FinJeHeW Finnish Journal of eHealth and eWelfare

SCIENTIFIC PAPERS

VERTAISARVIOITU
KOLLEGIALT GRANSKAD
PEER-REVIEWED
www.tsv.fi/tunnus

Investigating the Finnish elderly people's attitudes and motivation towards digital game-based physical exercises

Aung Pyae[1], Tapani N. Liukkonen[1], Mika Luimula[2], Christina Kattimeri[2], Veroline Cauberghe[3], Jouni Smed[1]

[1]University of Turku, Finland; [2] Turku Game Lab, Turku University of Applied Sciences, Finland; [3] Ghent University, Department of Communication Sciences, Belgium

Aung Pyae, University of Turku, FINLAND. Email: aung.sunday04@gmail.com

Abstract

Attitudes and motivation towards physical exercises play a vital role for elderly people's adherence to exercise. In recent years, digital games have been used to enhance elderly people's experiences in physical exercises. However, there is a limited number of studies regarding elderly people's attitudes and motivation towards digital game-based exercises. In this study, we aim at investigating the Finnish elderly people's attitudes towards physical and digital game-based exercises, as well as their motivation in the gameplay. Furthermore, we intend to investigate if digital games can be an alternative way of exercising for elderly people. We conducted a user experience test of the *"Skiing Game"* with 21 elderly participants in Finland. We applied both qualitative (e.g. interview) and quantitative (e.g. questionnaires) methods to collect data from the participants. Then, we analyzed the data by using SPSS and Nvivo. The findings show that the Finnish elderly people's attitudes towards physical exercises are more positive than digital game-based exercises. However, their attitudes towards digital games have become more positive after the gameplay. Their in-game and post-game user experiences were moderately positive. Their motivation to play digital game-based exercises was moderately high after the gameplay. Their feedback towards the Skiing game was positive. They recommend that digital game-based exercises can be an effective way of exercising. Based on these findings, we recommend that digital games are promising to be used as an alternative way of exercising for the Finnish elderly people. The discussion in this study can help researchers gain insights about using digital games for promoting elderly people's participation in physical exercises.

Keywords: digital games, usability, gamification, user experience

Introduction

Every year, 38 million people die due to non-communicable diseases (NCDs), including heart attacks, stroke, and diabetes [1]. One of the major causes of NCDs is physical inactivity, which is often associated with ageing population. Physical inactivity is one of the risk factors for death [2]. According to Taylor [3], there is a positive association between elderly people's health improvements and their active participation in exercises.

Peterson et al. [4] mentioned that age-related declines (e.g. limited mobility) can negatively impact on elderly people's quality of life, including activities of daily living and functional abilities. Regular physical exercises can

minimize the functional declines of elderly people. Functional independence is one of the important factors to have a quality of life for elderly people [5]. Physical exercises play an important role in improving elderly people's health such as cognitive function, mental health, physical fitness, and social engagement [6]. Although physical exercises have the potential to improve elderly people's physical well-being, it is still a challenge for healthcare professionals to encourage them to actively participate in regular exercise activities [3].

In recent years, digital games have been used to improve elderly people's physical well-being such as engagement and participation in regular exercise routines [7], rehabilitation [8], and fall prevention [9]. It has been also used for elderly people's social connection, including intergenerational communication between the older and the younger generation [10]. Furthermore, digital games can improve elderly people's cognitive abilities, including cognition, attention, spatial vision, and memory [11].

Many studies reported the positive impacts of digital games on elderly people, including physical health, socialization, and cognition; however, there is a limited study on understanding elderly people's attitudes towards digital game-based exercises, as well as their motivation in playing digital games as an exercise activity. Mäkilä et al. [12] indicated that to develop physical exercise interventions for elderly people, it is important to understand their attitude, motives, and barriers to participation in physical activity.

In this study, we aim at understanding the Finnish elderly people's attitudes towards physical and digital game-based physical exercises, as well as their differences. We are also interested in investigating their motivation in playing digital game-based exercises. We conducted a user experience test of a digital game-based exercise called the 'Skiing Game' with 21 Finnish elderly participants (>60 years old) at an elderly service home in Finland. We used questionnaires, in-depth interviews, and observations to investigate their attitudes, motivations, and user experiences in playing the Skiing game.

Based on the findings from this study, we discuss the Finnish elderly participants' attitudes and motivation towards digital game-based exercises. We also discuss their user experiences and the potential of digital game-based exercises as an alternative solution for elderly people. The discussion in this paper can help researchers and practitioners gain insightful knowledge into using digital games for promoting elderly people's participation in physical exercises and the adoption rate of digital game-based exercises among elderly people. The main objectives of this study are:

- To investigate the Finnish elderly people's attitudes towards physical exercises in general and digital game-based exercises,
- To find out their motivation in playing digital game-based exercises,
- To investigate their user experiences in playing the Skiing game, and
- To examine if digital game-based exercises can be an alternative way of exercising for the Finnish elderly people.

Background

Understanding elderly people's attitudes towards physical exercises

Attitude is defined as 'a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavour [13]'. Petty and Cacioppo [14] also defined 'Attitude' as a general and enduring positive or negative feeling about some person, object, or issue. Attitude is also related to a particular thing that is liked or disliked [15]. Attitude is one of the most important indicator variables that has a relationship to behavioral intentions regarding physical activity [16]. Regarding elderly people's participation in physical exercise activities, attitude is one of the key determinants that can have an influence on long-term participation [17]. The researcher also indicated that a person's attitude is one of the important factors that can

influence on the successful compliance of long-term physical exercises [17].

Almeida and Rui [18] pointed out that there is a strong relationship between physical activities and a person's attitudes because if the attitudes are manifested by behaviours, more positive beliefs about physical activities are likely to become more evident with more active behaviour and adherence to physical exercise practices. Regarding elderly people's attitudes towards physical exercises, Pappous et al. [19] stated that the elderly who reported more positive attitudes toward physical exercise showed better adherence rates. According to the literature, we found that there has been a limited study on elderly people's attitudes towards physical exercises [19].

Understanding elderly people's motivation in physical exercises

According to Wright and Wiediger [20], motivation is defined as "motivated behaviours as arising from a physiological and/or psychological need or desire. This need or desire activates and directs the individual toward appropriate goals that will hopefully satisfy this arousal". Petri and Govern [21] defined motivation as "a constant flow of behaviour that can be directed in many different ways".

Many studies suggested that physical activities and exercises are beneficial for elderly people. However, a challenge for healthcare professionals is how to motivate them to participate in regular exercise activities [3]. Brauner and Ziefle [22] indicated that participating in regular physical exercises can help elderly people reduce their risk of chronic disease (e.g. diabetes), improve their functional and cognitive abilities, avoid injuries (e.g. falls), and live more independently. The authors also highlighted that it is important to study how we effectively motivate elderly people to change their exercise behaviours and stay actively in old age [22]. According to the Mayo Clinic [23], motivation plays a key role in doing physical exercises.

