Serious games and active healthy ageing: a pilot usability testing of existing games

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Abstract: In this paper, we report the findings from the pre-studies of gamified solutions in healthcare (GSH) project, which include mapping the existing games for seniors, conducting a pre-test on console games, interviewing elderly, and a literature review on the motivational factors for elderly. The findings showed us the limitations of the existing games and technologies. The literature review gave the useful game design opportunities. The insights from these pre-studies helped us to form the agenda, activities, and plan for our project. According to the proposed activities, we conducted a pilot testing of existing games with elderly and found out that the existing games have potential to be re-used with further modifications in our project. Furthermore, we learned the important lessons from this testing in terms of game design, interaction, and design opportunities. Then, we continue to re-design the existing games and develop new games followed by a usability testing.

Keywords: serious games; gamification; active ageing; usability testing.

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1 Introduction

Active ageing is the process of optimising opportunities for health, participation, and security in order to enhance quality of life as people age (*Active Ageing: A Policy Framework*, 2002). This term can be applied to both individuals and groups and it emphasises the ability to participate in society while being provided with protection, security, and care. Well-being in this matter is understood widely as physical, mental, and

social well-being (Peel et al., 2005). Nowadays, many everyday services such as banking, insurance, and healthcare are becoming digitalised. Thus, the digital divide and unequal opportunities of using modern technology can alienate seniors from society. The inclusion of seniors in the development of the information society is very important. One aspect of the information society is the increased gamification of various things such as learning or exercise. Gamification is the process of applying game-design thinking to traditionally non-game applications and functions to make them more fun and – above all – more engaging.

Serious games are games that are used for purposes other than mere entertainment. They can be used in several application areas, such as military, government, educational, corporate, and healthcare (Susi et al., 2007). Some research has been conducted on the positive effects of games and they have been found to affect, for instance, analytical and spatial skills, strategic skills and insights, learning and recollection capabilities, psychomotor skills, and visual selective attention (Mitchell et al., 2004). In healthcare, serious games have been used to enhance physical fitness, educate health/self-directed care, distraction therapy, recovery and rehabilitation, training and simulation, diagnosis and treatment of mental illness, cognitive functioning and control; for example see (Taylor et al., 2011; Adamo et al., 2010).

This paper describes the purpose and research activities of a project called gamified solutions in healthcare (GSH). Moreover, we report the findings from our pilot usability testing with the elderly participants. Then, we also mention our future work and the direction of the project. Basically, GSH project develops new services and effective activity solutions for elderly people through gamification. The purpose is to include elderly people in the development and testing of games that could be used for more than just entertainment purposes. Since this field is quite new, we conducted a pre-study in the beginning of the project in order to form our research agenda and the activities. The aim of this paper is to describe the results of the pre-studies of GSH project. Our purpose is three-fold: firstly, to map the existing games on the market that could be used as such or could function as an example of features that a game suitable for seniors could have. This search was limited to games that could enhance health and well-being (physical, mental, and social). Secondly, we evaluate the features in games that could make them senior-friendly or unfriendly. Thirdly, we examine what kind of barriers or attitudes there could be in the process of introducing games for the elderly.

This paper is structured as follows: we start with a literature review on serious games for healthcare followed by an introduction to the GSH project. The methods and results of a pre-study will be summarised and then, we report the activities in the research agenda of GSH project. We present and discuss the findings from the literature review on the motivational factors for elderly and the pilot usability testing of the existing games. Finally, we mention our future works of the project.

2 Literature review

Nowadays, the use of digital games for specific purposes has become increasingly popular in several areas (e.g., education, healthcare). Digital games are designed to make the players experience high levels of motivation and engagement in the gameplay (Watters et al., 2006). Video games have been known as a form of an engaging platform

for the players because of their entertaining, motivating, and fun activities. One of the main motivational factors in computer games is the sense of control that includes users' influence on the course of events and a tight relationship between users' actions and the outcome of the game (McCallum, 2012). According to Prensky (2001), digital games are potentially the most engaging pastime in history and it is due to the combination of game elements such as fun, play, problem solving, challenge, rules, and story-telling. Over the years, there is an increasing interest in digital games among professionals, researchers, and practitioners. For example, the concept of edutainment (education and entertainment) is widely accepted in learning. In business, people tend to use the concept of gamification in their business models and marketing strategies (e.g., Nike gamified their marketing strategies).

