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Gamification in Social Networking

A Platform for People Living with Dementia and their Caregivers

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***Abstract*— In this paper, a gamified social platform designed for people living with Dementia (PLWD) and their caregivers is presented. This platform constitutes a support tool that strengthens self-care and builds community capacity and engagement at the point of care. Its architecture related to gamification aspects was designed to be flexible and scalable to support personalized services such as user monitoring, social networking, cognitive skills training and improvement of the adherence to treatment guidelines for PLWD and their caregivers. Advanced visual analytics and reporting tools are available for medical professionals and social workers to support the decision-making processes. The outcomes of this approach are delivered through a set of gamification concepts running in parallel to create motivation for achieving the desired behavioural change. After projecting all user group expectations on a social game canvas, the impact evaluation will assess the intended effects of the proposed gamification approach on the welfare on PLWD and their surroundings.**

Keywords- Dementia; Social Networking; Gamification; Cloud Platform; Caregivers; Interventions; Self-management.

I. INTRODUCTION

Gamification is about the application of game elements and mechanics in non-leisure contexts to engage and motivate people to achieve their goals [1]. On the other hand, gamification in online platforms, as a special application domain of Information and Communication Technologies (ICT), has not apparently a close similarity with dementia because the later includes memory or communication difficulties that could make several ICTs not easy to use. In addition, people living with dementia (PLWD) are mostly older, and could be unaccustomed in, or even scared of, using of such technologies. Even though all the above issues may be true, none of them should inhibit the progress and the utilization of ICTs in activities with PLWD.

A true challenge when designing gamified social networking services for PLWD and their caregivers -who may be at high risk of health conditions too- is the different motivational cues that those people may have. Considering the reduced capabilities of PLWD in adapting to the demands of the gamified online ICT platforms, it is also essential to maximize the adaptability of the related platform architectures [2]. The existing gamification approaches in the eHealth sector are focused mainly on creating motivation for younger populations, and most of them were designed to support physical exercise, not cognitive disorders.

The CAREGIVERPRO-MMD (C-MMD) is a gamified social networking platform designed to deliver accessible and highly personalized experiences through a set of intelligent services and applications. PLWD, their caregivers and the medical and social professionals can connect with each other improving the practices of care. In this context, the social platform is the place where user profiles are developed and social interactions between users are taking place. The designers of the gamified C-MMD platform considered the different motivational and inspirational quotes needed to satisfy the user needs in a shared social environment. Overall C-MMD proposes the use of an intelligent gamification-based motivational strategy to increase the: 1. participation of its users in the platform and 2. The consumption rate of its content (interventions). It is important for PLWD to receive immediate evidence of their active participation in the gamified social platform and to redeem their achievements (points collected, badges, privileges) into a higher social status in the C-MMD community.

II. RELATED WORK

Existing ICT solutions derived from research projects to support active and healthy ageing for PLWD include a variety of sensing components for user monitoring, analysis of collected data and a set of non-pharmaceutical interventions like notifications, alerts and Serious Games (SGs). For example, Briassouli et al. [3] used depth cameras (RGB-D sensors) and Internet-of-Things technologies in the context of Dem@Care project to make an umbrella of sensors in the living environments of PLWD in order to analyze their cognitive and behavioral status. Researchers in the PredictND project developed an early and evidence-based diagnostic model of neurodegenerative diseases using biomedical computer models to simulate the human brain and they combined information from several sources (clinical tests, imaging & blood samples) [4].

Other related online platforms, like the VPH-DARE@IT, were created to collect information from biomarkers and measures relevant for diagnostics to monitor the progression of dementia. Tools for differential diagnostics and a clinical decision-support component helped in disease modeling [5].

Similarly to C-MMD, the ICT4Life [6] and Doremi [7] projects created platforms to support healthcare for the early-stage cognitive impairment living alone by providing relevant knowledge of the patient status, create reminders, alerts and recommendations. The difference to the C-MMD

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is the fact that the sensing components of the other projects were made by a hard-sensing layer (depth cameras, bracelet/wristwatch) through a Wireless Sensor Network (WSN) at home environments. In addition, Doremi included exergames (physical exercise games) to stimulate the physical activity, social games on the online platform and training games for memory, language and attention. Another example of the use of SGs can be found on the FrailSafe project which developed a platform for real-life sensing of frailty, including cognitive frailty. FrailSafe developed a personalized Virtual Patient Model (VPM) for real-life sensing and used a virtual supermarket game as a non-pharmaceutical intervention [8].