Petersen [24] pointed out that motivation can be a significant barrier for elderly people to initiate physical exercise activities. Justine et al. [25] also indicated that lack of motivation is one of the important factors that have an influence on elderly people's inactivity in physical exercises. Kravitz [26] highlighted that elderly people's lack of motivation in physical exercises can lead to low adherence and termination from regular exercise routines. To overcome a barrier of lack of motivation for elderly people, they should try new and different exercise options, and find ways to make the workout sessions more enjoyable [26]. Based on the literature, in this study, we will introduce digital game-based exercises to the Finnish elderly people and investigate whether digital games can impact on their motivation to exercise.

Elderly people's user experiences in gameplay

User experience (UX) is defined as "focusing on having a deep understanding of users in a specific user group, especially what they need, what they want, what they value, their abilities, problems, and also their limitations" [27]. According to Alben [28], UX is also defined as "all the aspects of how people use an interactive product: the way it feels in their hands, how well they understand how it works, how they feel about it while they're using it, how well it serves their purposes, and how well it fits into the entire context in which they are using it". In this study, we are interested in investigating the Finnish elderly people's user experiences in playing the Skiing game. Thus, to understand elderly people's user experiences, we applied the Game Experience Questionnaire (GEQ), which is widely accepted by researchers in game UX [29]. According to Norman [30], GEQ is a reasonable and applicable tool in investigating a player's experiences with a game. The author also stated that the GEQ questionnaire has been widely and successfully used in many studies. Basically, GEQ has two modules to assess the player's experience, including in-game and post-game [29]. The GEQ in-game module can be used to assess a player's game experience during a game-play session. It includes seven components: Sensory and Imaginative Immersion, Flow, Competence, Positive Affect, Negative Affect, Tension,

and Challenge. For the GEQ post-game questionnaire, it can be used to assess how players felt after they have played the game. It has four components, including Positive Experience, Negative Experience, Tiredness, and Returning to Reality.

Related studies

Regarding elderly people's attitudes towards digital games, we found that there is a very limited number of studies on this topic. According to Brauner et al. [22], serious and pervasive games can change elderly people's attitudes, which can promote their healthy behaviors. Theng et al. [10] conducted a pilot study with 14 pairs of elderly-teenager participants to examine the effects of the Nintendo Wii games on the social communication between two generations (old and young). Their findings showed that the elderly group showed more positive attitudes towards the younger group through the gameplay.

With regard to elderly people's motivation in playing digital game-based exercises, Albaina et al. [31] designed and developed a persuasive system called "A Virtual Coach", which aims to motivate and encourage elderly people to exercise more. They co-designed the system with elderly participants, and the preliminary findings from the early evaluation with a small number of participants showed that they were motivated to exercise more through the digital gameplay. Brox et al. [32] conducted a review on how exergames can motivate elderly people to exercises regularly. They reviewed existing games, including Nintendo Wii games and Dance Dance Revolution. The researchers suggested that exergames have the potential to motivate elderly people to be more physically active, and it can be used as a supplement to physical training [32].

Jessen et al. [33] used a simple, fun, and challenging modular tile-based computer games to motivate elderly people for their physical activities. The researchers evaluated the game with 40 elderly participants at elderly centers, rehabilitation center, and hospital. They found that the introduction of modular tiles games was successful and highly motivating. Their findings showed that playing digital games can create a strong motivation for elderly people to participate in therapeutic training as well as to improve in measurable health outcomes. Nap et al. [34] investigated the motivation, preferences, and needs of elderly gamers, and they found the underlying motivation factors for elderly people to play digital games, including fun and relaxation, escape from reality, social connectedness, and meaningful play to their daily lives.

Research questions

The existing literature highlighted that attitude plays an important role in elderly people's participation in regular physical exercises. Furthermore, digital games have the potential to motivate elderly people to do regular physical exercises. Based on the findings from the literature, in this study, we aim at investigating the Finnish elderly people's attitudes towards physical and digital game-based exercises, and their motivation in playing digital game-based exercises. We also aim to investigate the potential of digital game-based exercises as an alternative way for elderly people to exercise. In this study, the following research questions are formulated:

- What is the difference in the Finnish elderly people's attitudes between physical and digital game-based exercises?
- What is the Finnish elderly people's motivation towards digital game-based exercise?
- Is there a correlation between the Finnish elderly people's attitudes and motivation towards digital game-based exercise?

A user experience test

We conducted a user experience test with 21 Finnish elderly participants at one of the elderly homes in Finland called 'Ruusukortteli'. The study took two days: 17 elderly participants for day-one and 4 participants for day-two respectively. Three researchers from the University of Turku were involved in the study to guide

elderly participants in playing the Skiing game and to ask questionnaires, as well as to conduct the interview.

Skiing game

In this user experience test, we used a digital game-based physical exercise called 'Skiing Game' (See Figure 1). Before we designed and developed the Skiing game, we conducted a number of pre-studies that included understanding the usability of existing commercial games [35,36], the usability testing of 'SportWall' game [37], the usability testing of multimodal input devices for elderly people [38-41], and the literature review on digital games for elderly people [35]. Based on the findings from the pre-studies, the Skiing game was designed and developed by the developers from the Turku Game Lab in Finland, especially aiming for the Finnish elderly people.

The main objective of the game is to improve the Finnish elderly people's participation in regular exercises by utilizing digital games as an alternative solution. In the Skiing game, we used a simple, easy, and age-friendly game interface, context, and gameplay. For the gameplay, we used a popular cross-country Skiing activity, which is familiar to most of the Finnish elderly people. Regarding user's interaction experience, we used a controller-free interaction for elderly people by using the Xtreme Reality Technology. For the technical environment, we used the Unity3D game engine with C# programming language to implement this game. In this game, a player needs to continuously move both hands forward and backward to skii in the game. In addition, a player simply needs to move his or her body to the left or right to avoid obstacles in the game.

Elderly participants recruitment

We recruited elderly participants at the elderly service home 'Ruusukortteli' in Finland. Before the study was undertaken, we collaborated with the healthcare professionals from the elderly service home for the recruitment, study design, protocol, and procedures. Regarding the inclusion criteria for elderly participants, they should be aged 60 years and above. He or she should have a stable health condition physically and mentally. In addition, they should be able to tolerate for at least 10 minutes to play the game in a standing position. They also should have no neurological or cognitive deficits. Based on these criteria, we recruited a total of 21 elderly participants: 14 female and 7 male participants with an age range between 60 and 87 years (M=76). More importantly, we requested a consent from every participant to be involved in this study, as well as a permission for the video-recording.

