The Relationships between Different Forms of Gamification and User Experience: A Study in the Context of Elderly Well-being Applications

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Abstract

Aging society is a global challenge. With its persuasive and engaging advantages, gamification is perceived as a potential approach to promote well-being for the elderly. This research seeks to address two extant caveats in the field. Firstly, there is a dearth of research investigating what types of gamification design may differently give rise to a variety of user experiences. Secondly, there is a paucity of research investigating gamification in the context of well-being for the elderly as unexpected audiences of game-based applications. Therefore, this study explores the relationships between gamification design types and the elderly's user experience (i.e., comfort, engagement, stimulation, dependability, perspicuity, novelty, sociality, and immersion) in the context of health applications using an offline experiment (N = 372). The results show that achievement-oriented gamification had a significantly positive association with engagement, dependability, novelty, and stimulation; social-oriented gamification had significantly positive association with all the dimensions of user experience except for perspicuity and immersion; and immersion-oriented gamification had a significantly positively association with comfort, immersion, engagement, novelty and stimulation.

Keywords: Gamification, elderly, mobile application, gameful experience, health

1. Introduction

Gamification refers to the transformation of different services, practices, products, and systems towards being more game-like, i.e., enabling them to provide similar positive experiences as games do, and consequently, to have a positive effect of sustainable practices (Hamari, 2019), and has been widely used in the field of health among others. By applying different features and design of games such as points, badges, levels, stories, avatars, competitions, collaboration, to name a few, into health systems and services, gamification has been believed to help users effectively maintain and develop self-health management and lifestyle through game-like experiences (Johnson et al., 2016; Lister et al., 2014; Koivisto & Hamari, 2019). There is still a consensus but biased view that gamification is more engaging and attractive for younger people (Koivisto & Malik, 2020) which can be seen in the majority of gamified health practices. With the popularization of information technology, the current aging population has been observed to have a relatively high technology acceptance (AARP, 2019; UNECN, 2021). Gamification is gradually considered to increase the enjoyment of the health system, quantify health management goals, make the health system easier to understand, and motivate and engage the elderly, so as to improve their well-being through technology. There are also some gamified health systems designed for the elderly on the market, such as MemoRide, AARP Games, and SilverSneakers GO. However, practitioners are still concerned about the effectiveness of gamification, as the limited practical evidence does not tell to what extent gamification brings what kinds of experiences to the elderly when using gamified health services.

Similarly, in the academic literature, there are relatively fewer studies in the gamification field related to the elderly than to other user groups. Due to the convenience of collecting samples from young users and the high availability of existing research materials such as gamified health systems/services, the majority of extant studies have not considered the needs of the elderly. Previous studies have proven that age is an apparent factor that affects user technology needs, as well as the ways that they use technology (Czaja & Lee,

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2009). In gamification research, Koivisto and Hamari (2014) have also confirmed that age could significantly affect users' perceptions of benefit that promotes technology use. But there is numerous evidence that generational digital gaps exist (Wang & Cheng, 2021). The effect of gamification on target behavior depends on the gaming experience created by the gamification service (Huotari & Hamari, 2017). Therefore, conducting an in-depth investigation into the elderly's perceptions and experiences can deepen our understanding regarding the age-related boundary conditions of gamification. Moreover, previous studies on gamified health management have mainly examined specific gamification elements and mechanics, or have regarded gamification as a whole to explore its impact. It is still unclear how different types and forms of gamification (e.g., immersion-oriented, social-oriented, and achievement-oriented) (Xi & Hamari, 2019; Koivisto & Hamari, 2019; Bitrián et al., 2020) would influence user experience, and especially the elderly's experiences (Damaševičius et al., 2023). Therefore, we propose the following research question: How do elderly users perceive gamified health services? To be more specific – what kinds of user experience do the different gamification forms bring to elderly users?

To answer the above question, based on the classification of gamification in previous literature, this study explores the impact mechanism of three types of gamification (achievement-oriented, social-oriented, immersion-oriented) on the experiences of the elderly, based on a between-subjects experiment. Participants (age ≥ 55) were recruited from China and randomly assigned to one of the four interactive vignette interfaces (achievement, immersion, social -oriented, and control (a version of the application without gamification)) of a gamified health application. In total, 372 valid samples were used for the data analysis.

