D2.2.1
Game Mechanics & Intelligence

Work package	**WP2 Emotional & Psychosocial Serious Game Framework**
Task	**T2.2 Game Mechanics & Intelligence**
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Project PLAYTIME

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Contents

1 Executive Summary

Serious games rely on game mechanics, the mechanical features of game play, to address discrete andragogical/pedagogical objectives. With respect to developing serious games for people with dementia and caregivers, the theory-driven design of game mechanics is no different. MBY has defined andragogical/pedagogical goals for the person with dementia and caregiver serious games as has FAM for the training games. With respect to the person with dementia and caregiver serious games, these have been mapped to game mechanics via the LM-GM model to ensure that the resulting game design explicitly addresses the intended learning objectives (Arnab et al., 2015). In particular, and as MBY is focused on integrating emotional and psychosocial aspects of caregiving a theory-driven conceptual approach is necessary. Accordingly, the serious game is intended to stimulate intrinsic experimental learning through antecedent-behaviour-consequences-approach, when caregivers' attitude to their role, care-recipients and care consequences can be modified by disclosed interlinks between caregivers actions and burden determinants. Game mechanics are then applied with this framework in mind.

Yet, MBY game design has been developed firstly with the caregiver in mind. Moreover, this has been validated with several focus groups of caregivers and clinical expert interviews. In turn, feedback from clinical experts such as GGZ and end users - through the first field study - will provide valuable input to identify if game mechanics should be uniquely adapted for people with dementia.

Artificial intelligence components will also be implemented in PLAYTIME to achieve personalisation and enhance user motivation and engagement, as described in additional detail in D2.2.1 and D3.4.1 (Bakkes, Tan, & Pisan, 2012). This is described in the current report also as MBY intends to personalise game mechanics with its artificial intelligence engine. Aligned with the perspective described above, feedback from GGZ and end users will provide important insights into usability and satisfaction of the initial prototype of the person with dementia serious game alongside additional caregiver input.

2 Introduction

Serious game mechanics (GMs) are defined as *"the design decision that concretely realizes the transition of a learning practice/goal into a mechanical element of gameplay for the sole purpose of play and fun"* (Arnab et al., 2015). Serious GMs rely not only on learning approaches and andragogical/pedagogical principles but also on validity of presentation methods. Therefore, it is important to define clearly in which way different game elements can facilitate the learning process. Related to this, the purpose of task 2.1 is to explore and describe the optimal game mechanics of the individual serious games within the PLAYTIME suite, with a focus on achieving the intended andragogical/pedagogical objectives. Moreover, the use of artificial intelligence elements to facilitate the achievement of the intended andragogical/pedagogical objectives is also explored.

3 Game mechanics

3.1 Caregiver & person with dementia serious game

3.1.1 Conceptual framework

While suddenly adding the role of caregiver to one's role as partner, child, sibling, which already implies quite the burden, caregiver's also see their family member becoming less and less the person they know. It is difficult and support is required to empower caregivers to embrace their new role and changing relationship with their loved one. The objective of this tool is to enhance caregivers' sense of competence, or self-efficacy, (via improving coping skills) of informal caregivers of loved ones with dementia.

Behavioral modifications are possible through reinforcement when authentic and realistic tasks are used. Interventions based on this approach demonstrate antecedents of an issue, behaviors to solve this issue and consequences of these behaviors and repeat this circle until learners realize interlinks between these antecedents, behaviors and consequences. Therefore, this approach is also known as an ABC-approach and may simulate real and complex issues with multiple interlinks, which is consistent with informal caregivers of people with dementia (Houts, Nezu, Nezu, & Bucher, 1996).

The game is intended to stimulate intrinsic experimental learning through ABC-approach, when caregivers' attitude to their role, care-recipients and care consequences can be modified by disclosed interlinks between caregivers actions and burden determinants. Moreover, ABC-approach is also assumed to possess psychotherapeutic capacity because of similarities to problem-solving training, a derivative of cognitive-behavioral therapy. This kind of therapy helps to find and alter interlinks between maladaptive thinking and behavior on the individual level. Although the game can hardly reflect exact personal experience, it can still help caregivers to find solutions for their personal situations by addressing common issues with ambiguous solutions, which stimulate thinking and ability to find creative decisions in real life.

3.1.2 Andragogical/pedagogical objectives

To achieve the higher-level objectives of reducing caregiver burden and enhancing coping skills of informal caregivers, a number of andragogical/pedagogical objectives were defined. These objectives are directly linked with the following key content topics: (1) functional independence of person with dementia, (2) social functioning and support from others, (3) dealing with stress, (4) family relationships, (5) motivation towards healthcare, (6) self-efficacy (7) respect towards person with dementia, and (8) caregiver's health.