But the sporadic use of training games is not considered enough to motivate people to participate into an eHealth platform and thus to achieve the wished behavioral change on users. For some user populations, like the elderly, the level of adherence decreases over time [9; 10] and this creates the need to create additional motivation. Most of the existing eHealth platforms explained earlier offered effective solutions, but did not adopted a clear strategy for creating motivation for user participation and loyalty.

Gamification can fit motivation patterns for most user groups -including the elderly- to maximize the use of eHealth technologies and the expected benefits. In this context, Gerling [11] indicate that gamification holds significant potential for elderly frail users, particularly in gamifying physical and cognitive therapy. Similarly, Link et al. [12] highlighted the effect game elements have on motivating the elderly. In general, it was found enough evidence on the literature to support that for PLWD and caregivers the gamification principles can provide a whole new world to perform and act.

There are also age differences in motives for playing [13]. Usually elderly people are attracted by the entertainment elements of the games and the well matching of the game to their lifestyle [14].

Other gamified platforms designed to support populations living with impairments, or the elderly and their caregivers, follow diverse architecture design approaches. However, they all share some commonalities like the decentralization of the medical and social information, advanced security, privacy and services on demand. The majority of these named "Health Behavior Change Games" [15], or simply "Health Games" [16] affecting the health behaviours of health care receivers [17]. Turning health communication or health behaviour change programs into games might thus be a good way to intrinsically motivate users to expose themselves to and continually engage with these programs [15; 18].

For cognitively impaired people who progressively lose their autonomy, like in C-MMD, a few solutions were structured around a dynamic integration of assistive services with their related sensing technologies and interaction devices [19]. But gamification approaches on social networking platforms were infrequently found for impairments related to cognition. Frutos-Pascual et al. [20] investigated the role of Game-based therapies on the improvement of cognitive and social skills of the elderly and Savulich et al. [21] suggested a "Brain Training" game to improve the memory of patients in the very earliest stages of dementia. But most of the above examples implemented platform architectures for delivering training game applications and not gamified social environments.

On the contrary, the gamified C-MMD platform deals with a wide range of user groups, and even wider activities from all aspects of everyday life. In addition, while some Active-Assisted Living (AAL) platforms introduced architectural components to integrate special hardware equipment, the sensing component of C-MMD is soft (eSurveys, behavioural scales, treatment interventions etc.) and thus, reducing complexity and enhancing extensibility and personalization.

III. THE GAMIFIED SOCIAL NETWORKING PLATFORM

C-MMD is an intelligent social platform, enhanced with gamification elements for PLWD and their live-in family or professional caregivers, integrating a broader diagnostic approach and interactive interventions. It implements all typical social networking features: friendship invitations, personal social networking, message posts, Likes, knowledge and materials sharing (photos, videos, and more). Moreover, some added-value features were inserted like the "gamification loop" according to which achieving a sub-goal triggers a reward system based on a point system [22; 23]. In this line, the expected user interactions depicting the wished behavior (loyalty, consistency to treatment, sociability) are linked to the sub-goals of the game to propel the gamification-loop. Fig. 1 depicts the four main layers of the C-MMD platform and their relations. Users can use various end-devices like PC and tablets to logon into the platform and draw their personal routes in a large informational space designed according to their needs. The user categories involved in the gamification lifecycle are:

- **Admins**: Gamification administrators who create and maintain gamification interventions ("Games"). Those can be IT personnel charged with providing platform management and/or medical and social personnel who design interventions.
- **Caregivers**: people who provide care to PLWD with their activities of daily living.
- **PLWD**: people living with dementia, separated into two subgroups with regards to the severity of their symptoms (mild and moderate).
- **Health and Social Professionals**: experts who work with PLWD and their families to provide care and assistance (doctors, nurses, psychologists, geriatrics, social workers and other specialists).