The use of digital games for healthcare is one of the promising areas. Recent studies showed that healthcare professionals are getting interested in using computer games for rehabilitation (Burke et al., 2010). Virtual rehabilitation can provide a natural or real-life environment; individuals have the opportunity to forget about their surroundings and situation and focus directly on a task in the simulated environment (Halton, 2008). Among commercially available games, Nintendo Wii seems to be one of the most promising technologies as a therapeutic tool in rehabilitation because of its low-cost hardware and physical-based interaction with the game. Wii encourages players to use natural actions to play games and has gained the support of occupational therapists because it is easy to use, entertaining and has a wide variety of games that can help patients perform therapeutic training (Anderson et al., 2010). The current needs of healthcare industries are low healthcare costs and affordable healthcare, better health outcomes and healthier population, and better patient experiences and patient engagement (IBM, 2014). To address these healthcare needs, serious games have potential.

Serious games have been proven in preventative care and behaviour modification (e.g., games for diabetes prevention and behaviour change for sufferers). Moreover, they have been used in long-term healthcare (e.g., rehabilitation) as well as chronic diseases (e.g., cancer). According to Anelea (2014), they have created a new game for smart-phone users that allows the players to analyse real cancer data with the intention to help scientists to find potential treatments. Exergaming is another interesting area and it has potential as a remedy to the growing societal healthcare problems (e.g., children's obesity and diabetes). Rizzo et al. (2011) reveal that game-based activities with functional body movements can have positive health outcomes for diabetes patients and obese children. Ruppert (2011) advocates that adopting virtual environments in the health context can make a significant difference in treating anxiety disorders, drug and alcohol abuse, eating disorders, impulsive disorders, and more.

For ageing population, digital games are used to improve the elderly's quality of life. Ijsselsteijn et al. (2007) reveal that the use of digital games to enhance the mental and physical activities of elderly (e.g., social connectedness and exercises) is promising. Nintendo Wii is used as a socialisation tool to promote the intergenerational relationship and communication between the young people and the elderly (Theng et al., 2012). Kahlbaugha et al. (2011) advocate that Wii can have positive impacts on the physical activity, loneliness, and mood of elderly. Pyae et al. (2013) reported that augmented reality-based rehabilitation system can have positive impacts on the motivational level of

elderly stroke patients. Tong and Mark (2013) mention that digital games can stimulate cognition and enjoyment, which often declines due to age-related changes. Whitlock et al. (2014) advocate that digital games are progressively used as a therapeutic tool in healthcare, context from improving cognitive abilities of the elderly to rehabilitation and pain management.

Despite having the potentiality, there are noticeable gaps and problems in using digital games for elderly and healthcare. Gerling and Masuch (2011) point out that not all commercial game are accessible to elderly. They conducted an exemplary focus group analysis of Wii Sports and Wii Fit games with the frail elderly players and a variety of usability issues were observed during the gameplay sessions (e.g., controller issues). Marinelli and Rogers (2014) advocate that most exergames available on the market do not support elderly-friendly design and gameplay. They evaluated two exergames for Microsoft Xbox 360 with the elderly players and the findings showed that the significant usability issues in these games may hinder the elderly's use of the games (e.g., cluttered interface). According to Webster and Celik (2014), they highlight on the limitations of current Kinect-based exercise games such as game designs for specific players, game customisation, lack of effective feedback, and lack of long-term study. Marin et al. (2011) reveal that the use of digital games for the elderly population requires an in-depth inspection to ensure optimum benefits on the elderly's healthcare outcomes. McLaughlin et al. (2012) point out that it is important for the designers to understand the capabilities, limitations, and interest of elderly to create successful game stories and mechanics.

In general, this literature review reveals that the area of gamification for elderly and healthcare has noticeable challenges that need to be overcome so that the researchers can investigate whether digital games are beneficial to elderly's well-being.

