

# Lessons Learned from the Usability Testing of Physical Activity Games for the Elderly

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Abstract

In this paper, we discuss usability lessons in designing physical activity games for the elderly. Physical activity games in this study refer to game-based activity that can enhance the elderly's experiences in doing physical exercise and improve their physical well-being. We learned these usability lessons through the usability testing of different physical activity games including commercial games as well as the games produced by the Gamified Solutions in Healthcare (GSH) project. The discussion is based on the findings from the observational study, interview, and questionnaires in the usability testing. These usability lessons are insightful and useful for our future game design and development as well as for researchers working on game usability for the elderly.

*Keywords:* *exergames, usability, game design, interaction, the elderly*

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## 1. Introduction

In recent years, digital games have been regarded as a promising tool to promote the elderly's quality of life in terms of physical fitness, mental well-being, and social connectedness [1, 2, 3, and 4]. Digital games are used to encourage and motivate the elderly to engage in regular physical exercise activities that lead to active ageing [5]. In physical rehabilitation, digital games have potential to improve the elderly's balance and motor skills, and they can also reduce risks of fall [6]. Game-based intervention for cognitive impairment is being accepted as an alternative approach in rehabilitation [7]. In addition, game-based social activities such as intergenerational gameplay become a trend recently. Theng *et al.* [8] advocate that intergenerational games can improve social bonding between older and younger generations. Among commercially available games, Nintendo Wii Sport games and Microsoft's Xbox Kinect-based Fitness games are widely accepted for the elderly's socialization and healthcare [8, 9, and 10].

There are a relatively good number of research articles recommending the usability and usefulness of digital games for the elderly. However, this research area is relatively young, and it is a broad topic to cover. Therefore, we need to study more widely in this area to create more usable and useful digital games for the elderly. Ijsselsteijn *et al.* [11]

point out that due to the limited functional ability of the elderly, they have higher risks of encountering usability problems in using technology, compared to younger users. The authors also highlight that game developers today are paying more attention to younger audience, and most of them are not aware of basic guidelines for game usability and accessibility for the elderly. The authors also suggest that these challenges can be addressed by doing extensive usability testing with the elderly users. Garcia et al. [12] also advocate that the use of digital games for the elderly's healthcare has shown positive outcomes, but it is critical to expand the study of usability and suitability of digital games for the elderly.

In this paper, we report the usability lessons that we have learned from the usability testing of physical activity games for the elderly in Gamified Solutions in Healthcare (GSH) project. These usability issues were observed through the observational study, interview, questionnaires, and the elderly's feedback and comments in different usability testing of physical activity games for the elderly. To report the usability lessons, we will discuss each usability lesson according to what we have learned from our observational and interview study. The usability lessons in this paper are only limited to physical activity games for the elderly. The main objective of this paper is to review and share our findings of game usability lessons for physical activity games for the elderly

## **2. Pre-studies**

GSH is a research project that focuses on four services to improve the elderly's quality of life in terms of rehabilitation, socialization, recreation, and counseling. The main objective of rehabilitation service is to provide game-based solutions for the elderly's physical rehabilitation. The major concept of this service is to utilize digital games to motivate the elderly to do regular physical exercise activity and rehabilitation training. The ultimate goal of GSH's rehabilitation service is to design and develop elderly-friendly physical exercise games. To design and develop such games, we conducted a number of pre-studies to understand the potentiality, usability, and usefulness of digital games for the elderly [13, 14, 15, 16, 17, and 18]. These pre-studies include the literature review, the usability testing of commercial games in the market, and the usability testing of game prototypes developed by GSH's team.

### **2.1. Pre-study 1: A Usability Testing of Commercial Games**

First of all, we conducted a usability testing of commercial games: Microsoft Xbox Kinect-based Climbing and Bowling game, and PlayStation's PlayMove Tennis game [16]. We conducted this study at one sport event in Finland that was dedicated to the elderly's physical well-being. We tested the games with 12 elderly participants. In this testing, the elderly played three games, and we asked open-ended interview questions to each participant regarding their experiences in playing games. We also captured their gameplay by using a video recorder. Then, we observed the usability of the games for the elderly based on the video recordings, interview notes, and questionnaire answers. The findings from this usability testing suggest that the commercial games are not elderly-friendly. However, we observe that the elderly showed their interest in playing digital games for their physical exercise.

