DESIGNING E-LEARNING ACTIVITIES FOR SENIOR LEARNERS BASED ON CORE DRIVE ANALYSIS USING THE OCTALYSIS GAMIFICATION FRAMEWORK: RESULTS FROM THE EPA-COACH PROJECT

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Abstract

The electronic Personal Health Record (PHR) is a patient-centric information management tool which allows the patient to maintain their own digital records with medical diagnoses, medication plans, vaccination, and other patient-related data. An adequate use of the PHR requires a set of competencies from the general use of digital technologies to the management of digital medical records according to regulations in a national healthcare system. Specific learner groups, including less digitally competent populations and older adults, may need specific support in learning how to use PHR and managing their own medical records. This paper presents the design of e-learning activities for senior learners as part of an e-learning application developed in the ePA-Coach project founded by the German Ministry of Research and Education. The design of the e-learning activities aims to support senior learners in acquiring competencies needed for a self-determined use of PHP in the context of the German healthcare system. The design of the e-learning activities is based on the core drive analysis using the Octalysis gamification framework and focusing on the eight core drives for human motivation. The paper presents the initial and the new design of e-learning activities based on the evaluation results from a study with 41 adults, from 65 to 93 years old. The paper describes how the initial design of the e-learning activities was derived from the Octalysis framework and how it was further adapted based on the evaluation results. The evaluation results showed that some core drives and gamification elements derived from the Octalysis framework were poorly rated by the learners in this age group. The paper outlines a range of learning design decisions which were taken based on the evaluation results and led to redesigning e-learning activities in the ePA-Coach application.

Keywords: Personal Health Record (PHR), e-learning, senior learners, gamification, Octalysis.

1 INTRODUCTION

The electronic Personal Health Record (PHR) is a patient-centric information management tool which allows the patients to maintain their own digital records with medical diagnoses, medication plans, vaccination, and other patient-related data. PHRs allow patients to view upcoming and past doctor appointments, review test/lab results, upload and manage medical records. Having and using an own PHR can benefit patients of all ages and is especially valuable to older adults who may be managing different health issues and conditions [1]. The implementation of PHR has become one of the central objectives of digitization policies in European countries, including Germany. Despite legislation (e. g. Act for Secure Digital Communication and Applications in the Health Sector from 2015, Germany still lags behind the implementation of the electronic PHR (German: elektronische Patientenakte, ePA) compared to other European countries [2]. While the introduction of PHR in different countries aims to make processes in national healthcare systems more efficient and transparent, there are still barriers to the adoption of PHR including concerns about privacy, security, insufficient measures for impaired people to manage their online health records and issues related to the usability of PHR applications [1][3][4]. Studies focusing on the usability issues of PHR revealed that the most challenging tasks were navigating PHR applications, making appointments, finding lab results, and interpreting instructions for taking medications [3]. Previous studies have also shown that the use of the PHR requires a set of competencies ranging from the general capability to use digital technologies to the specific skills in the management of digital medical records according to regulations of a national healthcare system [5].

Specific learner groups, including less digitally competent populations and/or older adults, may need extra support in learning how to use PHR applications and manage their own medical records. For example, the study by [6] evaluated the ability of middle-aged adults (40-59 years) and older adults (60-85 years) to perform common health management tasks, such as medication management, review and interpretation of lab results, and health maintenance activities, and showed that the participants in both

age groups experienced significant difficulties in using a simulated PHR. The study data also revealed that using the simulated PHR was especially difficult for older adults with lower numeracy skills and less technology experience [6]. This and further studies pointed out the necessity to meet the individual needs of specific populations such as older adults when designing and deploying PHRs. For example, the study by [5] showed that computer literacy is one of the key factors influencing how effectively patients are able to use their PHR. Additionally, age-related changes in cognitive abilities, such as working memory, processing speed and reasoning, may affect the ability to perform more complex PHR tasks by older adults, e. g. retrieving specific information from the PHR and interpreting lab results [6]. Since digital skills and experience in using the Internet and digital technologies matter [6], it is necessary to ensure that older adults are given an opportunity to acquire competencies necessary for a self-determined use of PHR. Learning about and how to use PHR is important to ensure acceptance, adoption and effective use of the service by older adults. From a societal perspective it is also important that older adults acquire necessary competencies for the PHR use in order to reduce the gap between those who are able to use PHR and those who are not [5][6].