Figure 1. The Skiing game.

User experience test design and procedure

Before the elderly participants played the game, a researcher asked the pre-study interview questions, including their demographics, physical activities, and attitudes towards participation in regular physical exercises. The pre-game interview session took about 15 minutes. Then, the elderly participants went through a game tutorial guided by a researcher, followed by the actual gameplay for 15 minutes. After playing the game, a researcher asked the individual elderly participant the post-game questionnaires and interview questions, including in-game and post-game user experiences, their motivation, and attitudes towards digital game-based exercises. Furthermore, we also asked the general interview questions regarding their feedback and opinions towards the Skiing game and digital game-based exercises. The post-interview session took about 15 minutes. The gameplay and data collection for the individual participant took 45 minutes approximately. During the gameplay session, we observed the elderly participants' behaviours, expression, emotion, and feedback towards the game by using a video recorder and a note-book. Table 1 shows the design and procedures of the user experience test of the Skiing game.

Questionnaires

We used different questionnaires to investigate elderly people's opinions towards digital game-based physical exercises. Firstly, we created the questionnaires to understand elderly people's attitudes towards physical exercises, based on 'the attitudes of older adults toward physical activity and exercise' developed by Terry et al. [42]. To investigate elderly people's user experiences during and after the gameplay, we used Game Experience Questionnaires (GEQ), which includes two modules: in-game and post-game to assess player's user experiences [29]. The in-game GEQ questionnaires investigate players' experience while they are playing a particular game, and it contains seven components including competence, challenge, negative effect, and positive effect.

Post-game GEQ questionnaires are used to find out how a player feels right after the gameplay, and it contains four components such as positive and negative experiences, tiredness, and returning to reality respectively. Both in-game and post-game GEQ questionnaires are created based on the 5-point Likert scale from "Not at all (0)" to "Extremely (4)". Regarding the questionnaires for elderly people's attitudes towards game-based physical exercise, we used the same questionnaire developed by Terry et al. [42].

For the questionnaires about elderly people's motivation, we used Intrinsic Motivation Inventory (IMI) developed by Plant and Ryan [43], which determines the levels of intrinsic motivation of a person. The IMI is a multidimensional measurement tool that is used to assess participants' subjective experience related to a particular activity in laboratory experiments and has been used in several experiments related to intrinsic motivation [44]. We created the post-interview questions based on the Senior Technology Acceptance & Adoption Model (STAM) [45].The questions include four items that investigate elderly people's perceived usefulness, perceived ease-of-use, gerontechnology self-efficacy, and gerontechnology anxiety. Figure 2 shows a photo of an elderly participant in the study of the Skiing game.

Table 1. User experience test design and procedure.

Task	Duration	Description
Introduction to the game Pre-study interview	15 minutes	Pre-study session
Game tutorial Gameplay	15 minutes	Gameplay session
Post-study interview	15 minutes	Post-study session

Figure 2. A user experience test of the Skiing game.

Ethical consideration

In this study, we followed the instructions and guidelines created by the University of Turku to conduct a particular user testing with human subjects, especially elderly participants. Furthermore, we obtained an approval from the elderly service home in Finland before we conducted the test. More importantly, we requested the individual participant's consent before he or she participated in the study.

Data analysis

In this study, we collected both qualitative and quantitative data from the user experience test of the Skiing game with the Finnish elderly participants. For qualitative data collection, we used interviews and observation to investigate the elderly participants' feedback, comments, and opinions towards traditional physical exercises as well as digital game-based exercises. For quantitative data collection, we used questionnaires for pre and post studies. After collecting both qualitative and quantitative data, we conducted the analysis of data to explore the elderly participants' attitudes and motivations in playing digital game-based exercises, as well as their experiences in the gameplay. For the qualitative data analysis, we quoted the participants' feedback, comments, and opinions. Then, we quoted and categorized the relevant findings, followed by decategorzation until we identified important themes, relationships, trends, and information. For the quantitative data analysis, we used SPSS, the statistical tool, to analyze the data collected from the elderly participants' responses to GEQ questionnaire, including in-game and post-game modules.

Results

Elderly participants' attitudes towards physical exercises

Based on the findings from the pre-study interview sessions, we found that 19 out of 21 elderly participants are active in regular physical exercises, which include walking, cycling, aerobics, and stretching. Only two participants had already stopped doing physical activity due to their old age: 85 and 87 respectively. Among the elderly participants who are active in regular physical exercise activities, only six elderly participants usually do daily exercises for one to two hours. All of them do weekly regular physical exercises for at least six hours.

Regarding the elderly participants' attitudes towards physical exercises, we found that they have a highly positive attitudes towards participation in regular physical exercises. All questionnaire items earned the highest scores (M=5.0) except the questionnaire item-2 'Physical exercise helps to work of emotional tension

and anxieties' (M= 4.9). Table 2 shows the mean scores and the standard errors of the questionnaires about elderly people's attitudes towards physical exercises, and Figure 3 demonstrates the graphical representation of it.

Table 2. Elderly participants' attitudes towards traditional physical exercises.

Questionnaire	Mean Score (M)	Standard Error (SE)
Q1. Physical exercise is essential to good health.	5.0	0.0
Q3. Physical exercise is important in helping a person to gain and maintain all-around health.	5.0	0.0
Q4. Physical exercise is beneficial to the human body.	5.0	0.0
Q5. Regular physical exercise makes one feel better.	5.0	0.0
Q2. Physical exercise helps to work of emotional tension and anxieties.	4.9	0.1

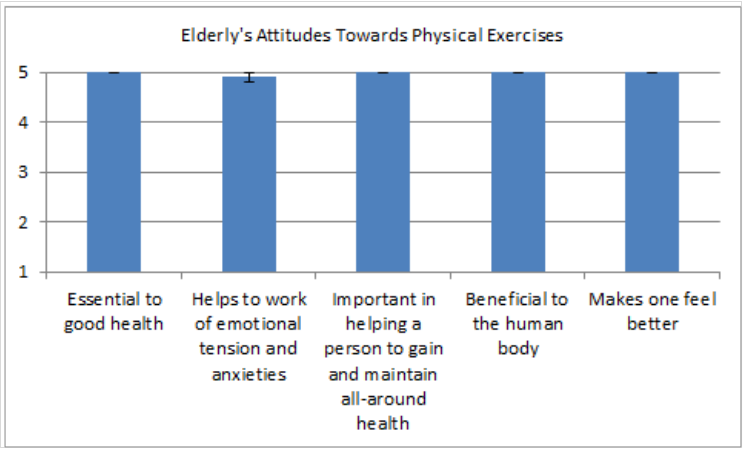

Figure 3. Graphical representation of elderly participants' attitudes towards physical exercises.