## 2.2. Pre-study 2: A Usability Testing of Commercial and SportWall Games

We conducted another usability testing at two elderly service homes in Finland. We used both commercial games and our own game prototype. For commercial games, we used Xbox Kinect-based Climbing game and PlayStation's PlayMove game. For the non-commercial game, we used SportWall game developed by Puuha Group Finland (See Figure 1). The SportWall game is a motion-based game that uses a traditional webcam using Xtreme Reality technology. In this game, elderly player plays a simple skateboarding activity by using body movements. In this study, we recruited two elderly groups: functionally independent elderly group and least independent elderly group. The functionally independent elderly group includes the elderly who perform physical exercises daily or weekly, and they are also socially active. For the least independent elderly group, they are physically weak, and they rely on therapists and caregivers to do their activities of daily living (ADLs). They are also socially inactive.



Figure 1. The SportWall game.

We firstly conducted the test with five elderly participants from the functionally independent group. They played all three games in this testing. After they have played each game, we asked the elderly regarding the usability of the game. Then, we conducted a general interview session after they have finished all games. We followed the same procedure for the second elderly group who are the least independent. We captured the elderly's gameplay by capturing with a video recorder. Based on the findings from this usability testing with two elderly groups, we observe that the second elderly group could not play all three games because of their limited mobility and memory. According to the feedback given by the functionally independent group, we observe that the elderly preferred SportWall game out of three games because of its uncluttered game interface, simple and easy gameplay, and controller-free interaction. The elderly preferred Kinect-based interaction to play the game, whereas PlayStation's PlayMove controller was the most difficult for them to interact with the game. Figure 2 shows the usability testing of SportWall game.



Figure 2. The usability testing of SportWall game.

### 2.3. Pre-study 3: A Usability Testing of Skiing Game with Finnish Elderly Participants

We also evaluated our physical activity game called “Skiing game” with 21 elderly participants in Finland [17]. The usability testing took place at one of the elderly service homes in Finland. The Skiing game is basically a webcam-based motion activity game. We also used Xtreme Reality technology in this game to detect player’s movements. The gameplay is based on a simple skiing activity by using body movements. In this usability testing, the elderly participants played the game, and we asked usability questionnaires and open-ended interview questions to all elderly participants after they have played the game. We also used a video recorder to capture every participant’s gameplay. Based on the findings from this usability testing, we observe that the usability of Skiing game is relatively good for the elderly. Their in-game and post-game experiences are positive. However, we also observe some noticeable usability challenges for the elderly through the interview and observational study. We will report our findings on usability issues in the next section. Figure 3 shows the Skiing game and Figure 4 shows the usability testing conducted in Finland.



Figure 3. The Skiing game.



Figure 4. The usability testing of Skiing game (Finland).

#### 2.4. Pre-study 4: A Usability Testing of Skiing Game with Japanese Elderly Participants

We also conducted another usability testing of Skiing game in Japan with 24 Japanese elderly participants [18]. The main objective of this usability testing is to understand the Japanese elderly's feedback towards the usability of the game. We followed the same procedure that we used in the usability testing in Finland. Basically, the elderly played the game, followed by the general interview session and questionnaires about the usability of the game. We also captured the elderly's gameplay with a video recorder. In all our usability testing, we received the consent from all elderly participants to use a video recorder. All recorded data are kept confidential. According to the Japanese elderly's feedback towards the usability of Skiing game, we observe that Skiing game is a simple and effective game for them although it has some minor usability flaws. Their experiences during and after the gameplay are relatively positive. We also learned the important usability lessons from this usability as well. Figure 5 shows the usability testing of Skiing game in Japan.



Figure 5. The usability testing of Skiing game (Japan).

### 3. Usability Lessons

In this study, we conducted four usability testings of physical activity games for the elderly. We used three commercial games (two Xbox Kinect games and one PlayStation PlayMove game). We also used two physical activity games developed by GSH's team and Puuha Group Finland. In these pre-studies, we observe the usability problems encountered by the elderly participants through video observation. Furthermore, we also observe the elderly's user experiences in their gameplay through interview studies. Based on the findings from the observational and interview studies, we identify the important usability lessons that we have learned from the usability testings. We report our suggestions and recommendations to each usability lesson in this study. In the next phase of our project, we will address these usability issues in designing and developing physical activity games for the elderly.