2. Literature review

2.1. Gamification in health management

Gamification can be regarded as a form of persuasive or motivating design. The broad definition of gamification is about making reality more gameful, and consequently affecting user behavior and cognitive processes in a positive way (Hamari, 2019). The commonly used gamification elements or mechanics include badges, points, levels, leaderboards, cooperation, competition, and storytelling, among other things (Hamari et al., 2014; Koivisto & Hamari, 2019). Based on game mechanics and game-designed motivations (Yee, 2006), gamification elements or mechanics were divided into three main categories, namely, achievement-oriented gamification, social-oriented gamification, and immersion-oriented gamification (Xi & Hamari, 2019; Koivisto & Hamari, 2019, Bitrián et al., 2020). Achievement-oriented gamification is characterized by a challenge and aims to make players feel more accomplished, which includes elements such as badges, points, and levels (Hamari & Eranti, 2011; Xi & Hamari, 2019; Xi & Hamari, 2020). Social-oriented gamification is mainly used to facilitate social interaction among users, such as social networking features, cooperation, and competition (Bayuk & Altobello, 2019; Xi & Hamari, 2019; Xi & Hamari, 2020). Immersion-oriented gamification primarily aims to engage and immerse players in self-directed and exploratory activities (Xi & Hamari, 2019; Xi & Hamari, 2020), such as customization, storytelling, and role-play.

Previous literature has proved that gamification can promote user motivation, engagement, and health behavior change in the field of health (Alahaivala & Oinas-Kukkonen, 2016; Hamari & Koivisto, 2015; Johnson et al., 2016; Yin et al., 2022). However, previous studies have mainly focused on young adults (Koivisto & Malik, 2020). As the global aging problem becomes more and more serious, researchers have begun to explore the applications of gamification in the elderly, and the differential effects brought on by age (Koivisto & Hamari, 2014; Martinho et al., 2020). However, in a review of gamification for the elderly, Koivisto and Malik (2020) found that although most gamification applications can increase physical activity, balancing ability, or learning performance, these effects were weak or even non-existent. In addition, the existing studies mostly focused on the examination of gamification's impact on health behavior, and how gamification affects elderly users is still a black box. Thus, as Koivisto and Hamari (2019) proposed, it is crucial to assess the effectiveness of gamification from the user's perspective, which can be measured by user experience.

2.2. Gamification and user experience

A good user experience can increase users' satisfaction, participation and continuous use intention to gamified health applications, and promote the achievement of goals (Yin et al., 2022). In accordance with the definition of user experience provided by Gentile et al., (2007), in this study, we define user experience of gamification as the overall experience of gamification design perceived by users when interacting with the gamification applications, including their rational, emotional, sensorial, physical, and spiritual perception.

Regarding research on the dimensions of user experience in gamification, a few studies focus on the

perspective of the game-like experience (such as challenge, accomplishment, and playfulness) generated by gamification (Hassan et al., 2020; Högberg et al., 2019; Wallius et al., 2023; Xi et al., 2023), Other studies focus on general user experiences, such as enjoyment (Suh et al., 2017), aesthetic experience (Suh et al., 2017), perceived usefulness, and ease of use (Huang et al., 2019; Wang et al., 2021). However, these studies only consider one or several aspects of user experience, and lack a comprehensive understanding of the mechanism of gamification. Also, most studies only focus on positive perception variables related to the gamification experience, without measuring users' negative perceptions which shouldn't be ignored (Koivisto & Hamari, 2019). Therefore, this study uses a semantic difference scale to holistically measure user experience by integrating both the gameful elements and the general system user experience.

In research on the relationship between gamification and user experience, gamification is generally considered as a whole concept. For example, Hassan et al. (2019) examined how gamification, as an independent variable, impacts users' emotional, social, and informational experiences. Furthermore, gamification studies usually regard progress and achievement-oriented gamification (i.e., points, badges, and leaderboards), or enumerate several commonly used elements as gamification (Koivisto & Hamari, 2019; Putz et al., 2020). Thus, the consideration of how different gamification elements affect user experience is still limited.

