Gamified Wellbeing for All Ages – How Technology and Gamification Can Support Physical and Mental Wellbeing in the Ageing Society

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Abstract— **This paper explores the role of technology and gamification strategies in addressing serious societal health issues by providing tools and practices which support healthy ageing (thereby reducing the cost of care for the elderly). These tools and practices also provide an infrastructure and ecosystem that enables effective care and rehabilitation to take place in a home environment with more cost effective patient management from remote medical professionals. This paper emphasizes the importance and cost effectiveness of preventative healthcare based on influencing patient lifestyle behaviors, awareness and understanding and the value of citizen empowerment in personal health management.**

The paper is based on the experiences of major European projects Rehab@Home, Pegaso and Doremi where the author's company has been developing technology tools and gamified applications to improve physical and mental well being for ages from teenagers to the elderly.

Keywords— **Gamification, wellbeing, prevention, ageing society, motivation.**

I. Introduction

Improved standards of living in the developed world, combined with advances in medical and pharmaceutical practices have led to greater life expectancies and reduced mortality rates from diseases and illnesses that had previously been life-threatening. These welcome phenomena have, however, resulted in serious challenges to society and severe problems for national health services. Extended life expectancies and falling birth rates have resulted in the "Ageing Society" phenomenon in which the percentage of the population in active economic employment has fallen whilst the percentage of people beyond retirement age has increased. This latter section of the population is prone to physical and mental decline which requires increasing levels of care intervention whose costs are borne by the working population. Cultural changes and greater population mobility has also meant that care for the elderly which would traditionally been carried out by family members at home, is increasingly now provided in care homes or hospitals.

In addition to these challenges, sedentary lifestyles and the impact of technology on social, cultural and economic structures has led to a variety of physical and mental conditions such as obesity and depression. These are likely to lead to chronic illnesses such as diabetes and COPD and an increasing incidence of strokes and cardiovascular problems, all of which will require costly medical support and potential demands on specialist units such as rehabilitation centers. The consequences of this situation are increasingly highlighted by senior public health policy makers as being potentially catastrophic and unsustainable.

The solutions to these problems are complex. It is generally accepted that lifestyle behaviors that encourage physical and mental exercise (as well as healthy eating) at as early an age as possible are an important key to reducing the cost of lifetime care. Providing tools to help citizens better manage their personal health by monitoring and tracking key health indicators are becoming consumer items. Devices such as wearable activity and sleep trackers, wireless body composition analyzers and blood pressure measurement tools can now accurately collect personal data for display on mobile devices. This personal data is used for aggregation into big data analytics that not only help citizens to understand, monitor and better manage their health but also provide valuable insights into public health, best lifestyle practices and impact assessment of policy interventions.

The key challenge however, is developing solutions which effectively influence long term lifestyle behavioral change whilst supporting the medical profession with tools to reduce unnecessary workload and enable them to be as productive as possible in their practices.

II. Materials and Methods

Gamification has many definitions but it is generally accepted as being "the application of game psychologies and mechanics within non-game scenarios". Game mechanics and game psychologies are used to engage and motivate "players", develop skills, build understanding and influence behavior. Being able to measure and compare is fundamental to all games and sports. Whether it is recording a golf score, winning points or scoring goals, the ability to apply measurement against a set of challenges and rules helps to engage and sustain our interest and motivation. It also encourages competition and supports team working, social connections and community development.

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The process of gamification is rooted in the psychological theory of operant conditioning – producing behavioral changes by rewarding some actions and punishing others [1]. Within the context of serious games, rewards for actions are preferred to negative punishments. Examples of rewards include points and leader boards [2], badges [3], progress monitoring, as progress bars or tick charts [4] and positive feedback, e.g. an encouraging message after a user has completed a task [5].

There are a variety of gamification techniques which can be combined in different ways. It is therefore important that gamification is applied in ways which are relevant and appropriate for the target participants. Successful gamification can enhance self-belief in a participant to perform a task, also known as self-efficacy [6]. Individuals with high self-efficacy towards a behavior are more motivated to complete that behavior than individuals with low self-efficacy. Health choices are dependent on self-efficacy [7].

One of the methodological approaches used to ensure effective gamification is to have a user-centered design. This design process captures the characteristics of the population for whom the system is being produced. The three projects presented in this paper used this approach with the aim of developing usable tools that are acceptable to the different target users.

A. The Rehab@Home Project

Rehab@Home is a closed European funded project that provides support for patients with physical conditions that require specialized exercise routines to support the rehabilitation process. Typically, Rehab@Home can be used by patients recovering from a stroke or a physical injury. It enables patients to conduct these specially designed exercises in their own home through the use of a game-like environment that uses a Microsoft Kinect to track movement and provide feedback to both the patient and the medical practitioner. This creates a potential win-win scenario in which both patient and clinician can achieve their objectives without the necessity for travel or the use of expensive rehabilitation centers.