#### **Game calibration and tutorials should be intuitive enough for the elderly to follow.**

Game tutorial is also an important part of a physical activity game for the elderly so that they can play the game without difficulties. In both commercial games and our physical activity games, game tutorials are provided for the elderly to learn how to play the game before they start playing. However, these tutorials are not easy and simple enough for the elderly. Based on the findings from the usability testing of SportWall game with ten elderly participants [16], we observe that the elderly participants could not follow the instructions given in the game tutorial. As a result, the researcher had to guide them how to play the game in the tutorial session.

Game calibration is also an important step for the individual player to meet their requirements to play the game. For instance, in Skiing game, elderly player needs to raise their hands so that the webcam can detect the player's movement and trigger the game. According to the findings from the usability testing of Skiing game with the elderly participants [17, 18], we found out that the elderly could not follow the instructions to calibrate the game before they play. Consequently, the researcher had to guide them in calibrating the game. Based on this lesson, we suggest that it is important to take into consideration how game calibration and tutorial can be designed to be simple, easy, and intuitive for the elderly.

**Game instructions and feedback should be user-friendly for the elderly.** In our physical activity games, we use simple instructions and labels for the elderly. However, it still cannot provide clear instructions and feedback that elderly can easily understand the progress of the game, the achievements, and how to proceed to the next step. In our games, we use simple and short text-based instructions. However, according to the findings from the usability testing in our study, we observe that it is still a challenge for the elderly to understand the game instructions, and they need the assistance from the researcher. With regard to the game feedback, we use different metaphors in the game such as icons, audio feedback, and animation. Nevertheless, we realize that the feedback in our games is not intuitive enough for the elderly to understand what it means. Therefore, we suggest that in designing physical activity games for the elderly, it is important to design and develop simple but effective game instructions and feedback for the elderly.

**Repetitive game actions can decrease the elderly's interest in the game.** We design games to be suitable and relevant for the elderly. Therefore, sometimes game design, context, and contents become simple and unattractive. As a consequence, it can make the elderly feel less interested in the game, and they might feel bored after a certain period of time. We also design a game with simple and easy actions for the elderly and their functional ability. As a result, when the elderly perform a particular game action repetitively for a certain time, the game action becomes monotonous for them, and they may feel less motivated and discouraged.

In our Skiing game, we design the game action of skiing activity for the elderly. The elderly moves both hands forward and backward to play skiing activity. According to the findings from the elderly's feedback towards Skiing game [16], we found out that some elderly participants felt bored to repetitively do the same action for a certain time. According to our interview session [16], we realize that the elderly prefer to play different game actions, and it makes them feel more motivated. Furthermore, we also find out that the elderly like game activities that can be related to real-life activities such as bowling, biking, and playing tennis. Based on this, we recommend that we should take into account different game actions in a particular game for the elderly to play so that they may be more motivated in the gameplay.

**Fun factors are important in physical activity game for the elderly.** The main objective of physical activity game for the elderly is to improve their physical well-being, as well as to have fun at the same time. Generally, most elderly participants in our usability testing gave positive feedback towards the games, and they mentioned that the games are fun to play. For instance, in the usability testing of Skiing game with both Finnish and Japanese elderly, we observe that Skiing game-based activity is enjoyable for them because most of them enjoy skiing activity in the real world when they were young [17, 18].

According to the findings from our usability testing with elderly participants, we found out that some elderly participants claim that physical activity games are not fun because they encountered negative experiences in playing game or interaction experiences. In our usability testing of PlayStation's PlayMove Tennis game [16], we found out that the elderly encountered problems in using the controller. As a consequence, they all mentioned that playing PlayMove Tennis game was not enjoyable although some of them expressed that they like to play tennis. The fun factors in physical activity games are depending on many factors such as game context, contents, interaction experience, and gameplay. Therefore, it remains a challenging topic how to design fun games for the elderly's physical activity. We suggest that in designing physical games for the elderly, we should consider different factors that can influence on the player's enjoyment in the gameplay.

**Social elements are important in physical activity game for the elderly.** Social contact is important for the elderly to remain active in society. There are many studies that report the positive effects of social and intergenerational games on the elderly's social connectedness with others [8, 19, and 20]. There are different types of social-based games that have the potential to improve the elderly's socialization such as multiplayer game, online games, intergenerational game, and competition games.