From the above user groups only PLWD and caregivers participate in the gamified environment as 'players', while others undertake administrative roles (set gamification objectives, create rules, monitor player's performance).

The gamification realization was made possible with the help of a Gamification Engine developed from scratch, a user modeling approach and some added-value gamification features like levels and performance reporting, as explained in the following sections in more detail.

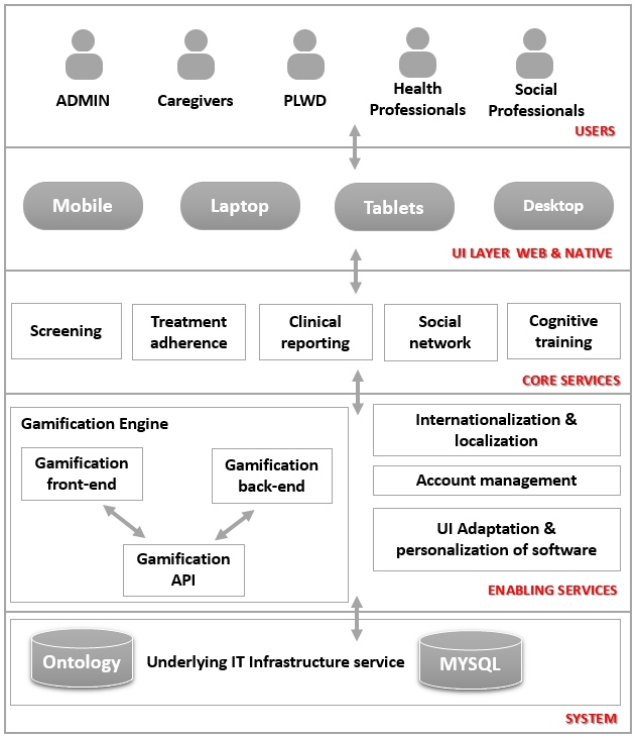

Figure 1. Overview of the gamified C-MMD platform

A. *Gamification Engine*

A custom-made gamification engine was used for the realization and the continuous support of the gamification proposals. This engine consists of the following three main components:

- The **back-end**, designed to perform low-level functionality regarding the lifecycle of a game, and the gamification interactions of users performed through the social platform.
- The **front-end**, used by the game-administrators to create new and maintain existing gamification proposals (set rules, award systems, gamification levels, etc.).
- The gamification **Application Programming Interface (API)** used for the integration of the social platform with the gamification component (Restful calls from the C-MMD platform to the gamification engine).

The C-MMD gamification engine consists of an *event detection mechanism* dedicated to capture all the interaction events users generate while interacting with the gamified social platform. The queue of registered interaction events (like button and hot area clicks, typing text, keyboard shortcuts and virtually any meaningful interface interaction) becomes the input to the *interaction data processing* mechanism which analyses user's behavior and detect progress made. Finally, the *gamification award system* is triggered as described by any typical Purposive Gamification Platform [24]. According to this schema, the gamification engine provides a coupled service applied on the social platform in order to transform the expected user behavior into game rules and thus to create motivation for participation. For example, socially active users who like to make new friends in the C-MMD virtual community and frequently post messages in the forums are rewarded by the gamification engine and later use those proofs (awards) to present to others a more appealing user profile. More detailed information on how gamification is applied on the wished user behavior is presented in the next sections.

B. *Adaptive User/Player Modeling*

Elements of the platform intelligence can be found in key-components like the advanced user modeling, the gamification, the personalization of contents and the adaptive user Interfaces (UI). Taking motivation by recent findings that personalized content adaptation can increase engagement in gameful activities [25], we proposed an adaptive user modeling approach to describe the user/player using a combination of demographics, medical and gamification-performance data. The players' current general interests are considered as well (self-reporting interests).

This multifactorial user modeling allows other platform components to trigger personal motivational cues. For example, personalized notifications and recommendations will ensure a better chance to be accepted by the users. Customization and personalization of interfaces could resolve accessibility issues and satisfy personal preferences. Similarly, gamification experiences, as well as other in-platform activities (training contents, non-pharmaceutical interventions, Serious Games) would be appeared more attractive to the platform end-users.

