



The Moderator of Gamification of Physical Activities in Older Adults

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Abstract. As the increase of age, many physical and psychological functions of aging and decline are derived. Through appropriate regular exercise, the impact of aging can be delayed. Based on the health problems of the elderly, this study attempts to understand the relationship between motivation and physical activity in older adults through gamification design strategies to help older adults stay healthy. Gamification design strategy is a design strategy that adds game elements in a non-game context, and to create a playing game-like experience to stimulates people's motivations and behaviors. Therefore, we conducted a questionnaire survey of 195 elderly people (over 50 years old) to analyzed the relationship between player motivation and gamification effects, further considering their individual differences such as gender, exercise frequency and game habits. The results shows the elderly people think that autonomy, sense of mission, and sense of accomplishment are all important; change is the least important. The elderly believe that major missions and calls, impact possibilities, development and achievement, social influence and empathy, and creativity and feedback are all important; scarcity and urgency, loss and avoidance are the least important. The elderly who play games agree that the sense of autonomy and accomplishment of the game is higher than that of the elderly who do not play games.

Keywords: Gamification · Player types · Physical activities · Older adults

1 Introduction

Many previous studies suggested that appropriate physical activities could reduce the impact of cognitive and physical senescence with aging (Clarkson-Smith and Hartley 1989; Hulstsch et al. 1993; Penedo and Dahn 2005), and it is one of the important factors in healthy life (Pate et al. 1995; Chodzko-Zajko et al. 2009). Therefore, how to improve the amount of physical activity in older adults be an important issue in many fields research.

One of the most effective ways to promote physical activity in older adults is gamification (Consolvo et al. 2006; Shlomo et al. 2010), which uses game design elements, or game-like methods, to encourage older adults to increase their physical activity. Gamification design strategy is a design strategy that adds game elements in a non-game context, generating behavioral mechanisms similar to “playing a game” to motivate their target behavior (Hamari and Lehdonvirta 2010; Deterding et al. 2011; Chou 2016). Gamification

design has been widely used for the purpose of promoting healthy living behaviors, improving sports performance (Consolvo et al. 2006; Shlomo et al. 2010), and can be effectively applied in the promotion of physical activity in the elderly (Ijsselsteijn et al. 2007; Kappen et al. 2016).

The effect of gamification on changing behavior can often be explained by the principles of self-determination theory (SDT) (Ryan and Deci 2000; Lamprinou and Paraskeva 2015; Landers et al. 2015), which suggests that gamification providing persuasive revelations and pleasant rewards (Fogg 2009 and 2002; Hamari et al. 2014) can increase extrinsic and/or intrinsic motivation more than the original context.

In recent years, research on gamification and player motivation has gradually shifted from exploring the motivation of the entire target group to considering the individual differences of the target group, so that gamification strategies can be driven more effectively and accurately. The factor including demographic variables (gender, Codish and Ravid 2017; age, Bittner and Shipper 2014), personalities (Sajanee 2010; Yuan 2016; Orji et al. 2017), player types (Tondello 2016).

As known from previous studies, gamification is driven by player's motivation that are affected by the factors of individual differences or player types. Therefore, the purpose of this study is to improve the physical activities of the older adults through gamification design, and to figure out the relationship between the effect of gamification to stimulate behavior changes and moderator in advance. The study expects to establish the predictive relationship between player motivations of the older adult and the effects of gamification, and add factors such as individual differences, exercise frequency, and game play habit to explore moderating variables.

1.1 Gamification Design Strategy

In the study, the key framework of Gamification Design Strategy is refer to Chou's (2016) book "Actionable Gamification: Beyond Points, Badges, and Leaderboards". Chou thinks gamification design is to extract interesting and fantastic elements from games and use them in real-world situations to improve users' engagement and motivation of target behaviors. According to Chou's book, eight core gamification strategies are proposed as a frameworks and strategy foundation for gamified design:

1. Epic Meaning & Calling (EC): this core strategy is to convince users that they are doing something meaningful and to feel a sense of adventure or competence.
2. Development & Accomplishment (DA): This core strategy is the most common in games. It lets users focus on growth, achieve specific goals and work hard, and in the process gain a sense of accomplishment such as player scores, badges, achievements, and milestones.
3. Empowerment of Creativity & Feedback (EF): this core strategy requires users to be creative and see immediate results. Diverse results are obtained through the infinite creativity in the game, so that users are deeply attracted.
4. Ownership & Possession (OP): this core strategy is closely related to ownership and possessiveness. Players can feel like they are doing something on their own terms - like developing a game, or earning their own virtual currency or collecting virtual treasures.