In our SportWall and Skiing game, being first generation prototypes, we do not integrate social elements in these games. Moreover, in the usability testing with the elderly participants, there was no co-gameplay for the elderly participants. According to the findings from the interview sessions in the usability testing, most elderly participants expressed their interests towards multiplayer gameplay. The therapists and caregivers involved in our usability testing also insist that the game system should allow the elderly participants to play together so that they can improve their social bonding among peers. Therefore, we suggest that integrating social elements in physical activity games for the elderly is an important factor.

**Interaction techniques and devices should be user-friendly for the elderly.** There are different types of interaction techniques that player can use to play games such as traditional controller (e.g., Xbox game controller), touch-based interaction (e.g., mobile phones), stylus-based interaction (e.g., stylus for iPad), motion-based interaction (e.g., Microsoft Kinect), and device-based interaction (e.g., Wii balance board). In our usability testing, we used different types of interaction devices that include Microsoft Kinect, PlayStation's PlayMove controller, and webcam-based Xtreme Reality Motion detection technology [16].

Based on the findings from the studies, we realize that controller-free interaction technique is easy and effective for the elderly. We also observe that the elderly's interaction experience can impact on their gameplay. For example, in our usability testing of PlayMove controller, all elderly participants reported that they had difficulties in using this controller. As a result, they could not enjoy the gameplay. Based on this usability lesson, we suggest that it is important to consider what type of interaction technique and devices will be used for physical games for the elderly before we design games.

**Game graphics should be user-friendly for the elderly.** Game graphic plays an important role in a good game system. When we design physical activity game for the elderly, it is important to understand what type of graphics the elderly prefer. According to our pre-studies [13, 15], we found out that graphical contents in commercial games are not appropriated for the elderly, and it can make them confused in their gameplay. For example, in Xbox Kinect-based Climbing game, the graphical representation is cluttered, and as a result, sometimes the elderly was distracted in the gameplay. The findings from our pre-studies highlight that the elderly prefer game context and contents that can be related to the real life environment and activity. For example, they like card games, bowling, and sport-based games. Thus, we used snowy mountains and skiing activity as game context and contents in our Skiing game because most of the Finnish elderly enjoyed skiing activity when they were young. In the usability testing of Skiing game, the elderly commented that they enjoyed doing game-based skiing activity. Therefore, in designing a physical game for the elderly, we recommend that the graphical representation of the game should be user-friendly for the elderly.

**Game music and sound should be appropriate for the elderly.** All commercial games basically use game music and sound that are more appropriate for younger players. Choosing appropriate game music and sound in designing physical activity game for the elderly is still not clear. To our knowledge, there are very limited or no studies that investigate the elderly's preferences in game music. Based on the findings from our pre-studies [13], we realize that elderly do not like noise game background music and audio

feedback, especially in commercial games. It can make the elderly distracted in their gameplay. We generally assume that elderly may prefer old-fashioned music and songs. However, there is no evidence that the elderly will prefer that kind of music in playing physical activity game. Thus, we recommend that it is important to understand the elderly's preferences in game music and audio feedback when we design physical games for them.

**Game scores and rewards should be meaningful for the elderly.** Designing meaningful game scores and rewards is an important step in physical games for the elderly to motivate them. In commercial games that we used for our usability testing, we observe that the game scores and rewards are not intuitive for the elderly. In SportWall and Skiing games, we use simple scores that display digits and text-based descriptions (e.g., “Excellent”, “Try again”). According to our usability testing, we found out that the game scores and rewards showing in graphical icons such as points, coins, and money, are not intuitive enough for the elderly because they do not understand what these scores and rewards mean. As a result, most of them do not know their performance and progress in the gameplay. Therefore, when we design physical games for the elderly, it is important to consider how to design simple and effective game scores and rewards that are easy to understand.

**The elderly do not know where they are now in the game.** The findings from the usability testing of commercial games show that the elderly sometimes have lost their focus in the game because of the cluttered user interface, unclear game labels, and noisy audio feedback. As a result, we observe that most elderly participants cannot proceed to the next action. That is why, they need someone's help to be able to move forward. Another issue is that most elderly participants cannot pay attention to the rewards or points to collect. Thus, they miss the opportunities to improve scores and points. The same situation happens in avoiding obstacles in the game. Because of these distractions, sometimes elderly cannot avoid the obstacles, and it delays them to move forward. Therefore, in designing physical activity game for the elderly, it is important to design simple and clear game context and content, effective game actions, intuitive game instructions, and appealing reward system so that elderly can be more engaged in the game itself.