The applications developed by Imaginary are designed not only to provide access to the personalized exercise routines, but also to provide a support and motivation mechanism to encourage long-term usage. The data collected by the Kinect application is made available to the rehabilitation specialist for the purpose of tracking progress and adjusting the exercise program based on patient progress.

B. The Pegaso Project

The Pegaso project addresses the global growth in obesity amongst young people, and aims to encourage more healthy eating and physical exercise, through the combination of wearable activity tracking devices to monitor physical activity and gamification strategies to educate and influence healthy eating practices. This mix of approaches is the basis for the pervasive game developed by Imaginary.

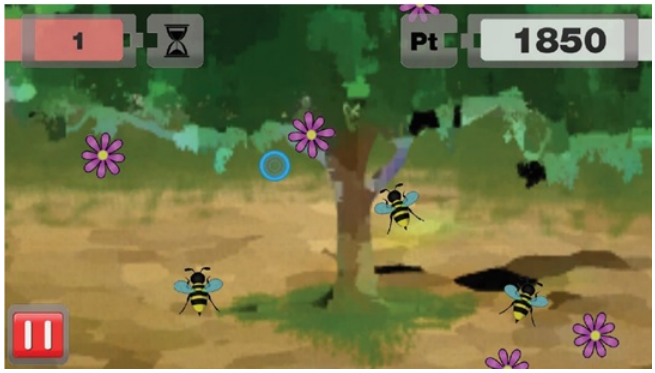

Fig. 1 One of the Rehab@Home games: Bees and Flowers

On a broader perspective, the Pegaso project seeks to explore and evaluate a range of novel mobile services, including a food diary, wearable sensors, companion messaging, and the use of gamification to stimulate and encourage sustainable lifestyle changes in adolescents aged 14-16, an age range frequently shown as critical in the formation of habits which persist into adult life [8]. Pegaso aims to explore how an integrative suite of components, able to measure, motivate, and recommend to users healthy challenges and choices, can be applied to impact their long-term lifestyle through shorter-term intervention during adolescence. Within such a context, games are seen as encouraging and rewarding positive behavior on a daily basis, as well as helping to facilitate them [9] [10].

Fig. 2 The Pegaso game: Zombies attack

C. The Doremi Project

The Doremi project is based on an active ageing framework, providing an effective therapy for older people by increasing physical, social nutritional and cognitive wellbeing, whilst encouraging autonomy and independence. Evidence suggests that preventative interventions such as

increasing physically activity, consuming a Mediterranean diet [11], completing cognitive training [12] and improving social support [13] may help to delay the onset of cognitive decline and slow down disease progression [14]. The Doremi project seeks to develop solutions to meet the challenge of the Ageing Society through the use of technology, gamification strategies and an understanding of the characteristics and influencers of older people. Within the Doremi project, Imaginary have developed a series of applications designed for tablet computers. These applications encourage physical and mental challenges and exercises which not only help to stimulate cognitive and physical activity but also provide valuable feedback data that can help clinicians monitor patient conditions and progress. The data collected has the potential to act as an early indicator of dementia which is important for making medical interventions that stabilize the condition.

Although the Doremi applications run on a tablet computer and are primarily mental exercises, they have been developed around a core of games psychology that also encourages physical exercise.

Fig. 3 The Doremi game: The dog visits Paris

III. Results

Rehab@Home. At the end of the pilot study of therapeutic effectiveness, 15 persons completed the whole treatment (someone dropped out of the study). 15 persons Post-stroke (N = 5) and with Multiple Sclerosis (N=10) finished all 12 sessions (mean age 58,73, SD 12,78). Results of the clinical evaluation before and after the 12 rehabilitation sessions showed that there was an improvement in functional abilities and fine hand use (Box and Block Test, Nine hole peg test). Further, evaluation of health perception (EQ 5D-5L) and the participants' perception of wellbeing (Short Form 12) revealed an improvement in those domains following rehabilitation with serious games. These results were corroborated by reduction in severity of impairment and activity limitations as classified through the ICF core set. In general, differences observed through the ICF core set following rehabilitation were small, but all showed improvements in the various domains. As an example, Exercise Tolerance increased enough to change the qualifier status, from very limited exercise tolerance to moderate impairment of exercise tolerance. Moreover, also fine use of hand was improved.

Overall, it could be concluded that the devices and games proposed to participants were positively accepted. The solution deployed in the assessment was very positively received by patients in terms of user experience and motivation to use, with the participants showing also improvements produced in terms of functional abilities of the treated arm/hand of patient and also regarding their perceived health status.