5. **Social Influence & Relatedness (SR):** this core strategy is derived from people's desire to socialize, in order to integrate into social groups, they often show behaviors that can be recognized by society to avoid social rejection. In games, such as the mentoring system, teamwork, and competition mechanisms.
6. **Scarcity & Impatience (SI):** This strategy is often used in business marketing. According to economics, scarcity occurs when demand exceeds a finite resource. Due to the scarcity of goods, users are fascinated by spending money and time queuing up to buy these goods.
7. **Unpredictability & Curiosity (UC):** People are curious about the unforeseen. This strategy uses the player's curiosity to drive the player. In Skinner Box, a famous behavioral experiment by psychologist Skinner (1990), it was found that unexpected positive reinforcement stimuli can increase the frequency of behavior more than expected or completely unrelated stimuli.
8. **Loss & Avoidance (LA):** This strategy comes from people's fear of losing things. The longest use of "health" in game characters is that there are many game designs. When the virtual character dies, the game journey must be restarted. Players feel that they have put in a lot of effort and time, and it would be quite frustrating to start over, so avoid this. In addition, Chou (2016) thinks that people are equally afraid of losing what they "already got" in addition to being afraid of losing what they "will get".

1.2 Gamification Design and Individual Differences

Discussions of individual differences in gamification research can be explored in terms of demographic variables, motivations, interests, personalities, habits, etc. As early as 1996, Bartle considered the relationship between different personality traits of gamers and game behavior, and proposed four types of gamers: achievers, socialites, explorers and killers. Each player type is attracted to different game elements, resulting in different behaviors and motivations. Yee (2006) further explores Bartle's (1996) player types and proposes three main components of player motivation: achievement (progress, mechanics, competition), social (social, relationships, teamwork), and immersion (discovery, role-playing, customization), out of reality). However, both Bartle and Yee's research materials are specific to the genre of games: massively multiplayer online role-playing games (MMORPGs), and application-level considerations are still open for research.

Later, as the concept of gamification was gradually applied, it was even discussed in academia. Marczewski (2015) formally proposed research on game player types, based on 4 intrinsic motivations and 2 extrinsic motivations defined by Self-Determination Theory (SDT). Marczewski's proposed a 24-item gamification player type test (user type test), which subscales 6 motivations (relatedness, autonomy, mastery, purpose, reward, change) and 12 player types for further comparison. Marczewski's research makes gamification design develop from the game field to other non-game fields, laying an important foundation for gamification design research.

1.3 Physical Activity and Senior Health

Problems arising from the aging of the elderly, many studies in the past have pointed out that appropriate regular exercise can reduce the impact of cognitive and physiological

decline in the elderly (Clarkson-Smith and Hartley 1989; Hultsch et al. 1993; Penedo and Dahn 2005), and even some studies suggest that proper and regular physical activity is one of the important factors affecting the healthy life of the elderly (Pate et al. 1995; Chodzko-Zajko et al. 2009). Numerous studies on aging have identified many of the health benefits of physical activity in older adults. In this study, the judging standard of the amount of physical activity, referring to the research method of Consolvo et al. (2006), took the amount of walking as its basic physical activity.

1.4 Purpose

Summarizing the above literature discussion, it can be inferred that gamification design has many factors affecting user behavior change, including intrinsic and extrinsic motivation, personal ability, difficulty of target behavior, personality and individual differences, behavior habits, etc. (Fogg et al. 2009; Marczewski et al. 2015). Therefore, this study focuses on the factors that influence the behavioral change of gamification design. Considering the user's motivational composition, behavioral habits and other factors, explore the interactive relationship between the benefits of gamification design strategies and behavioral motivations.