Elderly participants' in-game user experiences (GEQ)

Regarding the elderly participants' in-game user experiences (See Table 3), we observed that they had a relatively high positive affection (M= 3.0) during the gameplay, whereas they had almost no negative affection (M= 0.1). The in-game GEQ components 'Flow' (M= 2.6), 'Competence' (M= 2.3), and 'Sensory and Imaginative' (M= 2.3) had an average mean score. We also found that the component 'Challenge' had a noticeably low mean score (M= 1.2), while the elderly participants had almost no tension in the gameplay (M= 0.2). Table 3 shows the means scores of elderly participants' in-game user experiences, and Figure 4 shows a graphical illustration of it.

Elderly participants' post-game user experiences (GEQ)

For the elderly participants' post-game user experiences, we observed that 'Positive Experience' had an average mean score (M= 2.0), while other components had a noticeably low mean score, smaller than (M=1.0). The component 'Returning to Reality' had a mean score (M= 0.8). We also found that the elderly participants had almost no tiredness and negative experience (M= 0.1). Table 4 shows the mean scores of the post-game GEQ and the standard errors and Figure 5 shows the graphical representation of post-game GEQ mean scores and standard errors.

Table 3. The in-game GEQ mean scores and the standard errors.

In-game GEQ components	Mean Score (M)	Standard Error (SE)
Positive Affect	3.0	0.2
Flow	2.6	0.3
Competence	2.3	0.0
Sensory and Imaginative	2.3	0.3
Challenge	1.2	0.2
Tension	0.1	0.1
Negative Affect	0.1	0.1

*The highest score is 4.0 and the lowest score is 0.0.

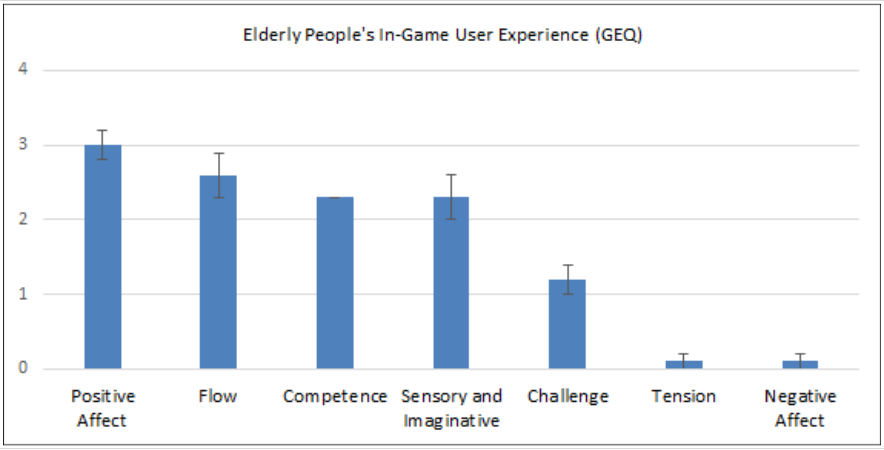

Figure 4. Graphical representation of elderly participants' in-game GEQ mean scores and the standard errors.

Table 4. The post-game GEQ mean scores and the standard errors

Post-game GEQ components	Mean Score (M)	Standard Error (SE)
Positive experience	2.0	0.2
Returning to reality	0.8	0.2
Negative experience	0.1	0.0
Tiredness	0.1	0.0

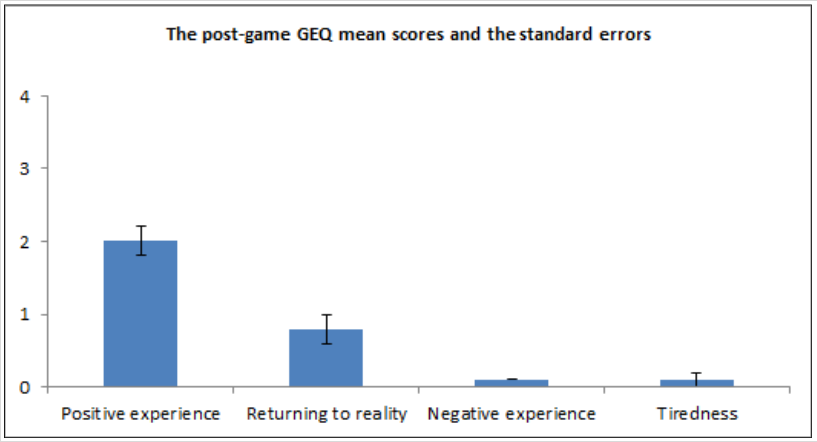

Figure 5. Graphical representation of post-game GEQ mean scores and the standard errors.

Elderly participants' motivation towards digital game-based exercise

Regarding the elderly participants' motivation towards game-based exercises, we observed that all questions had the mean score above 3.0, whereas only question 4 received the mean score 2.2. The elderly participants claimed that playing digital games is useful for doing physical exercises (M=3.5), as well as it can improve their motivation to do physical exercises (M=3.5). Most of them answered that they were willing to try the game again (M=3.5). In addition, they believed that playing digital games could be valuable to their daily and weekly exercises (M=3.3). Lastly, they reported that it could help them to do more physical exercises than before. Table 5 shows the mean scores and the standard errors of elderly's motivation towards game-based exercises. Figure 6 shows the illustration of it.

Table 5. Elderly people's motivation towards digital game-based exercise.

Motivation Questionnaires	Mean Score (M)	Standard Error (SE)
Q2. I think that doing this activity is useful for doing physical exercises.	3.5	0.3
Q3. I think this is important to do because it can improve my motivation to do physical exercises.	3.5	0.3
Q5. I would be willing to do this again because it has some value to my daily/weekly physical exercises.	3.5	0.3
Q1. I believe this activity could be of some value to my daily/weekly physical exercises.	3.3	0.3
Q4. I think doing this activity could help me to do more physical exercises than before.	2.2	0.3

*The highest score is 5.0 and the lowest score is 1.0.

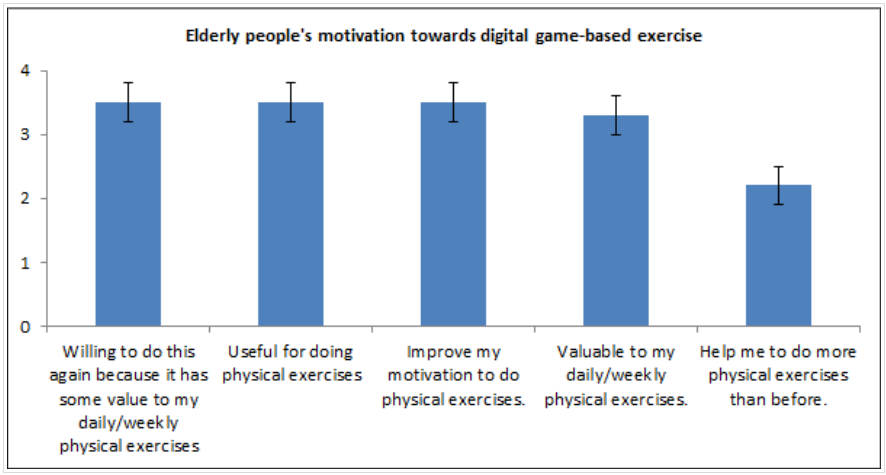

Figure 6. Graphical representation of the mean scores and the standard errors of elderly's motivation towards game-based exercises.