Although several studies have been concerned with the impact of different gamification elements such as badges, avatars and points (Hamari, 2017; Sailer et al., 2017), most of them have only selected a single or minimal feature of gamification elements to explore the impact on user experience (Xi & Hamari, 2019). Considering that different categories of elements satisfy users' internal needs through different mechanisms (Xi & Hamari, 2019), understanding the impact of different gamification elements on user experience can also help to verify the effectiveness of gamification design mechanisms (Yin et al. 2022). Subsequently, existing research has an insufficient understanding of the underlying mechanisms of action, and a limited understanding of specific game mechanics and design elements for promoting health behaviors (Damaševičius et al. 2023). Therefore, it is critical to explore the impact of different types of gamification elements on the elderly experience in health.

3. Research method

3.1. Design

We conducted a between-subjects design vignette experiment related to a gamified health application. Four conditions (achievement-oriented gamification, social-oriented gamification, immersion-oriented gamification, and control condition) that describe the scenario of exercise were designed. Corresponding to each condition, we designed the prototype of an interactive interface of a health application through a design platform. Compared with the control condition, participants could see the result of exercise steps in a gamified way in three gamified conditions (see section 3.2 for more details). Participants (age ≥ 55) were recruited (see section 3.4 for more details) and were randomly assigned to one of four conditions where they were required to interact with the application interfaces (see section 3.5 for more details). This study adheres to the research ethics guidelines formulated by the Ethics Committee of Hefei University of Technology.

3.2. Materials

The experimental scenario is that the participants recently uses a smartwatch to monitor their physical condition, and they can see detailed exercise results in a health application connected to the smartwatch. After the exercise, the participants can view their exercise information of the day, such as the number of steps, exercise distance, and heart rate. They can also click the "Daily" or "Weekly" button to view their past daily and weekly steps. This is the control condition as shown in Figure 1.

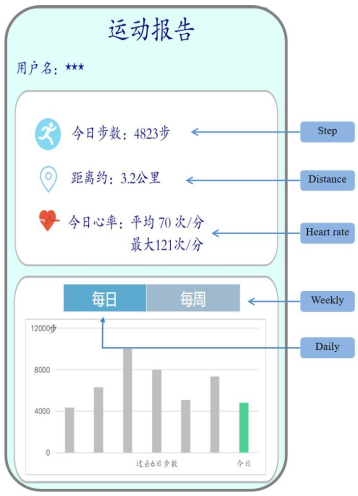
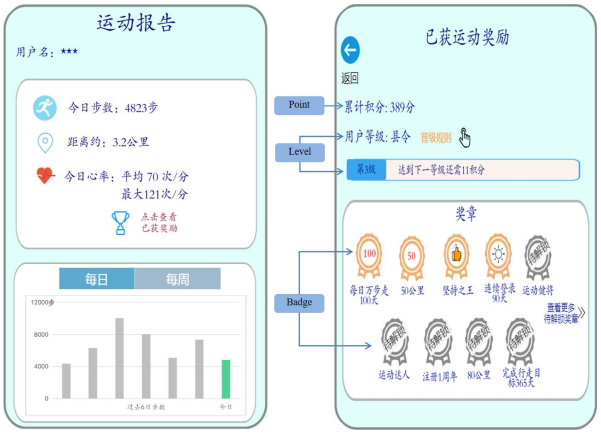


Figure 1. Health service interface without gamification

Based on the control group, the results of exercise steps were also displayed employing gamification elements in the experimental conditions. Three interfaces of a health application (i.e., achievement, social, immersion relative condition) were designed to represent different ways to gamify exercise results.

3.2.1. Achievement-oriented health service gamification. The achievement-oriented condition provides individual exercise steps feedback and information through achievement gamification elements (i.e., levels, points, and badges) (Figure 2). Points can be obtained according to the number of daily exercise steps. When a certain number of points is obtained, the participants can be promoted to a higher level, such as county magistrate, governor, or count, which are set at 27 levels according to the official positions in ancient China. In addition, by completing the goals in stages, participants can also get badges such as "walking 10,000 steps a day for 100 days", "50 kilometers", and "King of persistence".