A patient feedback, a week after he finished the protocol: "I would do another 40 sessions if I could. I believe it helped me a lot!"

Pegaso. The game concept was presented to small focus groups of adolescents in Italy (n=10) and Spain (n=18). The group activities consisted of a presentation of the aesthetics of the design, along with an overview of planned mechanics, followed by moderated discussion of participant's views and ideas. Goals of this activity were to evaluate the acceptability of a mock-up prototype, collect initial feedback on usability, and evaluate aesthetical options. The outcomes were consolidated by moderators on each site into an agreed set of outcomes; an approach limited with respect to sample and conclusiveness of results, but one which provided some high-level insight into adolescents' reactions to the proposed design.

At the Italian site, participants were reported to respond positively to the idea and novel topic and setting, disconnected from the real-world objectives of a healthier lifestyle. They engaged with the design in detail, commenting their worry that searching for and combining foods during the day could be tedious when compared to action during the night, prompting adjustments towards shorter daytime cycles and increased daytime content. They confirmed that their perception of the game would be something to play in their "spare time", matching the context required for Pegaso. Avatar customization and personalization was a theme which strongly arose for one male, however the majority didn't feel a requirement for the avatar to match their gender. Italian participants also responded positively to the energy bar system, and were enthusiastic about physical activity being rewarded in a game scenario, suggesting it could be advantageous in making the game unique in their library.

The Spanish group also described the energy system as a unique and interesting feature. Several participants' initial perceptions suggested a confusion with the game's message, in particular that unhealthy eating resulted in the player becoming a "monster", demonstrating the important of identifying and designing solutions that avoid misconceptions at an early stage. Interestingly, they differed from the Italian group when seeking to reach a consensus on the aesthetic - the Italian participants lent towards a cartoon look for the game, and the Spanish participants towards a realistic aesthetic. Inferring meaning from such a finding is difficult given the limitations in scope and context of the studies, though it may be reflective of cultural difference.

Overall, the limited findings from these focus group activities show encouraging responses with respect to the energy mechanism and its use to promote engagement. Participants leaned towards a perception of the system as rewarding rather than punishing behaviors, suggesting initial promise towards the use of such mechanics in serious games.

Doremi. Eight focus groups (four in Italy and four in UK) were conducted as part of an iterative user-centered design process in the development of serious games and gamification to develop a usable and acceptable prototype of the application. Participants were recruited who suffer from normal or mild cognitive impairment as assessed by the mini mental state examination (MMSE) [15] or the Montreal Cognitive Assessment (MoCA) [16]. Each focus group involved a minimum of 4 and maximum of 8 people, of both genders, with an age between 65 and 80, as the target of the Doremi project. The eight focus groups were involved at different stages of the design process, with different purposes, according to prototype status: first of all, information on the experience of participants about games, games for health and motivation were elicited; themes which emerged were then presented in a gamified way; different games were tested to collect feedback both from the usability and acceptability point of view; finally, this feedback was used to improve the prototype.

At the end of this process, it was concluded that the iterative user-centered design is an effective technique for developing both games and a gamified environment. This approach of gathering information and preferences from an older population can result in a gamification model that the target participants feel comfortable with, can engage with and will motivate them to persevere during an autonomous intervention. Not all older people have the ability to interpret the graphical display of information and some prefer numbers (such as percent completion) rather than graphics alone. It was observed how older people with no previous experience with technological tools, such as a tablet computer, very quickly learned how to use these devices. However, with age-related visual decline [17] and manual dexterity [18] usability issues of interface designs need to be considered carefully. Successful gamification should use the three principles of: providing meaning to participants; enabling mastery to maintain flow; and ensuring autonomy so users can participate freely [19].

IV. CONCLUSIONS

This paper presented 3 very different projects which target 3 very different groups. What all these projects have in common is that they are designed to explore the combined potential of gamification strategies and consumer technologies to support improved health and wellbeing for all the target groups.

Since it is generally acknowledged that lifestyle behavior are very closely linked to both physical and mental health and the increasing cost of public health services in an ageing society, these projects have the potential to protect healthcare provision for future generations.

The Pegaso project emphasizes the importance of influencing exercise and eating behavior at an early age in order to prevent chronic and expensive conditions in later life whilst Rehab@Home clearly illustrates the benefits of consumer technologies and gamification for patient empowerment.

The Doremi project focuses on an age group in which physical and mental decline places an increasing burden on both public health services and on families. Doremi shows that whilst games are stereotypically associated with the younger generation, there are significant potential benefits and a general acceptance of games in the ageing population.

Finally, it should not be forgotten that all 3 projects do not seek to replace medical professionals in the long term future of public health services but rather create a new partnership relationship between citizens, patients, society and the medical profession in which vital lifestyle data creates better care and a greater understanding of best practices.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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