Elderly participants' attitudes towards digital game-based exercises

For elderly participants' attitudes towards digital game-based exercises, we found that after the gameplay, the elderly participants have changed their attitudes more positively than before. They claimed that digital game-based exercises can be beneficial to their body (M=4.0) and regulation of emotional tension and anxieties (M=3.9). They claimed that digital gameplay can help them maintain all-around help (M=3.8), and make them feel better (3.4). Lastly, most of them agreed that it is essential to good health (M=3.0). Table 6 shows the mean scores of elderly participants' attitudes towards digital game-based exercises. Figure 7 illustrates a graphical representation of elderly participants' attitudes towards digital game-based exercises.

Table 6. Elderly participants' attitudes towards digital game-based exercises.

Questionnaires	Mean Score (M)	Standard Error (SE)
Q4. I think game-based exercise is beneficial to the human body.	4	0.3
Q2. I think game-based exercise can help to work of emotional tension and anxieties.	3.9	0.3
Q3. I think game-based exercise is important in helping a person gain and maintain all-around health.	3.8	0.3
Q5. I think regular game-based exercise makes one feel better.	3.4	0.3
Q1. I think game-based exercise is essential to good health.	3	0.4

*The highest score is 5.0 and the lowest score is 1.0.

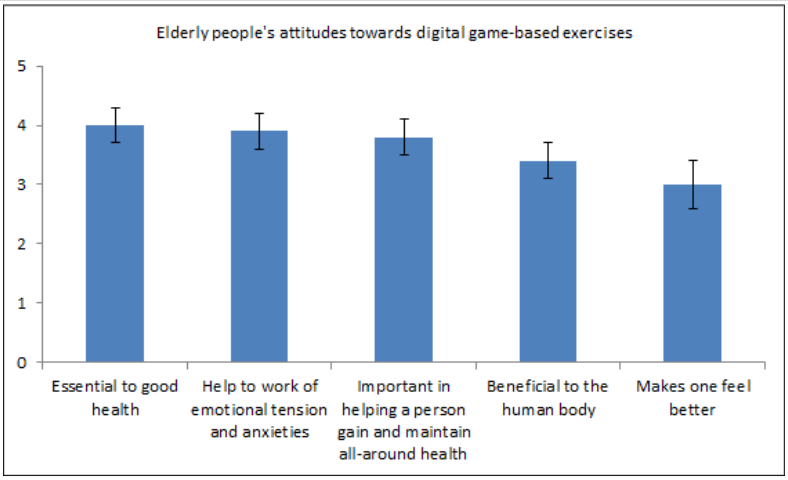

Figure 7. Graphical representation of elderly participants' attitudes towards digital game-based exercises.

We analyzed the difference in the elderly participants' attitudes between physical and digital game-based physical exercises by applying the Paired-Samples t-test. Based on the findings from the analysis, we found that there was a significant difference in the scores for physical exercises (M=4.9) and digital game-based physical exercises (M=3.6); $t(20) = -5.28$, $p < 0.05$. We also observed that there was no correlation between the elderly participants' attitudes towards physical exercises and digital game-based exercises ($r = 0.004$, $n = 21$). We assessed the relationship between the elderly participants' attitudes and motivation towards digital game-based exercises after the gameplay. We observed that there was a positive correlation between the two variables ($r = 0.75$, $n = 21$). Overall, the results showed that the increment of the elderly participants' positive attitudes was correlated with the increment in their motivation in the gameplay.

Post-gameplay interview

Based on the findings from the post-study interview questions, 15 out of 21 elderly participants agreed that playing digital games can be an effective and effortless way of exercising, whereas 6 elderly participants disagreed. We observed that all elderly participants claimed that the Skiing game was easy to play except one participant. We also found that 17 elderly participants commented that the game provided adequate in-game instructions. However, four elderly participants did not agree on this. Lastly, 20 elderly participants were not afraid of making mistakes during the gameplay, but one participant was anxious about it. Table 7 shows the elderly participants' responses towards the post-study interview questions.

We also conducted a post-study interview session with the individual elderly participant regarding their opinions and feedback towards digital game-based physical exercises. Based on the findings from the analysis of interview comments, we reported the classifications of the elderly people's comments towards the game (See Table 8). The elderly participants commented that digital games can be an alternative way of doing physical exercises. Most elderly participants suggested that traditional physical exercises came as a first priority. They recommended digital games as an another option when they can't have access to physical exercises and outdoor activities due to barriers including poor health, weather, lack of facilities, and long distance to sports center or gym. For instance, one elderly participant commented that "This could be good if you can't work out normally. Because at home, people don't do physical activity without an example".

Table 7. The percentages of post-gameplay questionnaires.

Post-Gameplay Questionnaires		Yes	No
Perceived usefulness	Could playing digital games be an effective and effortless way of exercising?	15	6
Perceived ease-of-use	Was playing the game easy?	20	1
Gerontechnology self-efficacy	Were you able to play the game after receiving instructions? Would the user instructions have been adequate?	17	4
Gerontechnology anxiety	Were you afraid of making mistakes when playing the game?	1	20

Table 8. Elderly's comments in the post-game interview.

An alternative solution	"Yes…… it could be in the autumn when it rains. But preferably I would go out to exercise" "…a rainy day does not prevent going out to exercise. But in the morning and evening, I could put the game on and ski"… "It might be good if you can't go out. It would be fun if you are alone" "Difficult question. Real exercise comes first. When the time comes that you cannot exercise for real then this is good". "If you don't exercise then it is a good start". "…it's good for spending time…" "….This could be good if you can't work out normally. Because at home, people don't do physical activity without an example" "This helps to stay at home".
User experiences	"I get excited" "It made me curious. Playfulness made me excited". "Nice but if it could be used often…" "….Interesting. More reasonable than shooting games". "…Easy and fun". "…I was amazed from this game. It was simple". "It was meaningful. It made my heart beat, I liked it".
Usefulness	"….for physical exercise and socializing with others". "It can improve my movements if I play at home regularly…" "….useful for exercise training"
Ease-of-play	"For a first-timer it was easy". "At first it was difficult after it became easier..." "It was easy when I understood the idea…." "…it was easy/effortless. Didn't need to use strength nor my brain".
User Interface	"Clear. It went better when I knew what was going to come next" "The picture made it clearer" "Picture and info…" "Yes. A picture would have been of help" "Nice scenery. *Lapland* came into my mind…" "I couldn't believe that I would experience this, it was very enjoyable. Beautiful scenery".
In-game Instructions	"I believe that instructions are adequate. A demo would be good." "Oral/verbal instructions are better." "It would be good if somebody tells instructs you, especially with stepping left and right." "Oral/verbal instructions are better"
Game Support	"Having an instructor is a good thing" "A demo would be good…"