This paper presents the design of e-learning activities for senior learners as part of an e-learning application developed in the ePA-Coach project founded by the German Ministry of Research and Education. The ePA-Coach project addresses the challenge of informational autonomy and digital sovereignty of senior citizens and aims to develop a coaching-based e-learning application for older adults to enhance their digital literacy as an enabler for an effective use of the electronic PHR. The ePA-Coach project defines digital literacy beyond the basic understanding of information technologies and encompasses competencies needed to exercise informational self-determination regarding the storage, transmission, and processing of personal health data [7]. The design of e-learning activities aims to support senior learners in acquiring competencies needed for a self-determined use of PHR in the context of the German healthcare system. The design is informed by the Octalysis gamification framework and its core drives for human motivation. Gamification design and research has been primarily tethered to the needs of younger populations, while neglecting the potential of gamification to enhance motivation among other groups including older adults [8]. As shown in previous studies, key factors that motivate older adults to play digital games include socializing, leisure time, social interaction, entertainment, maintaining physical and mental activity [9]. The ePA-Coach e-learning application aims to support older adults in learning how to navigate and manage their PHR in an engaging and motivating way. The Octalysis framework designed by [10] has been used in the ePA-Coach project to support learning designers in creating engaging learning experiences by focusing on the eight core drives, i. e. Epic Meaning & Calling, Development & Accomplishment, Empowerment of Creativity & Feedback, Ownership & Possession, Social Influence & Relatedness, Scarcity & Impatience, Unpredictability & Curiosity, Loss & Avoidance [10]. The design of e-learning activities utilizes common game techniques from the Octalysis framework, such as progress, levels, tasks, instant feedback, unlocking milestones, and mentorship [10].

The paper presents the initial and the new design of e-learning activities based on the evaluation results from a study with 41 adults, from 65 to 93 years old. The paper describes how the initial design of e-learning activities was derived from the Octalysis framework and how it was further adapted based on the evaluation results. The reminder of this paper is structured as follows. Following this introduction we present the methodology with the focus on the Octalysis framework including background information on the model and the application in the design of e-learning activities. Next, we present the initial design of e-learning activities, the evaluation results and the adaptation of e-learning activities based on the evaluation results. The paper ends with conclusions related to the application of the Octalysis framework to the design of e-learning activities for senior learners aimed at enhancing digital literacy of older adults as a prerequisite for a self-determined use of the PHR. Finally, we formulate recommendations for further research in the application of Octalysis for older adults.

2 METHODOLOGY

The design of the e-learning activities aims to support senior learners in acquiring competencies needed for a self-determined use of PHR in the context of the German healthcare system. The design of the e-learning activities is based on the core drive analysis using the Octalysis gamification framework [10]. This framework is used to support designers in creating engaging experiences by focusing on the eight core drives for human motivation. The ePA-Coach e-learning application aims to support older adults in learning how to operate their own PHR in a self-determined way by providing an engaging learning experience based on the eight motivational drives specified in the Octalysis framework. The design of the e-learning activities in ePA-Coach utilizes a range of game techniques proposed in the Octalysis

framework, e.g. progress, levels, tasks, instant feedback, unlocking milestones, mentorship. In addition to the motivational core drives defined in the Octalysis framework, users/learners can be divided into player types. For example, the Gamification User Types Hexad Scale by [12], divides player types into Philanthropists (motivated by purpose), Socializers (motivated by relatedness), Free Spirits (motivated by autonomy), Achievers (motivated by competence), Players (motivated by extrinsic rewards), and Disruptors (motivated by triggering changes).

2.1 Background

Octalysis is a framework for gamification, which is the use of game design elements in non-game contexts, in order to engage and motivate people [15]. The Octalysis framework was developed by Yu-kai Chou [10] and is based on the idea that there are eight core drives which motivate people to take action. The Octalysis framework is visualized as an octagon (Fig. 1). The drives on the left side of the octagon have a tendency for extrinsic motivation. After completing a task, one expects some kind of reward. The drives on the left side tend to lead to intrinsic motivation. The activity itself is the reward. On the other hand, the octagon can also be divided into an upper and a lower section. The upper area contains motivators that tend to raise a positive feeling, while the lower area contains drives, which are motivating by fear of losing something or not knowing what will happen next. The upper drives are called white, the lower black hat gamification drives. The Octalysis framework suggests that effective gamification design should include one or more of these core drives in order to motivate people to perform desired actions. If none of the core drives is reflected in the design, motivation will be low and/or no activity will happen. The eight core drives in the Octalysis framework are shown in more detail in Table 1 below.