3 Gamified solutions in healthcare

GSH is a joint research project between Turku University of Applied Sciences and the University of Turku. In cooperation with Serious Games Finland Oy, Attendo Finland Oy, City of Turku Welfare Division, and Puuha Group Oy, the project researches and develops new gamified services. The project results are aimed for healthcare utilisation, physical exercise, social inclusiveness, and enhanced quality of life. The project is funded by Tekes (the Finnish Funding Agency for Innovation) until the end of 2015. A basis for this project is a study that was conducted together with Serious Games Finland, Sendai Finland Wellbeing Center, and Sendai National College of Technology. Serious Games Finland was interested in testing their serious game called Liitäjä in Japan (Nakai et al., 2013). At the same time, our researchers were cooperating with Puuha Group in their gamified playground project resulting in the first prototype that was presented in the Turku International Book Fair in October 2013 (see Figure 1). Since this prototype is a combination of mechanical engineering and game development it represents a quite unique approach and it opens for the GSH project new research questions to be studied. Moreover, the industrial partners Serious Games Finland and Puuha Group both have interests in the emerging Asian markets.

Figure 1 The gamified playground instrument presented in the Turku international book fair (see online version for colours)

4 Pre-study methods and results

The purpose of the pre-study was to get a basic understanding of the current stage of games and attitudes towards games among seniors in order to form a more detailed research agenda and the activities for the project. The aim of the pre-study was not to get scientific or generalisable information about the topic but rather to help us to formulate the research topics that should be answered during the project. The pre-study consisted of three stages:

Phase 1 Mapping senior-friendly games in the market.

Phase 2 Evaluating senior-friendly and unfriendly features in the games.

Phase 3 Getting a basic understanding of possible barriers and attitudes when introducing games to the elderly.

In Phase 1, we identified 30 games. Our inclusion criteria were that the game is suitable for senior users and it should improve health and well-being. These 30 identified games were then tested and classified into the following categories:

1 games for physical activity

2 games for social activity

3 games for mental activity.

Games for physical activity are mainly console games that used different sensors that recognise movements. Games for social activity are games that one could play with other people such as bingo, chess, and chats. Games for mental activity are games that activate the brain and memory such as memory games, and problem solving games.

In phase 2, we selected different games out of many commercial games that will be used for our future usability testing with the elderly participants. Basically, a team of 12 health informatics students tested different console games and identified the game actions that can improve physical activity. Problems that we observed and identified during the test were related to:

- physical limitations: the games included jumps, fast movements and other elements that were not considered senior-friendly
- visual elements: the games were full of visual, moving elements
- usability: the beginning of the games was complicated and took a lot of time, the instructions were in small print and with no language options
- focus: the focus in many games was more in body building and fitness exercise
- selection of sports: several games were about roller skating, street dancing and many other sports that are not that familiar or important to seniors.

In phase 3, we conducted three interviews of seniors, who were over 70 years old and were using a health technology service. The themes of the interview were games in general, willingness to play digital games for health and well-being and issues related to the use of information technology in general.

The interviews revealed several interesting issues about gaming among seniors. For instance, attitudes towards games in general may not be as positive as among younger generations. Games were considered to be something for people with nothing better to do. Also the word 'exercise' was considered something that young people or women would do. However, when discussing the topic in more detail, the seniors revealed several games that they have played and could play, for instance chess, coin slots, poker and quizzes. Games that the seniors would play together with others seemed to gain a more positive response than games that you play by yourself. The seniors were also concerned about their information technology skills and some thought they would not have the mental capabilities to learn digital games. Physical limitations were also seen as a problem.

In the pre-study, we identified some gaps in the current knowledge, which gave us in-depth understanding and insightful ideas that will help us in designing and developing gamified services for elderly in the project. Based on the findings from the pre-study, project plan, and discussions, it became imminent that we should conduct more research about the seniors' attitudes towards gaming and digital games. Especially, we need more focus group interviews as well as some usability testing with console games. This includes also attaining more knowledge about the physical limitations and their influence on gaming. Finally, the research requires systematic analysis about the existing games for seniors, and the attitudes and perceptions of health and social care workers that work with seniors. The research activities of GSH can be summarised in four primary topics:

1 gamification mechanisms
2 usability for elderly people
3 effectiveness of game solutions for elderly people (e.g., business and production models)
4 attitudes and acceptance of games by the elderly people.