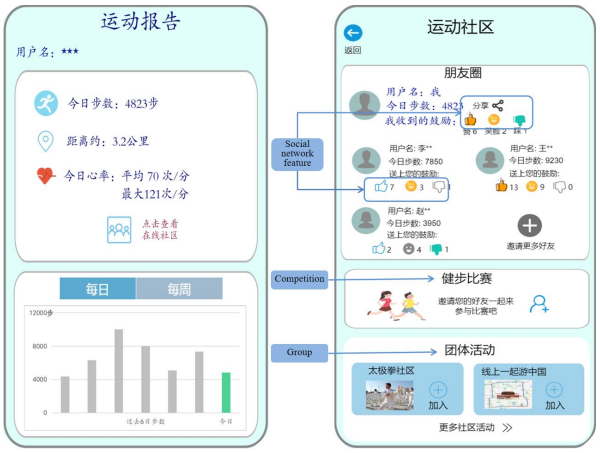


(a) (b)

Figure 2. Health service interface with achievement-oriented gamification

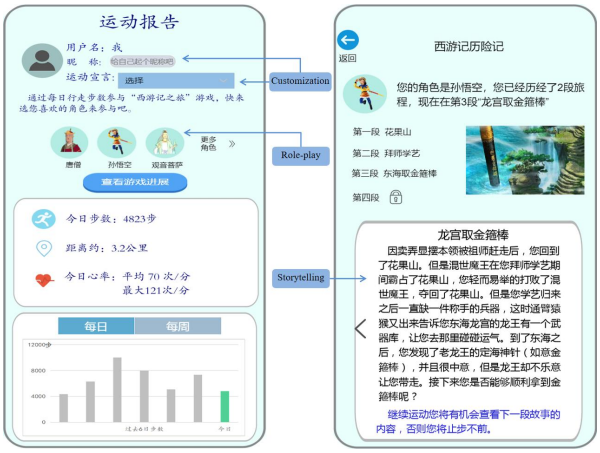
3.2.2. Social-oriented health services gamification. The social-oriented condition connects exercise steps with gamification elements which contain social network features, competition and teams (Figure 3). The participants can share their exercise results with friends through the share button, and send emoticons to cheer and encourage each other. To motivate the participants to take more steps, they can invite friends to participate in the competition and strive to win. In addition, the participants can also join a team with other people online to participate in group activities such as a Tai Chi community, travel to China together online, and achieve the goal of exercising steps with other team members.

3.2.3. Immersion-oriented health services gamification. The immersion-oriented condition also contains three gamification elements (i.e., customization, storytelling, and role-play) (Figure 4). The participants can experience more immersive activities, such as designing a personalized nickname for themselves, and choosing a sports manifesto according to preferences. In addition, the participants can also choose a role to participate in the game Journey to the West, and then they will participate in the game in this role. Each day, the journey proceeds according to the participants' exercise steps. The more steps the participants complete, the more stories the role could experience, and otherwise, the role will stay in the current segment of the journey.



(a) (b)

Figure 3. Health service interface with social-oriented gamification



(a) (b)

Figure 4. Health service interface with immersion-oriented gamification

3.3. Measurement

In general, 30 semantic differential items were chosen to measure user experience on a seven-point scale (-3 to +3). Among these items, 22 are adapted from the User Experience Questionnaire (UEQ) of Laugwitz et al. (2008) and 8 are adapted from the

Gameful Experience Questionnaire (GEQ) of Högberg et al. (2019). We used UEQ based on the following points. First, the UEQ contains 6 dimensions of user experience, is used for measuring software products, and it has been translated into many languages, including Chinese. It is comprehensive and effective. Second, compared with young people, the elderly may have more negative experiences (e.g., technology anxiety) with information systems (Wong et al., 2022). The semantic difference scale uses opposites to measure the user's positive and negative feelings, and can more accurately measure the experience tendencies of the elderly. In addition, the semantic differential scale is usually used to explore consumer perceptions of different products or brands, which is in line with our research aim of examining the differences in users' experience of different types of gamification. Since the context of the study is gamified health applications which are not aimed at completing tasks quickly or improving efficiency, this study did not consider the efficiency dimension. Thus, the remaining 22 pairs of adjectives from the UEQ scale measuring the other 5 dimensions were selected in this study.