Table 1. Core drives in the Octalysis framework [10].

	Octalysis Core Drive (CD)	***Description***	***Related game techniques (examples)***
1	Epic Meaning & Calling	The drive to do something that is meaningful and fulfilling, that makes a positive impact on the world.	Narrative Higher Meaning Beginner's Luck
2	Development & Accomplishment	The drive to learn and grow, and to accomplish goals and tasks.	Achievements Progress Bar Step-by-Step Tutorial
3	Empowerment of Creativity & Feedback	The drive to express oneself and to receive feedback on one's creations.	Milestone Unlock Instant Feedback Choice Perception
4	Ownership & Possession	The drive to acquire and possess things, and to feel a sense of ownership over them.	Avatar Learning Curve Virtual Goods
5	Social Influence & Relatedness	The drive to connect with others and to be influenced by them, and to feel a sense of belonging and social connection.	Social Prod Thank-you Economy Mentorship
6	Scarcity & Impatience	The drive to act quickly in order to acquire or achieve something that is limited or time-sensitive.	Fixed Intervals Countdown Throttles
7	Unpredictability & Curiosity	The drive to seek out new and novel experiences, and to be surprised and engaged by the unknown.	MiniQuests Random Rewards Mischief
8	Loss & Avoidance	The drive to avoid negative outcomes or to prevent the loss of something that one values.	Progress Loss Weep Tune Sunk-Cost Tragedy

2.2 ePA-Coach Application

The ePA-Coach e-learning application is divided into five main chapters called ePA-Coach competences. Each of these chapters include several micro-learning units based on different subjects within this competence. Those learning units differ in their difficulty level and are therefore split up into Beginner, Advanced and Expert units (Tab. 2). Advanced and expert units can only be selected after the respective previous difficulty level has been fully completed. Beginner units explain the content in a more theoretical way while the advanced and expert units use click dummies to demonstrate learning content in a more practical way. In advanced units, learners are given a practical task they should solve with a click dummy. Initially learners receive much support with a step-to-step explanation, and this support is progressively reduced with every following task according to the scaffolding principle. The final expert unit within each competence area describes scenarios where the learner must use what she/he learned in all previous units within the competence area and accomplish tasks within the click dummy without any additional help.

Table 2. Competence levels in the ePA-Coach e-learning application

	Difficulty level in 1 of 5 competences in ePA-Coach e-learning application		
	Beginner	***Advanced***	***Expert***
Complexity Level	Low, basic and easy tasks	Higher, clearly defined tasks	Highest, best practices for tasks
Autonomy Level	Independent, with guidance if needed	Independent, with minimum guidance	Guiding others, adapting to others' needs
Cognitive Level	Remember	Understand and apply	Apply

Since it is almost impossible to create something that pleases and motivates all learners equally, it is important to adapt the intensity of each core drive from the Octalysis framework to the desired target group [10]. The ePA-Coach e-learning application aims to support older adults in learning how to use PHR, so the first design step was to find out which core drives are most effective for senior learners.

In the first phase of the ePA-Coach project a base gamification model was conceptualized (Fig. 1). The base model was created using an extensive literature review, the guidelines from the Octalysis framework and data from a survey with experts from the project partner organizations. The analysis led to a model which has a significant tendency for intrinsic motivation on the right side of the octagon and just white hat gamification (Fig. 1). The base model is described in more detail by [13]. A follow-up evaluation with 41 older adults between 66 and 93 years asked about prior experience with digital games and learning applications, motivation in relation to the eight core drives of the Octalysis framework [10] and player types according to the hexad scale [12]. The results are described in [8].

3 RESULTS

Based on the initial gamification model [14] and the evaluation results with 41 older adults [8], an enhanced gamification model with adjusted and extended e-learning activities was developed. With regards to the motivational aspects, recommendations for improvement of the model were derived and were considered in further design iterations in the ePA-Coach project. The adjustments in the enhanced model of gamification are described in more detail in the sections below.