5 Understanding motivational factors for elderly in rehabilitation

According to our proposed research activities, we conducted a literature review on the role of motivation in elderly's rehabilitation (Pyae et al., 2014). We specifically focused on the motivation of elderly in stroke rehabilitation and ideated how we can be mapping out these motivational factors on designing games for rehabilitation. We have found out that there are many social and environmental factors that can influence on the level of motivation of elderly in doing rehabilitative physical exercises.

Social functioning such as social contact, social activity, and social encouragement, is one of the most important factors that can have an impact on the patient's level of motivation. In designing games, we can apply the idea of socialisation for elderly into social-based games such as intergenerational game, multiplayer game, and social activity game. The relationship between therapist and patient plays a vital role in rehabilitation that can improve patient's motivation. When we design games, we can apply this idea in using virtual characters (e.g., friendly therapists) in the game. We found out that personal goals are important in rehabilitation. Having a personal goal in the rehabilitation process can make elderly more motivated and engaged in their physical exercises. Therefore, we can design goal-oriented games for elderly's physical training and rehabilitation. In addition, rehabilitative environment and setting are regarded as an important motivational factor for elderly. Hence, we can design elderly-friendly environment in the game context such as household environment, neighbourhood, and service homes for elderly.

Individual motoric level can be varied from one patient to another. Therefore, the customisation or personalisation is an essential part of the rehabilitative training. Thus, we can design customisable games for elderly so that they can meet their individual needs. There are other important motivational factors for elderly and their rehabilitative activities such as meaningful rehabilitative tasks, information from healthcare professional, positive feedback and encouragement from therapist, and recreational and leisure activities. All the motivational factors are useful and insightful for our future game design and development. Moreover, these findings may be helpful when we are designing gamified services such as socialisation, rehabilitation, entertainment, and counseling systems. The summary of our findings from literature review is listed as below (see Table 1).

Table 1 Motivational factors for stroke patients in rehabilitation

Motivational factor	*Indication to game design*	*References*
Social functioning	Multiplayer game Intergenerational game	Maclean et al. (2002), Krause et al. (2001), Shimoda and Robinson (1998), Sanntus et al. (1990), Evans et al. (1988), Domboyy et al. (1986) and Barry (1965)
Patient-therapist relationship	Virtual character such as therapist and nurse	Maclean et al. (2002) and Barry (1965)
Setting relevant rehabilitative goal	Goal-oriented game	*Finding Motivation after Stroke or Brain Damage* (2014)
Rehabilitative setting and environment	Household environment, Service homes for elderly, Public spaces (e.g., park)	Holmqvish and Koch (2001)

Table 1 Motivational factors for stroke patients in rehabilitation (continued)

Motivational factor	*Indication to game design*	*References*
Information from healthcare professionals	Game help system Game tutorial	White et al. (2012)
Meaningful rehabilitative task	Elderly friendly sport games Household chores	Flores et al. (2008)
Individual needs and customisation	Game personalisation and configuration	Flores et al. (2008)
Positive feedback from therapist	Game feedback and score	van Vliet and Wulf (2006)
Music for rehabilitation	Game background music, Audio feedback	Knight and Wiese (2011)
Recreational activities for stroke patients	Recreational games such as chess, bingo, and dance games	Roth and Wisser (2004)

6 A pilot usability testing

According to our proposed research activities, we conducted a pilot usability testing of existing games at the elderly service home in Rääkkylä in Finland. Before we conducted the pilot usability testing, we recruited five elderly participants who are the regular participants in the social activities and physical exercises programs arranged by the community centre. Their average age range is from 62 to 85 and their health conditions are sound and stable although some of them suffer from age-related health problems such as memory loss, hearing problem, and limited mobility. They are fairly active in their daily lives in terms of social activities and physical exercises (e.g., walking, cycling). For this user testing, we chose two commercial games and Puuha Group's SportWall game which is designed for physical activities of various age groups. Basically, SportWall game uses Xtreme reality technology and a traditional webcam to detect the player's movement. This gameplay is designed for roller skating exercise and the player needs to use particular body postures and gestures to control the game.