We used GEQ based on the following points. First, to comprehensively consider user experience of the gamified health applications, GEQ is used to measure game-like experience (e.g., challenges, achievements, immersion), which is not contained in the UEQ. Second, though several studies have explored games and gamification-related experiences (Eppmann et al., 2018; Poels et al., 2007), Högberg et al. (2019) have a more comprehensive classification of the gamification experience. Therefore, we chose another 8 pairs of adjectives adapted from the GEQ semantic scale. The 8 pairs of adjectives are as follows: accomplished - unaccomplished (Högberg et al., 2019), challenging - undemanding (Dupont et al., 2019; Högberg et al., 2019), competitive - uncompetitive (with oneself) (Högberg et al., 2019; Veral & Macías, 2019), guided - unguided (Högberg et al., 2019), immersed – detached (Högberg et al., 2019), playful - unplayful (Högberg et al., 2019), connected (to others) – disconnected, and social interactive - not social interactive (Dupont et al., 2019; Poels et al., 2007; Veral & Macías, 2019).

3.4. Participants

The subjects of the experiment were the elderly (age ≥ 55). Participants were recruited from community centers, nursing homes and senior colleges. The age of our sample was restricted to 55 years old or above because the average retirement age in China is 55 (People.cn., 2015). Survey data was collected from April to May 2023 in China. A total of 419 questionnaires were collected. After eliminating 47 questionnaires that were incomplete or invalid, 372 valid questionnaires remained, with an effective rate of 88.78%. Among the participants, 179 were male and 193 were female. The largest age group was 55-59 years (128, 34.4%), followed by 60-64 years (98, 26.3%), 65-69 years (75, 20.2%), 70-74 years (52, 14.0%), and the 75 years and above age group (19, 5.1%). Considering the education levels, 104 participants had completed primary school or below, and the rest were 129 from secondary school, 79 from high school or vocational school, 34 held an associate degree, 17 had a bachelor's degree, and another 9 had a master's degree or above. For developing the dimensions of user experience, 60 samples were used for exploratory factor analysis, see section 4.2).

3.5. Procedure

The experiment was conducted in an offline environment. Two master students and one doctoral student assisted in the experiment as assistants. To ensure that assistants can follow a unified process to guide the participants to participate in the experiment, they trained before the experiment. The assistants helped participants who found it inconvenient to read. Each participant read the experimental material using the same model of tablet computer and spent approximately 30 minutes on the experiment.

First, participants were told the purpose of the experiment and signed a consent form. Second, after completing pretest questions such as their game and exercise habits, they were randomly assigned to one of the four scenarios. Third, the participants were asked to read the materials of the scenario and interact with the interface corresponding to the scenario. Fourth, the participants were asked to answer a series of questions related to manipulation checks to ensure the success of the operation. Then participants needed to complete a post-test survey to determine their experience with the ways exercise information was presented in the health application during interaction with the interface. Finally, each participant was paid 15 RMB after completing the experiment.

4. Results

4.1. Manipulation check

To verify the validity of the manipulative variables of gamification forms in the experiment, this study conducted a pilot test with 36 participants. Respondents were asked to evaluate the extent of perceived gamification forms. Based on the research by Bayuk and Altobello (2019) and Xi and Hamari

(2020), three items were developed to verify the manipulation for gamification forms: 1) Achievement relative gamification: The health application can increase my sense of accomplishment, 2) Social relative gamification: The health application can enhance my sense of social interaction and cooperation, and 3) Immersion relative gamification: The health application can immerse me in self-directed inquisitive activity. A 7-point scale was used to rate the items. In the achievement-oriented condition, the item for achievement gamification had the highest scores (M = 4.58). In the social-oriented condition, the item for social gamification had the highest scores (M = 4.75). In the immersion-oriented condition, the scores for immersion gamification had the highest scores (M = 4.42).