3.1 Adjustment of the Octalysis Core Drives

The evaluated base model of gamification took into account the assessment of the Octalysis core drives with regard to learning motivation, the assessment of the individual gamification elements and the classification of player types. Based on the findings from the analysis, the levels of the individual core drives were re-rated by the design team. The results showed that *Epic Meaning & Calling* was no longer the main core drive. The score of the core drive *Empowerment* was increased and *Ownership & Possession* was added as a new core drive as the first evaluation showed strong correlations to Development & Accomplishment as well as to the game technique Mentorship. However, this was only

done in a light form to prevent the proportion of values in extrinsic motivation from becoming too high. Table 3 shows the results of the first evaluation.

Table 3: Mapping of the mean values from the first evaluation into the Octalysis Framework.

	Octalysis Core Drive (CD)	*Old CD score before evaluation*	*New CD score after evaluation*
1	Epic Meaning & Calling	9	5
2	Development & Accomplishment	8	7
3	Empowerment of Creativity & Feedback	7	8
4	Ownership & Possession	0	2
5	Social Influence & Relatedness	8	7
6	Scarcity & Impatience	0	0
7	Unpredictability & Curiosity	0	0
8	Loss & Avoidance	0	0

Yu-kai Chou, developer of the Octalysis Framework, provides the Octalysis Tool as an online application [11]. After entering the individual values of the core drives, the model is visualized and feedback is provided by the Octalysis Tool. Entering the new values from Table 3 into the Octalysis Tool resulted in the following feedback:

*"Your experience is heavily focused on White Hat Core Drives, which means **users feel great and empowered**. The drawback is that users do not have a sense of urgency to commit the desired actions. Think about implementing light Black Hat Techniques to add a bit more thrill to the experience."*

This feedback was taken into consideration at the design of e-learning activities. However, the design team decided not to include the recommendation related to implementing Black Hat Techniques since the core drives 6 to 8 were perceived as less motivating by the older adults who participated in the first evaluation [8].

3.2 Focus on Player Types

For the final score of the Octalysis Core Drives the player types assessed by the senior learners in the first evaluation described in [8] were considered. These are based on the Gamification User Types Hexad Scale [12]. Statements for each player type from the HEXAD Gamification User Types Questionnaire by [13] were rated by study participants. The results showed that the intrinsically motivated player types (Free Spirit, Socializer and Philanthropist) received the highest ratings. Therefore the focus of design was put on these player types. This was also in line with the findings of [13], which showed that intrinsic values become more important with increasing age.

3.3 Adjustments to Game Techniques

Based on the previous results, the next step was to revise the game techniques used in the ePA-Coach model. The following sections provide an overview of the adapted elements. Afterwards, the implementation of these elements in the ePA-Coach application will be explained.

3.3.1 Overview

To ensure that the game techniques correspond to the ratings of the target group and the respective score of the Octalysis core drives, some game techniques were removed and some new added to the model. An overview of the modified techniques is shown in Table 4.

Table 4: Overview of the modified gamification techniques

	Octalysis Core Drive (CD)	*Score*	*Game technique* *(+) added (-) removed*
1	Epic Meaning & Calling	5	(-) Narrative (+) Narrative light (short scenarios)
2	Development & Accomplishment	7	Progress View Levels (-) Puzzles & Quizzes (+) Achievements
3	Empowerment of Creativity & Feedback	8	Tasks Instant Feedback Unlock Milestones (+) Poison Picker / Choice Perception
4	Ownership & Possession	2	(+) Avatar
5	Social Influence & Relatedness	7	Mentorship (+) Exchange of experience

The adapted Octalysis model with the modified core drives and the respective game techniques is shown in Figure 1. With more weight to the right, the new model keeps being driven by intrinsic motivation, just like the previous base model described in [8].