Concerning commercial games, there are many sport activity games on the market. Among them, we selected Microsoft Xbox's Kinect-based climbing game and PlayStation3's PlayMove Controller-based tennis game. The reason why we chose these two games over others is that Kinect-based games are promising to be used as a tool to improve the patient's experiences in rehabilitation. Moreover, Xbox supports a variety of sport games that may be used as game-based physical exercises for elderly. For PlayStation3's PlayMove tennis game, it also supports a variety of sport games (e.g., bowling, tennis). Moreover, PlayStation3's PlayMove controller is interesting to be tested with elderly whether it is elderly-friendly and useful for them. After discussing with the caregiver at the service home, we chose only three games to be used in our study because of the physical and mental tolerance of the elderly participants. The main objectives of this pilot study are as follows:

1 to investigate the usability and usefulness of commercial games and SportWall game for the elderly

2 to find out the usability and usefulness of multimodal input devices for elderly (Kinect for Xbox One, PlayStation3's PlayMove controller, and SportWall's traditional webcam and Xtreme reality technology)

3 to understand the general user experiences of elderly in gameplay.

7 Pilot usability testing design and procedure

Firstly, we prepared the game stations at the elderly service home before we conducted the testing. We set up the games: Xbox game console, PlayStation3 game console, Microsoft's Kinect for Xbox One, PlayStation3's PlayMove controller, SportWall game with traditional web cam, and two large-screen TVs. To be able to investigate the elderly participants' problems, difficulties, and responses during the game sessions, we recorded their actions and gameplay by using two video recorders from both front and back views. For the questionnaire session, we used a voice recorder to capture the conversation between the research and the elderly participant for future reference.

Before we started the game sessions, we asked every participant's consent to involve in the study. Then, we performed a quick introduction session to our usability testing, digital games, and the objectives of our study. There were three game sessions in this study. In session one, the elderly participants played Xbox's Kinect-based climbing game followed by a quick questionnaire session to investigate their responses and feedback towards the usability and usefulness of the game and the Kinect. In session two and three, the elderly participants played PlayStation3's tennis game with PlayMove controller and SportWall game with webcam respectively. For every game session, the researcher guided the elderly participants how to play the game by going through a quick game tutorial. To avoid learning effects in playing games, we randomly assigned the elderly participants to play the particular game. In the entire usability testing, the administrator at the elderly service home monitored every participant to protect them from being fallen and exhausted while they were playing the games.

After finishing all sessions, the researcher asked the general interview questions to the elderly participants about their overall experiences. Due to the limited time and tolerance of the elderly participants, we used short and simplified version of usability questionnaire to collect their feedback. Table 2 shows the detailed procedures of our usability testing. According to the estimated time taken for individual elderly participant, each game session took 15 minutes including game tutorial, gameplay, and questionnaire session. However, individual session was varied from one participant to another. As each participant had to play three games in the whole usability testing, it took about 60 minutes individually. The whole usability testing with five participants took about 3 hours.

Table 2 Usability testing design and procedures

Tasks	*Description*	*Time taken*
Introduction to usability testing and getting consent	Researcher explains about usability testing procedures and asks consent from every participant.	10 mins
Gameplay session 1	Quick tutorial of game	5 mins
	Participant plays Game 1 (Xbox climbing game)	5 mins
	Questionnaire	5 mins
Gameplay session 2	Quick tutorial of game	5 mins
	Participant plays Game 2 (PlayStation's PlayMove tennis game)	5 mins
	Questionnaire	5 mins
Gameplay session 3	Quick tutorial of game	5 mins
	Participant plays Game 3 (SportWall game)	5 mins
	Questionnaire	5 mins
Post gameplay interview	Researcher asks post gameplay interview questions to the participant.	5 mins
	Total time taken	60 mins

Figure 2 A pilot usability testing (see online version for colours)

In this study, we used a set of questions to investigate the elderly's personal information, health condition, user experiences, and feedback. The general interview session before gameplay includes questions such as age, gender, health status, physical activities, and prior experiences in playing digital games. The usability questions include usefulness, simplicity, and ease of use of the games and interactive input devices. Besides, we asked their experiences in gameplay in each game session such as how quick they can learn to use a particular device and how well they can perform by using this device. We also asked if they had fun to play the game and if each game was challenging enough to play.