**The elderly do not know their goal in the game.** Another usability issue that we have found out in our usability testing is that the elderly do not know where they are heading to in the game. They do not know what their goal in the game is. Generally, our games lack providing intuitive information about their progress and showing their goal in the game. Based on our observation in the usability testing, we found out that most elderly participants were not aware of game-level increment in the gameplay because they lack the experiences in playing digital games, and sometimes games are not intuitive enough for the elderly to understand what will happen next or what to do next. As a result, the elderly have lost themselves in the game. Therefore, we recommend that it is important to provide simple and intuitive information for the elderly to understand what is happening in the game and what will happen next.

**The elderly do not know what will happen next in the game.** Most elderly participants in our usability testing do not realize what to do next after they have played the game. For instance, if they have to choose “Play Again” or “Menu” options in the

game, they may not be aware of selecting a particular option to move forward. Therefore, they always need help from the researcher or caregiver to help them to continue the play. Therefore, we recommend that the intuitive design is crucial in designing a physical game for the elderly to understand what to do next in the game.

**Long-term effectiveness of physical activity games for the elderly is important to investigate.** Although the literature shows that digital games are promising to improve the elderly's physical fitness and their engagement in exercises, it is still questionable how physical activity games can have positive effects on the elderly's physical well-being. Most of the usability testing take only a few weeks and there are only a few studies that conduct the longitudinal study to investigate the effectiveness of physical activity games on the elderly. Furthermore, it is still unclear how the elderly can know their improvements in doing game-based physical activity.

Currently, our physical activity games cannot support the auto-assessment system that can report the progress and health information of the elderly. To date, most of the physical activity games rely on physiotherapists to assess the elderly's performance through traditional methods being used in physiotherapy. In our usability testing, we also conducted a short-term study to investigate the usability of the games and the elderly's feedback towards the game. Moreover, currently our games cannot perform auto-assessment to the elderly's physical improvements in terms of their balance, mobility, and motor skills. Therefore, when we design physical activity game for the elderly, it is important to investigate the long-term effectiveness of the games on the elderly. More importantly, digital games should provide the auto-assessment to the elderly's improvements.

**Physical activity games cannot be easily operated by the elderly alone.** In our usability testing, all the game devices and consoles for physical games were operated by the researchers. We also observe that it is not simple and easy for the elderly to operate and play the game alone. For instance, to play Skiing game in our study, they need to switch on the computer, TV, webcam, and game software. After that, they need to select games through the game menu. They also need to calibrate and configure game setting before they play the game. All these steps are not easy for the elderly to operate alone. It can be achievable only with the support from someone who can help the elderly. Therefore, it is an important usability issue how we can design a simple and intuitive device or console that can be easily operated by the elderly by themselves.

**We do not know whether the elderly will play the game again.** It is the most important question in our study. Most of the usability testing took place for a week or more. After that, the elderly do not continue to play although most of them showed their interests to continue to play the game. There are many factors to be considered to create such game-based activity sessions for the elderly. For instance, there must have someone who can operate the game and monitor the elderly's gameplay. Furthermore, most of the physical activity games are not ready for the elderly to play at home individually. Thus, it is a good question to ask how to design and develop the game for the elderly to play for long-term and home-based activity.

## 4. Conclusion

In this paper, we report the usability lessons that should be taken into consideration when we design physical activity games for the elderly. The discussion about the usability lessons is based on the experiences, findings, and observations from our usability testing of physical activity games for the elderly. These findings are insightful and helpful for us to consider for further game design and development. Furthermore, we aim at sharing our knowledge to those who are working in the same area of digital games for the elderly.

In our future work, we will address the usability issues that we have identified in the usability testings of our games. Then, we will design and develop a physical activity game system, which is comprehensive, intuitive, easy, user-friendly, and effective for the elderly's physical activity. Furthermore, we will evaluate our games with elderly participants in different countries including: Finland, Japan, Singapore, and other partners in Asia.

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