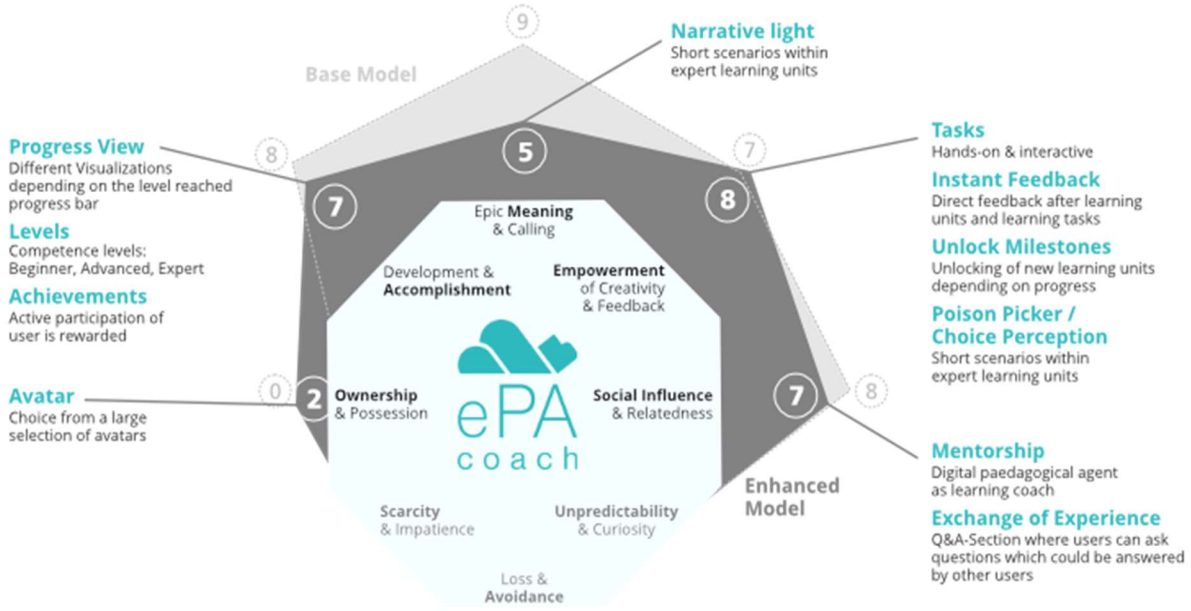

Figure 1. ePA-Coach enhanced gamification model

3.3.2 Implementation of Game Techniques

After the Core Drives were re-rated and game techniques in the Octalysis model were redesigned or adapted. Changes were implemented in the ePA-Coach application in the following way:

Progress View and Levels – The ePA-Coach application is divided into five competence areas with learning units, which are divided into three levels (beginner, intermediate and expert). Progress View shows personal learning progress in respective competence areas.

Narrative light – A narrative was originally intended to take place in the core drive *Epic Meaning & Calling* in the form of a large frame story "The Search for the Golden File". Due to negative evaluations

by the target audience, this drive was significantly reduced. With the narrative light, storytelling now only takes place in the form of short scenario stories which help learners solve tasks in expert learning units.

Puzzles and Quizzes were removed due to the negative rating in the evaluation.

Tasks – Thematic learning units contain various learning tasks to consolidate and monitor learning progress. In advanced units, tasks must be solved with the help of a click dummy and with decreasing support, and in the expert learning units independently through knowledge transfer and short stories.

Instant Feedback – When completing learning units and learning tasks, users receive direct feedback so that they can obtain information on their learning progress and any difficulties they may encounter.

Unlock Milestones – Learning tasks within the competences are divided into three achievable level. To unlock the next higher level, the learning units of the current level must first be completed.

Poison Picker / Choice Perception – Learners are free to choose which institution they would like to go to and thus which learning content they would like to work on next. There is no "better choice“, and alternatives are of equal value. This implementation corresponds to the *Free Spirit* player type, too.

Avatar – As described in the previous chapter, the core drive *Ownership & Possession* has been added to the gamification model. It was implemented with the game technique user avatar, since [16] indicated positive attitudes of older adults towards avatars. Learners are thus able to choose their avatar from a large selection. The avatar is displayed in their profile, in exchange with the learning coach, and within the questions & answers area.

Mentorship – Users of the ePA-Coach application always have a digital pedagogical agent available as a learning coach. The agent is AI-based and responds to questions via written input.

Exchange of experience – This game technique is implemented as a questions & answers area. Here, learners can ask questions about the ePA-Coach or the ePA, which are to be answered primarily by other learners. The forum is facilitated by the project team. Active participation is rewarded with the game technique **Achievements** and the evaluation of answers. The forum is meant to support consolidation of knowledge and knowledge transfer. This forum also corresponds to the player types *Socializer* and *Philanthropist*, which are characterized by the willingness to help others.