4.2. Exploratory factor analysis

Before testing the reliability and validity of the data, exploratory factor analysis (EFA) was carried out on the dimension of gamification experience by using principal component analysis. The first 15 valid samples from each condition (A total of 60 samples) were selected for EFA.

The Kaiser-Meyer-Olkin value is 0.742, and based on Bartlett's test of sphericity, the p-value of the chi-square test statistic is less than the significance level of 0.001. Thus, it is suitable for factor analysis. After removing three items (i.e., bad - good, not valuable - valuable, and does not meet expectations - meets expectations) with commonalities lower than 0.6, the communalities of most variables are greater than 0.7, indicating that the variables can be well expressed by common factors. The overall variance explained rate was 78.853%. indicating that the factor model can better explain the overall variance of the observed variables. The final extracted 8 dimensions of user experience, items, and common factors are shown in Table 1.

Table 1. Dimensions of user experience (EFA results)

Construct	Item	Factor loading
Comfort: A feeling of being relaxed or pleasing (Schrepp et al., 2017)	Unpleasant - Pleasant	0.819
	Unattractive - Attractive	0.797
	Annoying - Enjoyable	0.723
	Unlikable - Pleasing	0.717
	Unfriendly - Friendly	0.666
Dependability: The quality of being able to be trusted, controlled, or expected (Schrepp et al., 2017)	Unpredictable - Predictable	0.920
	Obstructive - Supportive	0.872
	Not secure - Secure	0.834
	Unguided - Guided	0.759
Novelty: The innovative and creative degree of the system (Schrepp et al., 2017)	Dull - Creative	0.828
	Usual - Leading edge	0.771
	Conservative - Innovative	0.749
Perspicuity: The ease with which the user is familiar with, learns or understands the system (Schrepp et al., 2017)	Conventional - Inventive	0.734
	Not understandable - Understandable	0.866
	Difficult to learn - Easy to learn	0.838
	Confusing - Clear	0.832
	Complicated - Easy	0.825
Engagement: Feelings of positivity, fulfilment, passion, energy, or enthusiasm (So et al., 2014)	Unaccomplished - Accomplished	0.786
	Demotivating - Motivating	0.731
	Undemanding - Challenging	0.714
	Uncompetitive - Competitive (with oneself)	0.712
Stimulation: The degree of making someone excited and interested (Schrepp et al., 2017)	Boring - Exciting	0.845
	Not interesting - Interesting	0.735
	Unplayful - Playful	0.724
Sociality: The degree to which individuals interact and enjoy being with each other (Poels et al., 2007)	Not social interactive - Social interactive	0.902
	Disconnected - Connected (to others)	0.843
Immersion: The state of being engrossed and absorbed in an experience (Högberg et al., 2019)	Detached - Immersed	0.804

4.3. Measurement model

Based on the EFA results in section 4.2, in total 312 samples were used for the measurement model (confirmatory factor analysis) and structural model analysis. Each factor loading of the items with the underlying constructs is greater than 0.7. The Cronbach's alpha value ranged from 0.821 to 0.900, indicating a high level of reliability (Nunnally, 1978). The composite reliability exceeds the acceptable threshold of 0.7 (Hair et al., 1992), which means that all items demonstrate sufficient internal reliability. Moreover, the average variance extracted (AVE) values exceed 0.547, which is considered acceptable according to the convergent validity criteria proposed by Fornell and Larcker (1981). We assessed multicollinearity, and found that the maximum variance inflation factor (VIF) was 3.01, below the recommended threshold of 5 (Hair et al., 2012).

Discriminant validity was assessed by comparing the square roots of AVE with the correlations between constructs. The square roots of AVE were found to be greater than the correlations which represent the relationship between the construct and other constructs, indicating good discriminant validity between the constructs (Fornell & Larcker, 1981). Moreover, the heterotrait-monotrait (HTMT) ratios of correlations were also used to assess discriminant validity (Henseler et al., 2015). The HTMT values, which range from 0.012 to 0.691, were significantly less than the thresholds of 0.85, satisfying the criterion proposed by Kline (2011).