After that, we asked the general interview questions to the elderly participants such as their problems and challenges encountered in each game session. All questionnaires, except general interview questions, were based on FIVE-points-scale from strongly disagree (1) to strongly agree (5). The researcher and the caregiver helped every participant to be able to answer the questions. Figure 2 shows that one of the participants was playing during the usability game session.

8 Findings

Generally, the elderly participants in our study are moderately active in their daily lives and physical activities. They all participated in every game session and they gave their feedback on the games and their user experiences. According to the general interview session before they played the game, they all did not have prior experiences in playing digital games and they had a few difficulties in answering questionnaire. Therefore, the caregiver at the centre and one of our researchers guided them in both questionnaire and gameplay session.

In session one, the elderly participants had some problems while they were playing the game (Xbox's climbing game) by using Kinect sensor because it was their first time playing digital game. However, after the researcher had guided them how to play the game and they have gone through the tutorial session, they could continue playing the game without major challenges. In this session, we found out that the graphics, the user interface, music, and audio feedback in the game were cluttered and not elderly-friendly. Therefore, sometimes they were distracted in gameplay and could not continue to play the game. Kinect-based interaction seemed to be effective for the elderly in gameplay.

In session two, we found out the major challenge experienced by all elderly participants. For PlayStation3's tennis game, they used PlayMove controller to interact with the game. Basically, it is necessary to press the buttons of the controller to play the tennis game. For the elderly participants, it was found out that they could not handle the controller properly and they forgot to press the buttons most of the time. As a result, they could not proceed with the game after some time. Although they liked the idea of tennis game, all of them did not achieve the game to a certain level in this game.

In session three, it was generally found out that all participants could perform well in SportWall game. The gameplay was simple and the game interface was clean and uncluttered. As the game used the traditional webcam, the interaction with the game for the elderly was not challenging. The elderly participants used different body postures and gestures to control the game. Noticeably, we found out that some game actions (e.g., jump, sit) were not safe for the elderly because it could make them fall and they may be exhausted after some time.

According to the elderly's feedback, we found out that Kinect for Xbox One was the most effective input device for the elderly participants (mean score 3.36) whereas PS3's PlayMove controller seems to be the hardest for the elderly participants (mean score 2.64). The SportWall's webcam-based interaction was the second most effective device for the player (mean score 3.28). However, the average scores of these two devices (Kinect and SportWall's webcam) were not noticeably different. Table 3 shows the summary of average usability score that each input device has achieved.

Table 3 Usability of interactive input devices

Input device	*Usability*	
Kinect for Xbox one	It is useful in gameplay.	3
	It is easy to use.	3.2
	It is simple to use.	4
	I learned quickly to use.	3.2
	I performed well.	3.4
	Mean score	3.36
PS3's PlayMove	It is useful in gameplay.	2.6
	It is easy to use.	2.6
	It is simple to use.	3
	I learned quickly to use.	2.4
	I performed well	2.6
	Mean score	2.64
SportWall's webcam	It is useful in gameplay.	3
	It is easy to use.	3.2
	It is simple to use.	3.4
	I learned quickly to use.	3.4
	I performed well.	3.4
	Mean score	3.28

Regarding their feedback towards the usability of each game, the elderly participants enjoyed the most to play SportWall game followed by the Xbox's climbing game. However, they were not noticeably different from each other in term of the mean score they have achieved (mean score 3.42 for Xbox and 3.46 for SportWall). In contrast, PS3's tennis drew the least attention from all elderly participants and they did not enjoy the gameplay (mean score 3.3). It seems that the difficulties to use the controller in playing game could influence on their overall user experiences.

In general interview session, 4 out of 5 elderly participants answered the questions whereas the participant (S3) did not comment on the games. The elderly participants mentioned their interests in all games. The participant one (S1) mentioned that it was enjoyable to play the games. However, he was not strongly confident to play it again by himself. Moreover, he advised that either therapist or caregiver should guide him how to play the game because he mentioned that he could easily forget it. With regard to the interactive input devices, he pointed out that PlayStation3' PlayMove was difficult to use and to interact with the game. The other participants (S2, S4, and S5) gave the general positive feedback on the games and controllers and they all would like to play the games at the community centre or home.