3.1.3 Application of game mechanics

Game mechanics were mapped to learning mechanics, consistent with the LM-GM approach described by Arnab et al. (Arnab et al., 2015). The learning mechanics were also linked directly

to the andragogical/pedagogical objectives described previously. The LMs and GMs are defined alongside the implementation in the current version in Table 1.

Table 1. Game mechanics, learning mechanics, and implementation in current caregiver serious game.

–	**Game mechanics**	**Learning mechanics**	**Implementation**	**Usage**
1	*Information*	*Instructional*	*Text box*	*To explain gameplay*
2	*Role play*	*Simulation*	*Reality related story*	*To align with reality for better immersion*
3	*Story*	*Demonstration*	*Real life scenarios*	*To disclose a problem*
4	*Question & Answer*	*Question & Answer*	*Three different solutions reflecting coping strategies*	*To give a choice for people with different beliefs and understanding*
5	*Action points*	*Immediate feedback*	*Intuitively readable bar chart dashboard*	*To explore easily consequences of a certain solution*
6	*Resource management*	*Repetition*	*Three logically connected scenarios for each problem and three tips during play to improve results*	*To trail multiple contingencies in order to find a better way to cope*
7	*Information*	*Cognitive feedback*	*A short medical view on the issues*	*To explain some underlying interdependences*

3.2 Player

The front end of the PLAYTIME system is closely related to the player and the multimodal training platform attached to it. The player as well as the MTP will be developed on the basis of Cordova (Phonegap before) which is a framework that enables to develop apps on a basis of standard web technologies like java script, HTML5 and CSS3 and to employ them on various operating systems (actually at least 11 operating systems are covered) in this way. It is assumed that there will be a very simplified user interaction based on touch display. The GUI will be designed in a barrier-free way including easy readable and usable displays. The individual major components, such as, the socio-emotional, the motion related component, are accessed via APIs and then are capable to either provide data, background or even frontend services, the latter being interactive applets that are "played" in the foreground.

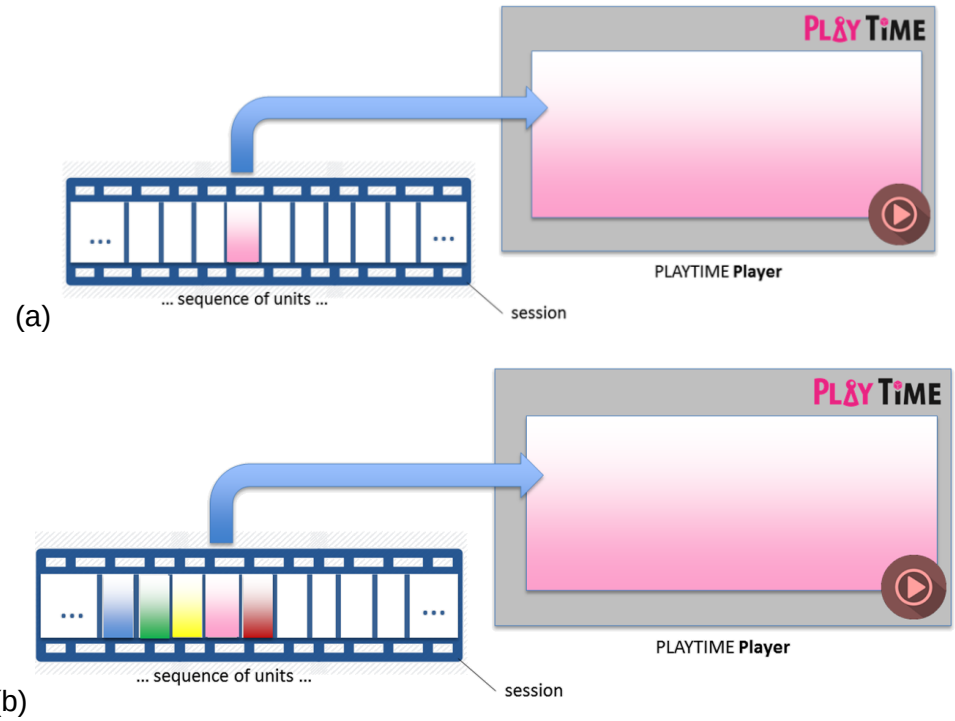

Figure 1. Player major function. (a) The PLAYIME player is operating on a sequence of units that the "sequencer" has defined before. (b) These units can originate from various other components, such as, the multimodal training component (pink), the attention unit (yellow), etc. Loading these units means running an applet that provides interaction opportunities that are specific to this unit. In this manner, the player remains "transparent" to various novel implementation ideas and any multimodal training session.

Figure depicts the key idea of this function: (a) The PLAYIME player is operating on a sequence of units that the "sequencer" has defined before. (b) These units can originate from various other components, such as, the multimodal training component (pink), the attention unit (yellow), etc. Loading these units means running an applet that provides interaction opportunities that are specific to this unit. In this manner, the player remains "transparent" to various novel implementation ideas and any multimodal training session.