4.4. Structural model

To examine the relationships between different gamification designs and user experience, dummy variables were created for each gamification condition. The control condition was used as a reference in the analysis. We estimated the significance of the model path coefficients employing bootstrapping with 3000 samples and 2-tailed t-tests in SmartPLS 4.0 (Table 2). Achievement-oriented gamification was found to have statistically significant positive correlations with engagement (β = 0.734, p < 0.001), dependability (β = 0.604, p < 0.001), novelty (β = 0.478, p < 0.01), and stimulation (β = 0.518, p < 0.01). Social-oriented gamification had a positive influence on engagement (β = 0.712, p < 0.001), comfort (β = 0.440, p < 0.01), dependability (β = 0.430, p < 0.01), novelty (β = 0.532, p < 0.01), sociality (β = 0.946, p < 0.001), and stimulation (β = 0.609, p < 0.001). Immersion-oriented gamification was statistically significantly positively associated with engagement (β = 0.439, p < 0.01), comfort (β = 0.557, p < 0.01), immersion (β = 0.690, p < 0.001), novelty (β = 0.646, p < 0.001), and stimulation (β = 0.574, p < 0.001). Other paths had no significant relationship.

Table 2. Relationships between gamification and user experience

Path	β	p	Path	β	p
Achievement-oriented gamification → Engagement	**0.734**	**0.000**	Social-oriented gamification → Novelty	**0.532**	**0.001**
Achievement-oriented gamification → Comfort	0.241	0.104	Social-oriented gamification → Perspicuity	-0.194	0.255
Achievement-oriented gamification → Dependability	**0.604**	**0.000**	Social-oriented gamification → Sociality	**0.946**	**0.000**
Achievement-oriented gamification → Immersion	-0.014	0.916	Social-oriented gamification → Stimulation	**0.609**	**0.000**
Achievement-oriented gamification → Novelty	**0.478**	**0.002**	Immersion-oriented gamification → Engagement	**0.439**	**0.004**
Achievement-oriented gamification → Perspicuity	-0.173	0.283	Immersion-oriented gamification → Comfort	**0.557**	**0.002**
Achievement-oriented gamification → Sociality	0.095	0.551	Immersion-oriented gamification → Dependability	0.151	0.353
Achievement-oriented gamification → Stimulation	**0.518**	**0.001**	Immersion-oriented gamification → Immersion	**0.690**	**0.000**
Social-oriented gamification → Engagement	**0.712**	**0.000**	Immersion-oriented gamification → Novelty	**0.646**	**0.000**
Social-oriented gamification → Comfort	**0.440**	**0.005**	Immersion-oriented gamification → Perspicuity	-0.284	0.094
Social-oriented gamification → Dependability	**0.430**	**0.009**	Immersion-oriented gamification → Sociality	-0.025	0.866
Social-oriented gamification → Immersion	0.014	0.914	Immersion-oriented gamification → Stimulation	**0.574**	**0.000**

5. Findings and discussion

5.1. Main findings

This study aims to examine the mechanism of how different gamification influences the elderly user's experience in the context of health management. We conducted an offline experiment and demonstrated that different types of gamification (i.e., achievement, social, and immersion-oriented) impacted user experience through different paths.

First, to comprehensively understand users' perceptions of gamification in health management, 8 dimensions of user experience are extracted through EFA. They are comfort, engagement, stimulation, dependability, perspicuity, novelty, sociality, and immersion. The 8 dimensions of user experience merge the previous dimensions of gameful experience and general user experience, and also expand the application of user experience in the field of health management.

Second, from the perspective of overall results, gamification has a relatively positive and significant impact on user experience of the elderly in health management. This implies that gamification can be effectively utilized as a tool to enhance the engagement, motivation and enjoyment of the elderly in health management services, which is in line with the original intention of gamification design (Hamari et al., 2014). This also verifies the findings of Altmeyer et al. (2018) and Chesham et al. (2017), which show that the elderly have positive attitudes toward the integration of game elements in non-game contexts. Although the elderly may have technology anxiety or technophobia and are often skeptical towards new technologies (Nikou, 2015), the positive experience of technology among the elderly is gradually increasing with the advancement of technology and their increased exposure to new technologies.