For user experiences, we learned from the findings that most elderly participants commented that it was an interesting, fun, and exciting experience for them. One elderly participant highlighted that the Skiing game is more reasonable than shooting games, and the other elderly advocated that it was a meaningful play. Overall, the elderly participants' comments towards their experiences in playing the Skiing game was quite positive. Regarding the usefulness of the game, the elderly participants recommended that digital game-based exercise can improve their physical activities. In addition, it can enhance their socialization with others through co-gameplay. Regarding the ease-of-play of the game, the elderly participants insisted that it was an easy game for non-gamer players if they knew how to play it. Furthermore, they suggested that the gameplay was effortless and easy to follow. They commented that it can be useful for their physical exercise activities.

We also observed the useful usability and game design guidelines for designing digital game-based physical exercises for elderly people. First of all, the elderly participants highlighted that the pictures and information provided in the game were clear and easy to learn. They recommended that the graphical representation of the game was helpful for them in the gameplay. One of the elderly participants commented that the game context reminded him of a famous land called "Lapland", which is situated in the northernmost region in Finland where ski resorts are built. The elderly participants also mentioned that they could connect to the game context and gameplay because of the familiar game contents.

The elderly participants highlighted the importance of effective in-game instructions. Some elderly participants suggested that verbal instruction in the gameplay will be helpful for them to be able to understand the game more easily. Lastly, the elderly participants provided insightful comments towards game system support, highlighting the importance of effective tutorial and instructor for them in the game. Table 8 shows the classification and compilation of comments made by the elderly participants.

Discussion

Elderly people's attitudes towards physical and digital game-based exercises

Regarding the elderly participants' attitudes towards physical exercises, they agreed that doing physical exercises is essential and beneficial to good health and the human body, and it plays a major role in maintaining all-around health. In addition, they highlighted that regular exercise activities can make a person feel better. They also pointed out that playing digital games can help to work of emotional tension and anxieties. Based on the findings from the pre-study questionnaire, we learned that the elderly participants have a very high positive attitude towards physical exercises. They are also aware of the benefits of doing regular physical exercises.

Regarding their experiences in digital gameplay, most of them did not have prior experiences. Before they played the game, their attitudes towards digital games were moderately negative. Most of them mentioned that they were not interested in digital games, and it was a waste of time. Some of them claimed that they did not have a device to play. They had a misconception that playing digital games is only for the younger people, and not suitable for elderly people. Based on the findings from the pre-study interview, we state that the elderly participants had a relatively negative attitude towards digital games prior to the gameplay.

However, the findings from the questionnaire showed that after they had played the game, the elderly participants had a relatively high positive attitude towards digital game-based exercises. They had a moderately high positive attitude that digital game-based exercises are essential to good health, and it can help to regulate emotion, tension, and anxiety. In addition, it can support the maintenance of all-around health for them. They had a moderately positive attitude that digital games can be beneficial to human body. Lastly, they showed their average positive attitudes towards digital games that it can make them feel better. This finding is also in line with the finding by Brauner et al. [22] that serious games or digital game-based exercises can

change elderly people's attitudes in doing physical exercises.

According to the findings from the analysis of the comparative analysis using a t-test, we found that the elderly participants' attitudes towards physical exercises are significantly more positive than digital game-based exercises. We can take into account that most of the elderly participants never played digital games before, and it was the first attempt for most of them. Thus, it may impact on their attitudes towards digital game-based exercises. Although the elderly participants showed more positive attitudes towards physical exercises, we learned that their attitudes towards digital games for physical exercises have changed noticeably more positive after the gameplay. We also observed that the elderly participants' attitudes did not have a relation to their attitudes towards digital game-based exercises.

Elderly people's motivation in playing digital game-based exercises

Regarding the elderly participants' motivation in playing digital game-based physical exercises, we observed that they had a relatively high motivation to play the game. They were moderately motivated that digital games can help them to do more physical exercises than before. Furthermore, they have also motivated that digital games are valuable to their daily and weekly physical exercises. Noticeably, they agreed that digital games can improve their motivation to do physical exercises, followed by a claim that it can also be useful for doing physical exercises. Lastly, they had a high level of motivation to play digital game-based exercises again. Based on the findings from this, we found that the elderly participants were relatively motivated in playing digital game-based physical exercises. We also observed that the elderly participants' attitudes digital games after the gameplay had a positive relation to their motivation in the gameplay. It means that while their attitudes had changed more positive after the gameplay, the elderly participants were more motivated to play the game. The finding in this study is also supported by the whited paper by TNO and VitaValley (2015) in which it is stated that digital games are promising for fulfilling the motivational requirements for elderly people in exercising. Furthermore, the findings from the small-scale study conducted by Albaina et al. [31] supported that the elderly participants were motivated to exercise more by the digital game system. It is also in line with the findings from the studies reported in the literature review, including Brox et al. [32].

Elderly people's user experiences in the gameplay

For the elderly participants' in-game GEQ, we learned from the findings that their affection in the gameplay was quite positive, and they were relatively absorbed in the game. Furthermore, they were moderately interested and successful in playing the game. The participants reported that the game was not challenging enough for them. Significantly, they had almost no tension and negative affection in the gameplay. Based on the findings from the analysis of in-game GEQ, we observed that the elderly participants' in-game user experiences were moderately positive. Regarding the elderly participants' post-game GEQ, we found that the elderly participants had an average positive experience after they had played the game. Noticeably, they had almost no disorientation and tiredness after the gameplay. More importantly, their negative experiences after the gameplay were almost none. Overall, their post-game experiences were moderately positive. According to the findings from both in-game and post-game experiences. Although most of the elderly participants in this study never played digital games before, we observed that their experiences in playing the digital game-based physical exercises were relatively positive.

Findings from the post-study interview session

According to the findings from the post-gameplay interview questionnaires, we observed that the majority of elderly participants suggested that playing digital games can be an effective way of exercising and an alternative solution for their physical exercises. We also found that they were excited and interested in the gameplay. They highlighted that playing digital games have the poten-

tial to improve their socialization with others, as well as their health. Most of them claimed that although it was the first time for them, the game was simple and easy to play. Based on the findings from the post-study questionnaire and interview questions, we stated that the Skiing game is an easy and effective game for the Finnish elderly participants and digital game-based exercises are promising to be an alternative solution for them to exercise. In the existing literature, many studies also supported that digital games are promising to promote elderly people's physical activities in terms of physical exercises and rehabilitation [8].