In addition to the feedback from the elderly participants, we managed to interview the caregiver at the centre regarding the usability and usefulness of the games and the interactive devices. She generally thought that game-based physical activities are interesting and it is promising to improve the elderly's motivation in doing physical exercises and also it can enhance the socialisation of elderly if they perform in group activities. Besides, she advised that the games should be simple and easy enough for the

elderly because of their limited mobility and weak memory. She also mentioned that majority of elderly residing at the service homes are not familiar with digital games. Thus, it would be useful if the games are elderly-centred. She also suggested that controller-free motion-based games are easy and simple enough for the elderly players. She requested that she would like to install some digital games at the centre and test it out with elderly for long-term.

9 Discussion

We pinpoint the important findings from this pilot usability testing. The commercial games that we used in this study are not elderly-friendly due to the cluttered user interface, distracting graphics, and audio feedback. Sport activity-based games could draw the attention from the elderly participants. However, the gameplay should be simple but challenging enough for the elderly player. SportWall game seems to be the most effective game in terms of its user interface, gameplay, and instruction because it is simple, clean, and easy to play. However, it is noticeable that we should avoid the game actions or body posture that can trigger the possibility of elderly's fall during their gameplay. Besides, when we design the games for elderly, we should consider avoiding the extreme game actions that can easily lead to the exhaustion of the elderly player. For example, jump action in the game is unsafe for the elderly.

With regard to the interactive input devices, we found out that controller-free motion-based input devices seem to be rather effective and efficient for the elderly players. In contrast, complicated functions of the controller can make the elderly confused and distracted in playing games. Concerning the motion-based input devices, the synchronisation, responsiveness, and accuracy of a particular sensor are important for better user experiences. Although the elderly participants would like to play the games again, most of them still lack the confidence in playing the games by themselves. Therefore, it is important for us to take into consideration how we can improve their level of confidence in terms of game design and gameplay. Based on the findings from this pilot study, we can outline our future tasks as below:

1 to re-design the Puuha Group games to be suitable for elderly player

2 to further develop, enhance, and run the pilot test of Puuha group games to investigate whether these games are elderly-friendly

3 to run the pilot usability testing of other existing games in our project

4 To conduct the usability testing of new games with a large number of elderly in the service homes in Finland and in Asia.

In this pilot study, we have a number of limitations. Firstly, the number of elderly participants is quite small. Secondly, we have tested only two commercial games out of many other games because of limited time and physical tolerance of the elderly participants. Thirdly, we have conducted the study for only one day and the elderly participants have played only three game sessions in the entire user testing. Lastly, we have used short and simple questions in the interview session and it did not cover all parts usability questionnaire.

10 Conclusions

We have conducted a pre-study of existing games, forming a research agenda and activities, a literature review on motivational factors for elderly, and a pilot usability testing. The findings from these studies are insightful for our future game development. By conducting these pre-studies, we had a clear vision on our future research direction. In the first pre-study, we have selected the suitable commercial games for our future user testing. We have also investigated the elderly's general attitude towards digital games for physical activities. Based on the findings from this study, we have found out the limitations of existing games in terms of interface, gameplay, visual and audio feedback, interaction, and genre. These findings helped us to emphasise on the particular games that are promising to be used for future testing. The literature review on the motivational factors for elderly provided us game designs opportunities that can be mapping out on the existing games and future development.

According to the research activities of GSH, we have conducted a usability testing with five elderly participants and we have learnt the important lessons from this usability study. By conducting this testing, we have learned to avoid the unsuitable game interfaces, features, game context, and movements that are not friendly for the elderly whereas insightful game design principles that we have learned from this study can be applied in our future game development and improvement. Moreover, we have found out that some existing commercial games and technologies (e.g., Kinect sensor, Xbox Sport games, SportWall game and Xtreme reality technology) can be modified and used for our future games.

In the future, we will test our existing games with modifications and new games with large elderly sample size so that we can investigate the new insightful findings for our project and games. Besides, we aim at testing these games in the different cultural context and regions (e.g., Asia) to understand how they can be adaptable and customisable for different user groups.

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