Different from the previous discussions on gamification design, which are mostly based on the perspective of analysis or design, this study will further explore the factors that affect the influence of multiple variables on gamification design strategies, and expect to establish a persuasive model for gamification design strategies. Through the setting of parameters (demographic variables, player types, behavioral habits, and the tendency of gamification design strategies), it is predicted that users will produce different degrees of behavioral change effects, which can be extended to subsequent habit establishment.

Explore the effects and moderating variables of the elderly on gamification strategies: from the existing research on gamification strategies, we compiled the main types of gamification strategies, and explored the effect of different gamification designs on the promotion of physical activity by the elderly through a questionnaire method. The degree of effect, as well as a comprehensive consideration of individual differences in the elderly, motivational preferences and player types, exercise habits, and game touchpoint habits. Then, through the analysis method of prediction model, the effect of gamification design on the elderly was clarified, and a quantitative model that could repeat the prediction was proposed.

2 Method

The purpose of this study is to explore the extent to which different motivations, behavioral habits, and frequency of exposure to games affect real behavior for each gamification design strategy. There are multiple factors interacting between behavior and motivation. The research focuses on using the player type scale as a tool to measure motivation, and formulating the corresponding questions of gamification design strategies as the basis for the influence of subjects on various gamification design strategies. Questionnaire items included demographic variables, the Marczewski (2015) Player Type Scale, and 9 gamified situational tests of everyday physical activity.

2.1 Material

The questionnaire method was used to conduct a questionnaire survey for middle-aged and elderly participants over 50 years old, and it is expected that at least 100 valid questionnaires can be collected. The questionnaire design consists of three parts:

1. The first part is a survey of demographic variables. It includes gender, age, whether you are retired, whether you have exercise habits and how often, the sports you do, exercise habits, average daily game frequency, and the name of the game you play.
2. The second part is the Marczewski Player Type Scale (2015). The scale consists of 24 items that can accurately describe the 6 motivations players prefer. Participants were asked to respond to the degree of agreement with the item statement. Items use a 7-point Likert scale ranging from “1: Strongly disagree” to “7: Strongly agree”. In the study, the player type scale was translated into Chinese by an academic translation agency, and the final version was revised through a test study ($N = 20$, M of age = 28.95, $SD = 9.73$), as shown in Table 1.

Table 1. Test results of the translated version of the Marczewski Player Type Scale ($N = 20$)

Subscale	<i>N</i> of items	<i>M</i>	<i>SD</i>	<i>Skewness</i>	<i>Kurtosis</i>
Relatedness	4	4.69	1.33	0.37	-.535
Autonomy	4	5.70	0.93	-0.52	.082
Mastery	4	5.24	1.21	-0.22	-.330
Purpose	4	5.19	1.19	0.16	-.865
Reward	4	5.09	1.22	-0.38	-.270
Change	4	4.35	1.19	1.03	.452

3. The third part of the questionnaire is a 9-item gamification design situational test, as shown in Table 2. The main goal of gamification design is to enhance the physical activity of elderly people, so the content of the project will be driven by the 8 cores of the gamification design strategy by Chou’s book (2016), corresponding to the content of 8 situational quizzes, and 1 question without gamification strategy (general statement). Participants were asked to judge the likelihood that the situation described by the item would affect their physical activity, using a 7-point Likert scale ranging from “1: very unlikely” to “7: very likely”.

Table 2. Gamified situation items for the older adults' daily physical exercise.