3.4 Results from the second evaluation

The second evaluation aimed to determine the extent to which the target group was able to effectively use the ePA-Coach e-learning platform and the associated e-learning units. The second evaluation report included results from questions related to gamification and motivational approaches in the ePA-Coach project. The evaluation started in June 2022 and ran until the end of October 2022, resulting in a total of 262 participants, of which only 46 completed all three parts of the evaluation, i. e. the initial questionnaire, the learning part and the exit questionnaire. Participants were randomly selected and ranged in age from 65 to 88. The gender distribution was relatively balanced, with 25 male and 21 female participants. Until the start of the second evaluation, only a part of the planned e-learning units at beginner and advanced levels were created in the platform. The beginner learning units can be completed with final learning assessments designed as one-choice or multiple-choice quizzes. Further learning assessments include practical tasks with the help of click dummies.

The questionnaire was implemented using the REDCap tool. Questions about demographic aspects, such as age, gender and the highest level of education, but also previous experience with electronic devices such as cell phones, tablets or laptops and the ePA, were asked in the initial test. Results and evaluations about learning units during the use of the ePA-Coach, perceptions of applied gamification elements, usability of the learning platform and learning progress were asked in the exit test. The items were rated on a 7-point Likert scale, ranging from 1 to 7, with 7 = “I completely agree” and 1 = “I absolutely disagree”. Scored values were recorded as +3 (= “I completely agree”) to -3 (= “I absolutely disagree”). The data analysis was performed with IBM SPSS using descriptive methods such as means (M) and standard deviations (SD). Table 5 visualizes the results.

Table 5: Results from the exit questionnaire (means and standard deviations)

Octalysis Core Drives	***Element***	***Item***	***M***	***SD***

Development & Accomplishment	Progress bar	The progress bar was very useful for me.	1.17	1.71
	Steps & Levels	The division of the learning content into different levels (beginner, advanced) was very useful.	1.01	1.7
Empowerment	Instant feedback	The immediate feedback through the program in the learning units on my answers was very useful.	1.56	1.64
	Unlock milestones	I would find it very motivating to be able to unlock more learning units.	1.00	1.56
	Practical tasks	The hands-on tasks (e.g. with the ePA click dummy) in the learning units were very useful.	0.79	1.81
Ownership & Possession	User avatar	The user avatar was very useful for me.	-0.91	1.82
	Action reward	I would find it very motivating if more user avatars are unlocked as a reward.	-1.37	1.65
Epic Meaning & Calling	Narrative	I would find it very motivating if the ePA used an exciting story for better visualization.	-0.47	1.99
Unpredictability	Election awareness	I would find it very motivating to have the choice of multiple learning units.	1.00	1.57
Social Influence & Relatedness	Mentor	The digital learning support was very useful for me.	0.74	1.87
	Online status	I would find it very motivating to be able to see how many and, if applicable, which other users are currently online.	-1.33	1.82
	Friendship	I would find it very motivating if I could add my acquaintances and friends from real life as digital friends in the ePA-Coach learning platform and thus see my friends' learning progress, for example.	-1.65	1.57
	Experience sharing	I would find it very motivating if I could exchange ideas with other users on the ePA-Coach learning platform and, for example, provide support with the learning tasks.	-0.93	1.87

Figure 2 below additionally visualizes which aspects were considered by the participants of the study to be particularly important or less important. In particular, the elements included from the Octalysis core drives *Development & Accomplishment* and *Empowerment*, reached highest scores. Looking at the Octalysis core drive *Social Influence*, only the digital learning support scored positively. The other aspects, such as online status, friendship and experience sharing, tended to play a less important role for study participants. The core drive *Ownership & Possession* received a lower rating, with the user avatar almost triggering an indifference but being rated with a slight negative weighting (M = - 0.91).

Unlocking further user avatars turned out to be the element with the second lowest rating, after online friendships. The single best rated element was direct feedback after completion of a learning unit with a mean score of 1.56. Surprisingly, the relatively low value for practical tasks (M = 0.79) was the second least important of the positively evaluated items, after the digital learning support (M = 0.74).

