Scotland focuses on exploring and disseminating the efficacy of using computer games in terms of their positive impact on teaching and learning. The use of games as a pedagogical tool is also demonstrated by other initiatives such as the Institute of Play's Quest to Learn Middle School in New York, North West Learning Grid's DiDa program in England and Futurelab's Teaching with Games project.

Further, over the past few years there has been an increased use of digital technologies including games to initiate and sustain engagement across the healthcare sector, where the focus on tackling the attitudes and behaviours that may lead to complicated health conditions has seen games deployed to wide audiences [18], [19], [20].

As a tool to engage and educate young people, games such as 'Privates' have been commissioned by UK's Channel 4 TV Company to address sex health issues. Other entities, such as the Parliamentary Education Group, DEFRA and the US government (who held a competition around games for health) are increasingly commissioning games for learning purposes [20]. Some important scientific and empirical studies have also been undertaken towards establishing the scientific validity of a game-based approach. Controlled trials for game-based interventions such as Re-Mission demonstrates effectiveness in the support for medication adherence in children with cancer [21], and PR:EPARe shows positive outcomes in changed attitudes towards the issue of sexual coercion and pressure in adolescence relationships [22]. The issue of individuals' motivation to change is the most significant obstacle in promoting positive health behaviour. Games' ability to reach and engage large number of players for long periods of time provides an opportunity for them to be used as a pedagogical tool. Activities related to healthy living require individuals to embrace delayed satisfaction, where the reward may be as obscure as the prevention of a chronic condition [18]. The use of game mechanics and concepts to facilitate participation in such activity i.e.

gamification, will commonly benefit from rewards and incentives to be used to sustain positive engagement. Behavioural change may be initiated by extrinsic sources of motivation, or external factors that influence how we behave [23]. The long-term goal will include nurturing intrinsic motivation and positive habit through sustained engagement, where individuals could discover their personal incentives and rewards for healthy behaviour. An example of a gamification ecosystem includes the Monster Manor gamification programme, which involves parents and clinicians in the ‘playful’ and ‘incentivized’ ecosystem. The aim is to encourage children with Type 1 Diabetes to check their blood sugar regularly. The HealthSeeker game promotes a healthy and social community by utilising on competitions and recognition, where peer-driven health challenges are issued through Facebook. Both the use of digital games and the concept of gamification present an opportunity for better understanding of individuals’ knowledge, attitude and behaviour and assessment of their progresses, the provision of more personalised feedback and support towards a healthier lifestyle. Gamification as an enabling platform may provide a solution that will promote behavioural transformation towards healthier individuals.

In the next section the Mirror project will be presented. In particular the serious games developed within this project will be described as an example of games able to trigger reflection in order to make users more aware of behavior.

### **3 Learning by reflection: an example from the Mirror project**

As described in the previous section, the primary purpose of most existing IT-based health and daily life support tools is to enable users to generate novel solutions to problems. From a problem solving perspective there is a very limited support for learning per se in immersive and personalized environments. Nevertheless, when a role-play game that encourages users to solve tasks, make decisions and adopt behaviours is carefully designed to enhance reflection, it supports awareness building and learning in the given context.

The topic of ‘reflective learning’ has been deeply investigated in the Mirror project<sup>1</sup>. ‘Mirror-Reflective learning at work’ is a FP7 project with the aim of encouraging human resources to reflect on previous experiences at the workplace and learn from them. The focus of the project is the creation of a set of applications (‘Mirror apps’) that enable employees to learn lessons from their own experiences (as well as from the experiences of others) and thereby improve their future performance. A prerequisite for exploring innovative solutions in this context is the reliance on human ability to efficiently and effectively learn directly from tacit knowledge, without the need for making it explicit. Among all the techniques explored by Mirror, serious games have a special role as they provide virtual experiences to reflect upon. In particular in the Mirror project it has been studied how serious games can support learning by reflection and how support in form of a virtual tutor can be added to a game

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<sup>1</sup> [www.mirror-project.eu](http://www.mirror-project.eu)

without breaking the flow. Three different games for three different business sectors (health, social care and emergency) were developed to empower and engage employees to reflect on past work performances and personal learning experiences in order to learn in ‘real-time’ and to creatively solve pressing problems. In particular, in order to support learning by reflection some specific tools were added into the games:

- in-game notebook functionality (the possibility to take notes during the game allows users to stop the flow of the game for a while and reflect on what they have done in the game until that moment);
- feedback (the possibility to receive a tutor’s feedback after each choice of options helps users to better understand how they are performing);
- scores (the possibility to see their personal scores on the play-screen increases users’ awareness that each of their actions has a consequence);
- wizard tool (the possibility to insert own content and experiences in the games allow users to reflect on what they have done in their work until that moment);
- individual reflection session (the possibility to self-evaluate own behavior during the virtual experience and to see all the activities that learners have carried out during the game helps users to reflect and to create a bridge to transfer what they have learnt in the virtual, safe environment into the real world).