The adaptive user/player model allowed different approaches to motivate users based on social psychology and behavioral economics [26].

C. *Gamification of User's Behavior*

Typical gamification principles were applied in all user activities in the C-MMD platform leading to a holistic gamification approach. For PLWD this includes: 1) health screening processes (regular neuropsychological tests, health and depression diagnostics), 2) social networking activities like making friends, communication activities, likes etc., 3) treatment adherence surveillance, 4) participation in cognitive-training activities (implemented as SGs). For caregivers, who may face high level of stress and are at risk of depression, or have subjective memory complaints, the above gamification features are applied as well.

In general, the desired user behaviours lead to gamification achievements, but the undesired behaviors remained untouched according to the non-negative awarding system that was adopted at the early phases of the gamified platform design. Thus, acquired honors and awards are never removed from the personal achievements of lazy players. Instead of penalties, the gamified C-MMD platform utilizes positive motivations. It was highlighted by other studies that the application of gamification principles on elderly populations should be characterized by lesser player commitment, meaning that users will be allowed to leave and

return according to their will and without penalties or negative effects on their game status [27].

Similarly, the treatment adherence component in the gamified C-MMD platform will monitor the user's behaviour regarding the degree to which the user correctly follows medical advice and treatment plan, but a continual reinforcement to remind players of the consequences of their poor performance will never be used.

D. C-MMD Gamification Proposals

Currently there are two gamification initiations running in parallel for PLWD and their caregivers:

The "Social Collaboration" Game: Instead of handling users as separate entities, social games are aware of the "socially constructed presence" that the users of the platform create, and can further enhance their engagement and treatment adherence. Thus, the social gamification service focuses on an incentive scheme based on rewarding models (e.g. points earned by messages posting). This gamification proposal provides extra motivation for social interaction to platform users.

The "Treatment Adherence" Game: This gamification proposal was introduced to improve the degree to which users correctly follow medical advice and participate in cognitive-training interventions like the SG.

Those two games -as a set- implement the basic C-MMD platform user-engagement requirements: to offer motivation for participation, motivation for achieving even better treatment adherence results and for meeting personal development goals.

E. Multileveled Gamification Difficulty

Based on the Zone of Proximal Development (ZPD), proposed by Vygotsky [28] and adopted by recent researchers with an interest in games and gamification [25], we defined the difference between what a player can do without any help and what he or she cannot do. The ultimate purpose of our gamification approach was to maximize the size of the ZPD for new-coming and unexperienced players. In other words, we developed some gamification features to help PLWD and their caregivers to participate in gameful activities that otherwise would be very difficult to take part, or win others with equal chances.

Since there are no formal educational activities on how to participate in gamified social networks and the participation of the users is unsupervised, this help was provided by carefully designed 'gamification levels'. From a practical point of view, this approach is closely related to the scaffolding further developed in most recent studies [29]. According to this approach, an instructor provides aim to learners and as they gain more experience they remove or eliminate this aid as it becomes unnecessary. In our gamified environment, this scaffolding was implemented by a levels-management component which applied a stepped difficulty at each stage of user's matureness. As players gain more experience in the gamified networking environment, the level of difficulty to achieve the gamification goals becomes higher. The overall process was applied in a transparent way in order not to be noticed by the players. This way, the perceived difficulty of each player remains constant throughout the game lifecycle.

F. Personal Gamification Status Reporting

Users receive visual evidence of their participation in the gamified environment by two ways: 1) by little game-like UI components like small icons and hints which accompany their personal profile (total points, badges and other rewards previously achieved) throughout the C-MMD platform, or 2) with accessing their "personal gamification wall". The latter is a protected information space designed to offer a detailed graphical report of player's own performance (Fig. 2). This gamification report is used to receive notifications related to the gamification activity of users (who participate in the same games as you), to enter new 'games' (register your user profile in new gamification proposals), get notified on personal achievements like the number of points and badges earned (e.g. you are the "Player of the Month") and leaderboards (e.g. you are in the top 10 players in your category). Those gamification features are based on gold-standard theories like the self-monitoring, dialog support and competition [23; 30].