Summary

In this study, we formulated three research questions and conducted a user experience test of the Skiing game with the Finnish elderly participants in Finland. The first research question asked if there is any difference in the Finnish elderly people's attitudes between physical exercises in general and digital game-based exercises. The findings showed that the Finnish elderly participants' attitudes towards physical exercises were significantly more positive than digital game-based exercises. They had a strong passion for doing regular physical exercises. Regarding their attitudes towards digital games, although they had a fairly negative attitude towards digital games, they became more positive towards digital game-based exercises after they had played the game. The second research question asked if the Finnish elderly people are motivated in playing digital game-based exercises. The findings showed that their motivation in playing digital game-based exercises was relatively high after the gameplay. They were quite motivated to play the game and they would like to play it again.

The last research question asked if there is a correlation between the Finnish elderly people's attitudes and motivation towards digital game-based exercise.

The findings showed that the Finnish elderly participants' motivation was higher to play the game while their attitudes towards digital games have become more positive than prior to the gameplay. Overall, their in-game and post-game user experiences were fairly positive although they did not have prior experiences in playing digital games. They showed their interests, enjoyment, and positive experiences in the gameplay. The findings from the interview session suggested that they recommended digital game-based exercises can be an alternative form of physical exercises. They highlighted that digital games can help them improve their physical activities, health, and socialization. Based on these findings, we conclude that digital games are a promising tool to be used as an effective solution to improve the Finnish elderly people's participation in regular physical exercises.

Conclusions

In this study, we reviewed a literature on elderly people's motivation and attitudes towards digital game-based exercises. Based on the findings from the literature, we formulated research questions and conducted a user experience test of the Skiing game with 21 Finnish elderly participants in Finland. We investigated the Finnish elderly participants' motivation and attitudes towards digital game-based exercises as well as their in-game and post-game user experiences. The findings show that the Finnish elderly participants' attitudes were more positive than their attitudes towards digital game-based exercises. Nevertheless, their attitudes have become more positive towards digital game-based exercises after they had played the game. Their in-game and post-game user experiences were moderately positive. The elderly participants commented that digital game-based exercise was interesting, exciting, and fun for them. The findings from this study support that digital game-based exercises can be an effective way of exercising for the Finnish elderly people. The discussion in this study can be insightful for researchers who are interested in adopting digital games to improve elderly people's participation in regular physical exercise activities.

Acknowledgement

We would like to thank Tekes (Finland), City of Turku, and Ruusukortteli elderly service home in Turku, Finland.

References

[1] WHO. Noncommunicable Diseases. WHO; 2015 [cited 2017 4 April 2017]. Available from: http://www.who.int/mediacentre/factsheets/fs355/en/

[2] WHO. Global Recommendations on Physical Activity for Health. WHO Press; 2010 [cited 2017 9 April 2017]. Available from: http://apps.who.int/iris/bitstream/10665/44399/1/9789241599979_eng.pdf

[3] Taylor D. Physical activity is medicine for older adults. Postgrad Med J. 2014 Jan;90(1059):26-32. https://doi.org/10.1136/postgradmedj-2012-131366

[4] Peterson D, Jones G, Rice C. Ageing and physical activity: evidence to develop exercise recommendations for older adults. Can J Public Health. 2007;98 Suppl 2:S69-108.

[5] Lau RS, Ohinmaa A, Johnson JA. Predicting the future burden of diabetes in Alberta from 2008 to 2035. Can J Diabetes. 2011;35(3):274-81. https://doi.org/10.1016/S1499-2671(11)53011-4

[6] Wan M, Wong RY. Benefits of exercise in the elderly. Canadian Geriatrics Society Journal of CME. 2014;4(1):5-8.

[7] Taylor MJ, McCormick D, Shawis T, Impson R, Griffin M. Activity-promoting gaming systems in exercise and rehabilitation. J Rehabil Res Dev. 2011;48(10):1171-86. https://doi.org/10.1682/JRRD.2010.09.0171

[8] Pyae A, Tan BY, Gossage M. Understanding stroke patients' needs for designing user-centered rehabilitative games. 7th Annual International Conference on Computer Games Multimedia and Allied Technologies. Singapore; 2013. p. 151-156.

[9] Santos A, Guimarães V, Matos N, Cevada J, Ferreira C, Sousa I. Multi-sensor exercise-based interactive games for fall prevention and rehabiliation. The 9th International Conference on Pervasive Computing Technologies for Healthcare; 2015. p. 65-71.

[10] Theng YL, Chua PH, Pham TP. Wii as entertainment and socialization aids for mental and social health of elderly. CHI'12 Extended Abstracts: ACM; 2012. p. 691-702.

[11] Rodríguez-Isasi A, Méndez-Zorrilla A, García-Zapirain B. Supporting elderly people's cognitive rehabilitation with iPad based serious games. The 8th International Conference on Pervasive Computing Technologies for Healthcare; 2014. p. 354-357.

[12] Mäkilä P, Hirvensalo M, Parkatti T. Changes in physical activity involvement and attitude to physical activity in a 16-year follow-up study among the elderly. J Aging Res. 2010 Jul 15;2010:174290. https://doi.org/10.4061/2010/174290

[13] Eagly AH, Chaiken S. The Psychology of Attitudes. Fort Worth, TX: Harcourt, Brace & Jovanovich College Publishers; 1993. 794 p.

[14] Petty RE, Cacioppo JT. Attitudes and Persuasion: Classic and Contemporary Approaches. Dubuque, IA: Brown; 1981.

[15] Maio G, Haddock G. The Psychology of Attitudes and Attitude Change. 2nd ed. SAGE Publications; 2015.

[16] Araújo J, Dosil J. The influence of attitudes toward physical activity and sports. Motriz Revista de Educação Física 2015;21(4):344-351. https://doi.org/10.1590/S1980-65742015000400002

[17] Franklin BA. Program factors that influence exercise adherence: Practical adherence skills for the clinical staff. In: Dishman R (ed). Exercise adherence: Its impact on public health. Champaing, IL: Human Kinetics Books; 1988. p. 237-258.

[18] Almeida P, Rui N. Physical Activity - the Attitude of the Institutionalised Elderly. Journal of Physical Education and Sport 2014;14(1):12-5. https://doi.org/10.7752/jpes.2014.01002

[19] Pappous A, Cruz F, Leseleuc E-D, Marcellini A, Recours R, Schmidt J. Attitudes of the elderly toward physical activity and exercises. Adaptation of the older per-

son's attitudes toward physical activity and exercise questionnaire in Spain. Studies In Physical Culture And Tourism 2006;13(1):69-77.