Third, from the perspective of the specific impact of gamification forms on dimensions of user experience, we offer the following findings: 1) Achievement, social, and immersion relative gamification have significant positive impacts on the engagement and stimulation of elderly users. This indicates that gamification can motivate elderly users' sense of the game, such as goals, accomplishment, and playfulness. Our findings are slightly different from those of Wallius et al., (2023), probably due to

differences in the application domain and research objects (Koivisto & Hamari, 2019). 2) Although both social-oriented and immersion-oriented gamification have a positive and significant impact on the hedonic experience (i.e., comfort, novelty, and stimulation) of elderly users, only the gamification elements related to achievement and social can bring a utilitarian perception (i.e., dependability) of health management (e.g., guidance, support). This may be because achievement-oriented gamification tends to pursue more specific goals and accomplishments, while immersion-oriented games focus on providing immersive experience and emotional enjoyment, attracting players by creating virtual situations and stories, and so the sense of goal is not so direct. Sailer et al. (2017) also confirmed a similar view, exposing that achievement gamification (e.g., badges and leaderboards) can affect users' perceptions of task meaningfulness, while immersion-oriented gamification (e.g., avatars and meaningful stories) creates more sense of belonging. 3) There was no significant difference in the perception of perspicuity between gamification and non-gamification groups among the elderly users. This means that although the elderly are more inclined to use simple systems, different types of gamification per se do not significantly increase the cognitive load of older users. This finding is not consistent with the results of Koivisto and Hamari (2014) which indicated that age had a negative impact on convenience and effortlessness. However, our findings are consistent with those of Chung et al. (2010) which showed that age had no effect on perceptions of ease of use. These inconsistent findings also make us speculate that the cognitive challenges associated with gamification may be attributed to a complex interface design and the integration of various gamification elements, rather than gamification itself.

5.2. Theoretical contributions and practical implications

This study has three theoretical contributions. First, this study broadens the scope of gamification literature, and explores the impact of gamification on elderly users' experience. This research pays attention to the elderly, enhancing the understanding of how different forms of gamification work among the elderly, which is a topic that is insufficiently explored in previous studies (Koivisto & Hamari, 2014). This study focuses on gamification in the context of health management, which also expands the development of gamification in interdisciplinary applications. Second, this study systematically explores the underlying mechanisms of gamification from an elderly user experience perspective, which enriches the theoretical research related to gamification experience overall. User experience contains both gameful experience and general user experience, and is divided into 8 dimensions to reflect the effect of elderly users using the gamified health system. It contributes to filling in gaps in the limited understanding of the underlying mechanisms of action and specific game mechanics and design elements that can be used for promoting health behaviors (Damaševičius et al., 2023). Third, from the perspective of the research method, this study uses the gamification interactive interfaces designed by us to conduct experimental research. It facilitates control of the variables of gamification form, reduces the interference between different gamification forms, and so increases the reliability of the research results.

This study also has practical implications for practitioners. First, this research helps managers and providers of health systems to understand the preferences of elderly users for gamification. As the results show, different types of gamification can bring different experiences, and thus they can provide strategies that meet elderly user needs to promote their positive engagement in health management systems. Second, for gamification designers, a deep understanding of user experience on gamification helps them evaluate the effectiveness of gamified systems designs while developing more personalized and effective gamification systems. For example, for users who have strong utilitarian purposes, designers can add more achievement-oriented and social-oriented forms of gamification.

6. Limitations and future research

This study has a few limitations which can be improved on in future studies. First, this study designed and conducted a relatively rigorous experiment in offline venues to investigate three different gamification forms. However, such short-term interaction experiences may still not be able to reproduce the real-life experiences of using gamified well-being apps. Therefore, to enhance the external validity and generalizability of the results, future researchers are encouraged to conduct field and longitudinal experiment-based studies. Second, this study focused on the elderly group as the research object, which has received limited attention in previous studies (Koivisto & Malik, 2020). However, individual differences were not considered. Future research can therefore consider the impact of demographic differences (e.g., personality, gender, technical proficiency, and personal preferences) on the experience of elderly users.

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