No.	Statement of Gamified situations (English version)	Gamified strategy
1	The use of gamified design in daily life can encourage you to engage in more physical activity	(General statement)
2	There is a gamified design that let you feel you got an excellent talent, and born to be a star at daily walking	Epic meaning & calling
3	There is a gamified design that allows you to get corresponding scores, badges, achievements, milestones or continuous upgrades based on your daily walking steps	Development & accomplishment
4	There is a gamified design that allows you to activate your creativity and create everything you like, that based on the amount of daily walking steps	Empowerment of creativity & feedback
5	There is a gamified design that allows you to obtain virtual wealth or collect virtual treasures, that based on the amount of daily walking steps	Ownership & possession
6	There is a gamified design that allows you to take to cooperate or compete with your friends or players, that based on the amount of daily walking steps	Social influence & relatedness
7	There is a gamified design that gives you a chance to win precious and rare prizes, that based on the amount of daily walking steps	Scarcity & impatience
8	There is a gamified design that allows you to explore a novel things, and has a chance to get a unpredictable bonus, that based on the amount of daily walking steps	Unpredictability & curiosity
9	There is a gamified design that helps you to avoid virtual losses or penalties when you reach a goal of the amount of walking steps	Loss & avoidance

2.2 Participant

There are 195 participants who aged over 50 years old, including 47.7% of them are 50–59 years old, 46.2% of them are 60–69 years old and 6.1% of them are 70+ years old; there are 105 females adults (53.8%). Moreover, the most of them (91.8% are used to exercising regularly at least once a week; almost a half of the them (51.3%) are used to playing video games or mobile games.

3 Result

The all questionnaire data from 195 older adults (aged 50+ years old) were analysed by ANOVA. In order to figure out the influence and relationship between player types and gamification design preferences in older adults, the results show that their main effect and correlation with both two. Furthermore, to consider the difference of individual variables in older adults, such as their gender, exercise frequency and habits of playing games.

3.1 Main Effect

An analysis of variance (ANOVA) was calculated based on the participants’ responses to the questionnaire. In the Table 3, the summary of the user type hexd scale shows that the within-subject test is significant, $F(3.87, 751.17) = 44.922, p < .05$ (the F -value should be adjected by Greenhouse-Geisser method, because the Mauchly’s Test of Sphericitya is not significant, $p < .05$). Furthermore, through the LSD post hoc test, the result shows that there are significant differences between the subscales, summarizing: autonomy[2] = mastery[3] = purpose[4] > relatedness[1] = reward[5] > change[6].

Table 3. The ANOVA table of player types in the older adults.

Subscale	<i>M</i>	<i>SD</i>	ANOVA results	Post Hoc test
Relatedness [1]	4.73	1.51	<i>Df</i> = 3.87, 751.17 <i>F</i> value = 44.922 <i>p</i> value = .000*	[1] > [6]
Autonomy [2]	5.12	1.29		[2] > [1], [5], [6]
Mastery [3]	5.03	1.28		[3] > [1], [5], [6]
Purpose [4]	5.06	1.36		[4] > [1], [5], [6]
Rewards [5]	4.65	1.47		[5] > [6]
Change [6]	4.14	1.24		–

* significant at $p = < .05$.

The analysis of the situational test is shown in the Table 4, and the within-subject test is significant, $F(3.87, 751.17) = 44.922, p < .05$ (the Mauchly’s Test of Sphericitya is not significant, too). And then, the result shows that there are significant differences between the subscales through the LSD post hoc test. The conclusion is: Epic Meaning & Calling [2] = Development & Accomplishment [3] = Social Influence & Relatedness [6] = Empowerment of Creativity & Feedback [4] > Ownership & Possession [5] = Unpredictability & Curiosity [8] > Unpredictability & Curiosity [8] > Loss & Avoidance [9].

The individual difference has been discussed frequently in the lots of the game or gamified research. In this research, discuss not only their motivations (that means user type hexad scale) but demographic variables and lifestyles to figure out the elaborate results for older adults.

Table 4. The ANOVA table of gamified strategies in the older adults.

Subscale	<i>M</i>	<i>SD</i>	ANOVA results	Post Hoc test
General statement [1]	5.10	1.61	<i>Df</i> = 5.42, 1052.35	(skip)
EC [2]	5.19	1.68	<i>F</i> value = 11.529 <i>p</i> value = .000*	[2] > [5], [7], [8], [9]
DA [3]	5.07	1.73		[3] > [5], [7], [8], [9]
EF [4]	5.03	1.64		[4] > [5], [7], [8], [9]
OP [5]	4.84	1.66		[5] > [7], [9]
SR [6]	5.04	1.67		[6] > [5], [7], [8], [9]
SI [7]	4.66	1.73		[7] > [9]
UC [8]	4.81	1.70		[8] > [7], [9]
LA [9]	4.43	1.740		–

* significant at $p = < .05$.