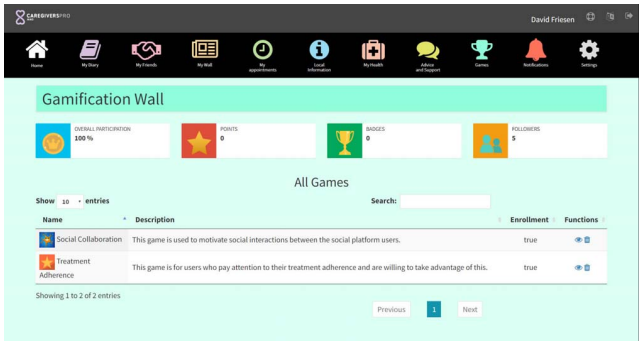

Figure 2. User gamification wall and reward indicators

G. Medical and Social Status Reporting

The results of the behavioural data analysis are being reported using an advanced visual analytics tool. Fig. 3 presents a screenshot as an example of this tool. Medical and social professionals use their own user accounts to enter the reporting screen and to monitor the progress made by the users (PLWD & caregivers) they are responsible for. Information visualization principles are used for the design of the interactive visual interfaces to deal with the size and the complexity of the available data with the purpose to support decision making made by the responsible medical and social professionals.

The reporting component can handle data related to the user's models (demographics & status), health history and user monitoring within a certain period of time, user performance on the gamified social environment and the perceived performance on the received cognitive training interventions (e.g. memory-training games). In addition, adapted screen-views and visualization components can help medical and social professionals to partially examine the

available information and to make comparisons between users' data.

Visualization components include standard bar-charts, timeseries, heatmaps, radar-graphs and other combinational types of graphs. Those components smartly share the available screen size depending on the characteristics of the end-device (tablet, PC). The reporting tool is customizable not only to the screen size but also to the interests of the professionals. Thus, a social worker may give emphasis on the personal social network development of the users he/she is responsible for, while a medical professional may create a view to monitor the recent results of the neuropsychological assessment.

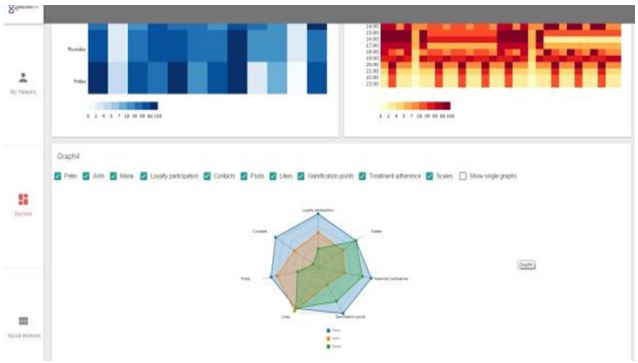

Figure 3. Medical and social professionals can access the reporting service through their user accounts in order to check the current status of the users they take care of (PLWD & caregivers at risk).

IV. CONCLUSIONS

In this paper, we have presented the concept and the major architectural components of the gamified C-MMD platform and specifically the gamification services. Our approach provides an intelligent social gamified platform promoting the quality of life, well-being and medication compliance for PLWD and their caregivers. The main objective is to assist and develop a mutual assistance community related to dementia across Europe.

Our gamification approach was based on the Vygotsky's [28] Zone of Proximal Development (ZPD) and side theories like the scaffolding, the need for self-monitoring and the effect of social presence on user's behaviour (like competition).

The forthcoming evaluation of the C-MMD gamified platform, to be piloted in France, Italy, Spain and UK, will provide to the gamification designers valuable input. Moreover, in our short-term future plans PLWD and caregivers will be able to access the medical and social reporting tool to examine their own information (personal history) and their performance in relation to the average performance of other users (of the same category). Performance comparison indicators include average values to critical variables like the average gamification points, average treatment adherence performance, rhythm of intervention's consumption, player's loyalty, etc.

Overall, gamification design for special user categories like the PLWD and their caregvers is an ongoing research field and as Marache-Francisco and Brangier [23] conclude, gamification can become a crucial factor for successful human-technology relationship.

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