[20] Wright J, Wiediger R. Motivated behaviours: The interaction of attention, habituation and memory. In: Brown L (edit). Psychology of motivation. Nova Science Publishers Inc; 2007. p. 5-28.

[21] Petri H, Govern J. Motivation: Theory, Research, and Application. 6th ed. Cengage Learning; 2012.

[22] Brauner P, Ziefle M. Exergames for Elderly in Ambient Assisted Living Environments – Determinants for performance and technology acceptance. In: Giaffreda R. et al. (eds) Internet of Things. User-Centric IoT. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, vol 150. Springer; 2015. p. 145-50. https://doi.org/10.1007/978-3-319-19656-5_21

[23] Mayo Clinic. Fitness: Tips for Staying Motivated. Mayo Clinic; 2015 [cited 2017 9 April 2017]. Available from: http://www.mayoclinic.org/healthy-lifestyle/fitness/in-depth/fitness/art-20047624.

[24] Petersen T. Aging, Exercise and Motivation. 2016 [cited 2017 9 April 2017]. Available from: http://www.aahf.info/sec_news-/section/aging-motivation_petersen_012407.htm.

[25] Justine M, Azizan A, Hassan V, Salleh Z, Manaf H. Barriers to participation in physical activity and exercise among middle-aged and elderly individuals. Singapore Med J 2013. 2013;54(10):581-6. https://doi.org/10.11622/smedj.2013203

[26] Kravitz L. What motivates people to exercise? IDEA Health & Fitness Association; 2010 [cited 2017 9 April 2017]. Available from: http://www.ideafit.com/fitness-library/what-motivates-people-to-exercise.

[27] Usability. User Experience Basic. U.S. Department of Health & Human Services; 2017 [cited 2017 9 April 2017]. Available from: https://www.usability.gov/what-and-why/user-experience.html.

[28] Alben L. Quality of experience: defining the criteria for effective interaction design. Interactions. 1996;3(3):11-5. https://doi.org/10.1145/235008.235010

[29] IJsselsteijn WA, Kort YAWd, Poels K. Development of the Game Experience Questionnaire (GEQ). 2015 [Manuscript in preparation].

[30] Norman KL. GEQ (game engagement/experience questionnaire): A review of two papers. Interacting with Computers. 2013;24(4):247-62. https://doi.org/10.1093/iwc/iwt009

[31] Albaina I, Visser T, Mast Cvd, Vastenburg M. Flowie: A persuasive virtual coach to motivate elderly individuals to walk. Proceedings of the 3rd International Conference on Pervasive Computing Technologies for Healthcare (Pervasive Health) 2009. p. 1-7. https://doi.org/10.4108/ICST.PERVASIVEHEALTH2009.5949

[32] Brox E, Luque LF, Eversten GJ, Hernandez JEG. Exergames for elderly: Social exergames to persuade seniors to increase physical activity. 5th International Conference on Pervasive Computing Technologies for Healthcare (PervasiveHealth) 2011. p. 546-9. https://doi.org/10.4108/icst.pervasivehealth.2011.246049

[33] Jessen JD, Lund HH, Jessen C. Physical computer games for motivating physical play among elderly. Gerontechnology. 2014;13(2):220. https://doi.org/10.4017/gt.2014.13.02.185.00

[34] Nap HH, Kort YAWd, IJsselsteijn WA. Senior Gamers: Preferences, Motivations and Needs. Gerontechnology. 2009;8:247-62. https://doi.org/10.4017/gt.2009.08.04.003.00

[35] Pyae A, Luimula M, Smed J. Understanding Stroke Patients' Motivation for Motivation-driven Rehabilitative Game Design. In: Giaffreda R. et al. (eds) Internet of Things. User-Centric IoT. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, vol 150. Springer. p. 99-111. https://doi.org/10.1007/978-3-319-19656-5_16

[36] Raitoharju R, Luimula M, Pyae A, Pitkäkangas P, Smed J, editors. Serious games and active healthy ageing: A pre-study. The International Conference on Well-being in the Information Society; 2014.

[37] Pyae A, Raitoharju R, Luimula M, Pitkäkangas P, Smed J. Serious games and active healthy ageing: a pilot usability testing of existing games. International Journal of Networking and Virtual Organisations. 2015;16(1). https://doi.org/10.1504/IJNVO.2016.075129

[38] Nakai A, Pyae A, Luimula M, Hongo S, Vuola H, Smed J. Investigating the effects of motion-based Kinect game system on user cognition. Journal on Multimodal User Interfaces. 2015;9(4):403-11. https://doi.org/10.1007/s12193-015-0197-0

[39] Pyae A, Luimula M, Smed J, editors. Investigating the usability of interactive physical activity games for elderly: A pilot study. 2015 6th IEEE International Conference on Cognitive Infocommunications (CogInfoCom); 2015 19-21 Oct. 2015.

[40] Pyae A, Luimula M, Smed J. Pre-studies on Using Digital Games for the Elderly's Physical Activities. In: Li H, Nykänen P, Suomi R, Wickramasinghe N, Widén G, Zhan M, editors. Building Sustainable Health Ecosystems: 6th International Conference on Well-Being in the Information Society, WIS 2016, Tampere, Finland, September 16-18, 2016, Proceedings. Springer International Publishing; 2016. p. 82-96. https://doi.org/10.1007/978-3-319-44672-1_8

[41] Pyae A, Luimula M, Smed J. Rehabilitative games for stroke patients. EAI Transactions on Serious Games. 2015;1(4):1-11. https://doi.org/10.4108/sg.1.4.e2

[42] Terry PC, Biddle SJH, Chatzisarantis N, Bell RD. Development of a Test to Assess the Attitudes of Older Adults Toward Physical Activity and Exercise. Journal of Aging and Physical Activity. 1997;5(2):111-25. https://doi.org/10.1123/japa.5.2.111

[43] Plant RW, Ryan RM. Intrinsic motivation and the effects of self-consciousness, self-awareness, and ego-involvement: An investigation of internally controlling styles. Journal of Personality. 1985;53(3):435-49. https://doi.org/10.1111/j.1467-6494.1985.tb00375.x

[44] Seft-Determination Theory. 2016 [cited 2017 29 April 2017]. Available from: http://selfdeterminationtheory.org/intrinsic-motivation-inventory/.

[45] Renaud K, Van Biljon J. Predicting technology acceptance and adoption by the elderly: a qualitative study. SAICSIT '08 Proceedings of the 2008 annual research conference of the South African Institute of Computer Scientists and Information Technologists on IT research in developing countries: riding the wave of technology 2008. p. 210-9. https://doi.org/10.1145/1456659.1456684