Further, within the Mirror project, it has been studied a method to enlarge the gaming environment introducing a Virtual Tutor, starting from the Vygotskian theory<sup>2</sup>[24], for supplying tutorial help to make learners more autonomous and confident. In particular some key aspects for the development of a Virtual Tutor inside a game were identified. In order to be able to maximize a users’ ‘Zone of Proximal Development’<sup>3</sup> a tutor to a peer must be able to:

- act as co-learner;
- provide a cognitive model of competent performance;
- have no position of authority with respect to the learner, because this creates relationship based on trust that facilitates self-disclosure of ignorance and misconception;
- add new capabilities and extend current capabilities (accretion), modify current capabilities (re-tuning), and build new understanding (restructuring in areas of completely new learning or cases of gross misconception or error) [25].

According to this theoretical framework the figure of the Virtual Tutor was designed inside the games to provide the user with:

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<sup>2</sup> Vygotsky (1978) is one of the main authors of the Socio-Cognitivism theories. According to his perspective learning occurs within a social context, and that interaction between learners and their peers is a necessary part of the learning process.

<sup>3</sup> Vygotsky (1978) describes those capabilities that are beyond the learner on their own, but are able to be carried out with the assistance of more knowledgeable peers, as capabilities in the Zone of Proximal Development (ZPD).

- additional relevant information on demand;
- frequent, rapid and clear feedback completed by deep final reports showing a clear link between acts and consequences;
- specific help when repetitive errors or patterns are detected by the game system;
- adequate tools to take a step back and collect one's own thoughts.

The various gaming characteristics and supports offered by the Virtual Tutor create favourable conditions so as to allow learners to adopt a reflective attitude towards their own past/present acts and experiences, learning to take place and eventually to maximize the Zone of Proximal Development of the learner.

The games were tested with more than 100 users with different tools (questionnaire, focus group and interview) and the preliminary analysis of this set of evaluations have shown that games were perceived positively, and were evaluated as a useful tool to support learning by reflection.

The lessons learned, insights and scientific results derived from the Mirror project will be exploited and applied on the teen-agers target group of Pegaso in the given health scenario to prevent obesity.

## 4 Conclusions

According to what has been discussed in this paper, obesity is a worldwide public health problem that increasingly affects the younger population. Motivate teenagers to modify their bad food habits in favour of a healthy lifestyle seems to be one of the possible solution in order to prevent overweight and obesity in the younger population. Serious games and 'gamified' daily life processes appear to be a suitable means for supporting persuasion towards healthful behaviour within this frame: however there are some important characteristics that a serious game should have in order to prevent obesity in adolescents.

Although effective in delivering pedagogical contents, serious games in fact offer limited explicit support for adaptation and personalization in daily life motivational processes. One reason for this is the need to encode all of the required behaviours of a game in response to all possible player choices. In simple terms, the capability of a game to respond to nonlinear, non-standard thinking and problem-solving by a player is heavily constrained by what the game designer has predefined. Currently available serious games fail to adapt and evolve in response to dynamic and flexible thinking. Hence, the specification, design and development of the Pegaso game will ensure that these issues will be addressed both individually and collaboratively. In addition, users should be empowered to customize their game, for instance the level of a cognitive challenge, the frequency of a specific activity.

Further, the game's fruition should be essentially conceived as an activity on-the-move, in order to avoid teenagers sitting for hours in front of a PC thus jeopardising the prevention of obesity. With the aim of increasing users' mobility the exploitation

of augmented reality as well as ‘real virtuality’ (i.e. the intervention of a moderator within real life technology-supported gaming scenarios) will be explored. The game should be dynamically aggregated within a virtual highly-interactive and personalised environment, which should offer a very engaging and stimulating daily experience by taking into account both individual needs as well as the promotion of socialization, networking and inclusion, thus in turn contributing to users’ motivation to interact with the game.

The game-based environment should be conceived as a reactive tutoring system, enriched through the integration of a smart virtual companion, as a non-playing character is able to support users in their daily life and in the system usage. Therefore, besides being a continuous support in more general non-gaming daily activities, the virtual intelligent companion should also flexibly act and react within the gaming environment according to the users’ personal profiles, their behavior and the surrounding context at that moment. The solutions by which awareness is raised, attitudes and behaviours are transformed and positive habits are nurtured should therefore be improved, which could potentially reduce pressure on public health expenditure in the long run.

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