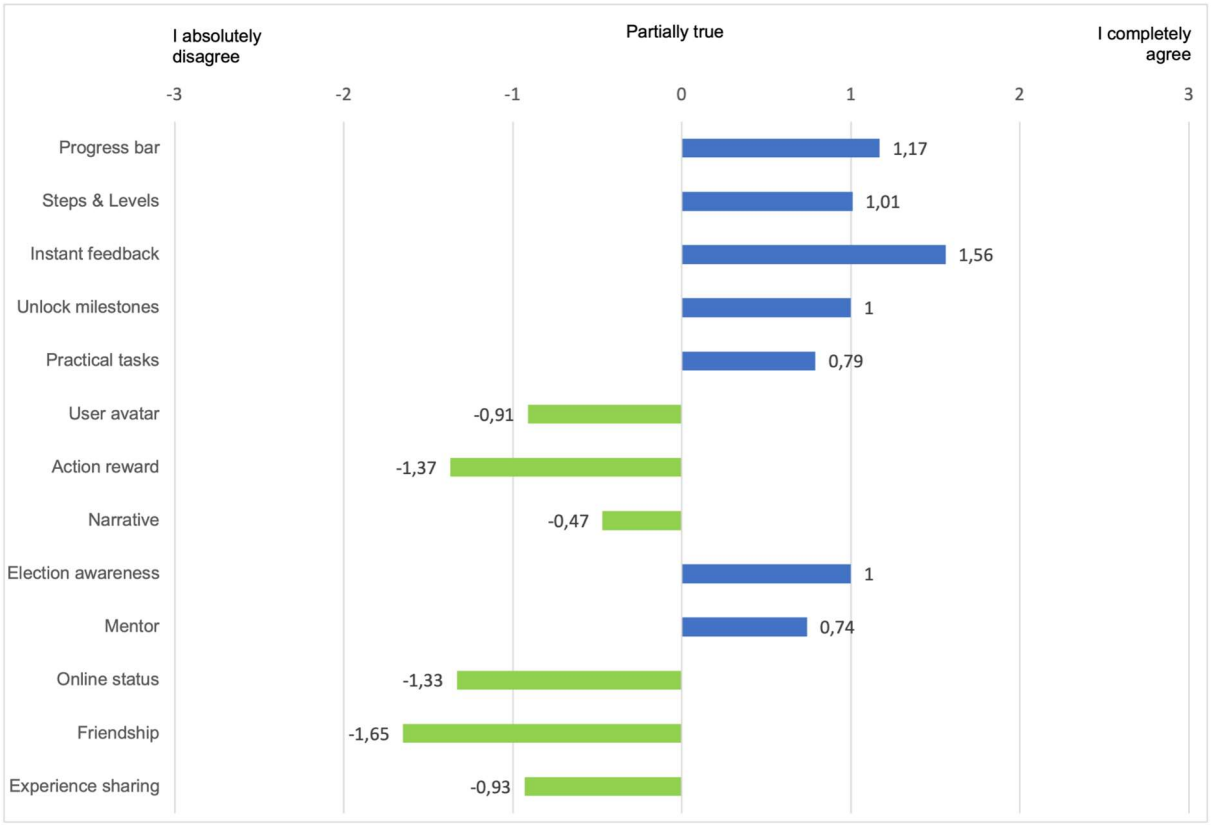

Figure 2: Mean value of the ratings of the different gamification elements.

4 CONCLUSIONS

The conclusions from the second evaluation in the ePA-Coach project help to further optimize the learning platform with e-learning activities, which is planned to be evaluated in its final state after the last design iteration. Based on the evaluation results, more learning units will be created to cover more competencies. Furthermore, in addition to beginner and advanced levels, there will also be expert levels, with the scenario based tasks implemented as a *narrative light* concept. Additionally, the questions and answers area will be implemented to address the game technique *exchange of experience.* This new gamification approach is also relevant for the core drive *social Influence* which was previously negatively rated by the target group but could possibly enhance learning of senior learners on the learning e-platform ePA-Coach. Further research in gamification for older adults in the context of PHR should include larger samples and explore in more detail which core drives and corresponding game techniques are most effective for enhancing the motivation of senior learners for acquiring the necessary skills for a self-determined use of electronic personal health records.

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