According to the participants’ responses to the questionnaire, the one-way ANOVAs were calculated through 4 kinds of individual variables, including gender, retirement, exercise frequency and habits of playing games. The following Table 5 is composed of all the significance in the one-way ANOVA test, and the non-significant results were deleted to make sure the table is simplified and focused (Table 6).

Table 5. The ANOVA table of gamified strategies and player types in the older adults.

Variables		<i>N</i>	<i>M</i>	<i>SD</i>	ANOVA results	Post Hoc test
(Gamified Strategy × Gender)						
EC	Female	90	4.94	1.81	<i>F</i> (1, 193) = 4.922 <i>p</i> value = .028*	Male > female
	Male	105	5.40	1.54		
LA	Female	90	4.70	1.73	<i>F</i> (1, 193) = 4.222 <i>p</i> value = .041*	Female > male
	Male	105	4.19	1.72		
(Gamified Strategy × Exercise frequency)						
OP	Never or seldom [1]	16	4.31	1.08	<i>F</i> (3, 191) = 2.903 <i>p</i> value = .036*	[3] > [2] [4] > [2]
	Times monthly [2]	54	4.41	1.78		
	Times weekly [3]	67	5.03	1.60		
	Everyday [4]	58	5.17	1.67		
SR	never or seldom [1]	16	4.50	1.59	<i>F</i> (3, 191) = 2.842 <i>p</i> value = .039*	[4] > [1], [2]
	Times monthly [2]	54	4.67	1.77		

(continued)

Table 5. (continued)

Variables		<i>N</i>	<i>M</i>	<i>SD</i>	ANOVA results	Post Hoc test
	Times weekly [3]	67	5.10	1.62		
	Everyday [4]	58	5.47	1.56		
(Player types × Habits of playing games)						
Autonomy	Not playing games	100	4.91	1.38	F(1, 193) = 5.406 p value = .021*	Play > no play
	Play games	95	5.33	1.15		
Mastery	Not playing games	100	4.84	1.31	F(1, 193) = 4.844 p value = .029*	Play > no play
	Play games	95	5.23	1.22		

* Significant at $p = < .05$

Table 6. The correlation table of gamified strategies and player types in the older adults.

Gamified Strategy	Player Motivation					
	Relatedness	Autonomy	Mastery	Purpose	Reward	Change
(General statement)	.443*	.352*	.472*	.483*	.309*	.335*
EC	.494*	.399*	.443*	.533*	.362*	.322*
DA	.468*	.373*	.420*	.467*	.418*	.297*
EF	.513*	.366*	.444*	.469*	.410*	.299*
OP	.423*	.354*	.347*	.347*	.495*	.339*
SR	.544*	.414*	.446*	.501*	.465*	.283*
SI	.466*	.404*	.420*	.413*	.461*	.322*
UC	.520*	.416*	.454*	.509*	.439*	.299*
LA	.436*	.349*	.348*	.360*	.423*	.335*

* Correlation is significant at the 0.01 level (2-tailed).

4 Discussion

Elderly people (over 50 years old) think that autonomy, sense of mission, and sense of accomplishment are all important; change is the least important. The elderly believe that major missions and calls, impact possibilities, development and achievement, social influence and empathy, and creativity and feedback are all important; scarcity and urgency, loss and avoidance are the least important. The elderly who play games agree that the sense of autonomy and accomplishment of the game is higher than that of the elderly who do not play games. Elderly females believe that the game strategy of major missions and calls can more stimulate sports; the elderly male believe that the game strategies of loss and avoidance can more stimulate sports; elderly people who exercise more frequently think that game strategies of ownership and possessiveness, social influence and empathy are more capable of inspiring exercise.

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