4 Artificial intelligence

4.1 Conceptual Framework

Artificial intelligence components ensure that users receive personalised content, which is believed to enhance motivation and engagement (Bakkes et al., 2012). As this content is not only personalised in a fixed manner, but is dynamic and based on real-time system statuses (via multimodal analytics and in-game decisions) it has the potential to systematically immerse users. AI algorithms are particularly focused on achieving maximal engagement by challenging users at the appropriate and optimal level (e.g. not too challenging or too easy). These AI components are further described, with a focus on the player in which they are implemented.

4.2 Caregiver & person with dementia serious game

As MBY is focused on achieving learning objectives and realizing behaviour change through the use of educational software, it has incorporated psychosocial factors and their link to clinical outcomes into its serious game system. This is absolutely necessary to ensure that the environment and evolving narratives created within serious games reflect reality and provide users with the most realistic simulations – maximizing engagement and motivation. Through the integration of psychosocial determinants and their relationships with clinical outcomes, MBY pushes scenario-based simulations closer towards reality. This means that results of user decisions on stakeholders' states and relationships, including clinical outcomes, are also more accurate. MBY believes its serious games have a greater potential for realizing behaviour change because they incorporate the link between psychosocial determinants and outcomes (clinical and psychosocial) in a realistic environment. As the interdependencies resulting from this on emotional, disease state, and relational parameters are complex and large, AI is needed to compute the equilibrium that results from stakeholder decisions.

In particular, an AI engine is implemented in the caregiver & person with dementia serious game to maintain an understanding of relevant emotional, psychosocial, and disease parameters in real time. In turn, this allows for personalization of serious game content (scenarios, visuals, etc.) to the baseline situation and the evolving statuses in the game (e.g. dynamic change based on real-time user decisions). The AI engine also allows for customization of serious game content based on diagnostic information collected by other players, such as gaze and emotional psychophysiological measurements. The integration and interfacing with other analytics is further explored in PLAYTIME task 3.4.1.

4.3 Recommender

Recommender systems have recently obtained great success as an intelligent information system (Adomavicius & Tuzhilin, 2005). Content-based filtering approaches utilize a series of discrete characteristics of an item to recommend items with similar properties. In recent years, contexts, tags and social information have taken recommender systems (Ricci et al., 2011) into

account. Personality aspects were recently considered to personalize recommendations and enhance both recommendation quality and user experience (Nunes, 2009; HU & Pu, 2010). An important aspect of recommender systems is the sequential, long-term aspect of interaction and learning of recommendation strategies (Shani et al., 2005). The system learns the optimal strategy autonomously by observing the consequences of its actions on the users and also on the final outcome of the recommendation session (Mahmood & Ricci, 2007).

PLAYTIME will particularly focus on the analysis of correlations in the data streams of the diagnostic toolbox and derive rules for the recommendation of useful exercises, such as, cognitive training or physical activities.

In particular, the recommender engine will be applied to control the difficulty level of the cognitive tasks in an adaptive way. Furthermore, JRD will implement a simple model of human motivation and analyse emotional and performance related parameters.

5 Conclusions and Outlook

As serious game mechanics are inherently linked with the overarching andragogical/pedagogical objectives, it is necessary for game designers to first define high-level objectives before establishing game design features to realize these factors (Arnab et al., 2015). To achieve this, MBY utilizes a theory-drive approach, defined as the LM-GM model, to map game mechanics to learning objectives. Although MBY has previously validated its serious game for caregivers, including game mechanics, with end users and clinical experts, it will receive additional input in the PLAYTIME project from end users in the first field trial. This is especially important for the prototype serious game for people with dementia, which has not been validated previously. Information obtained in the pilot trial will be used to iteratively refine game mechanics and other game design features covered in D2.2.1 and 2.4.1.

With the particular focus on emotional and psychosocial aspects of dementia, as it relates to caregivers and people with dementia, MBY is also developing an artificial intelligence engine to personalise the user experience through aspects such as game mechanics. Personalisation has been described as an important driver of user engagement and motivation. Therefore, this is an important factor in the success of PLAYTIME. This AI engine will interface with emotional and multimodal analytics applied in PLAYTIME, which is described in additional detail in D3.4.1. FAM has also implemented a recommender engine based on artificial intelligence algorithms, which will be used to recommend personalised content. This is further explored in D2.3.1.

6 Glossary

Table 1. *Glossary.*

Notion	Description
Game mechanic	*"the design decision that concretely realizes the transition of a learning practice/goal into a mechanical element of gameplay for the sole purpose of play and fun"* (Arnab et al., 2015)

7 Abbreviations

Table 2. *Abbreviations.*

Abbreviation	Description
GM	Game mechanic
LM	Learning mechanic

8 Bibliography

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