Designing Digital Games with & for Home-dwelling Older Adults' Social Interaction under Sheltering Measures

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Keywords: Gaming, Social Interactions, User-centered Design, Home-dwelling, Sheltering Measures.

Abstract: Social relationships and participation have been considered essential elements in contributing to a higher quality of life for older adults. Due to the COVID-19 pandemic, many home-dwelling older adults have been reported as having less social interaction. Older adults are one of the groups most vulnerable to COVID-19, and they have been heavily impacted by the sheltering measures. Previous studies have shown the potential of digital games in enhancing the social interaction of older adults. However, the research within this field is still at an early stage. Furthermore, games that were designed before the pandemic might no longer be suitable for them due to sheltering measures. Therefore, taking into consideration sheltering measures, in this study we attempt to enhance the social interaction of home-dwelling older adults by designing gaming technologies with and for them. A user-centered design approach was adopted where 10 older adults were involved remotely throughout the study, from gathering user requirements to evaluating prototypes in iterations. The outcomes included an application with three favorite games and a proposed list of design guidelines. The older adults were positive in using the application. Further study is required to evaluate the impacts on social interaction among older adults.

1 INTRODUCTION AND RELATED WORK

Social relationships and participation have been considered essential elements in older adults' quality of life (Bowling, 2009; Bowling et al., 2002). Older adults having an active social life tend to have a higher quality of life (Antonucci, 2001; Cohen & Janicki-Deverts, 2009). Due to the COVID-19 pandemic, older adults who are considered to be in a vulnerable group have had to shelter themselves (WHO, 2020). Sheltering measures, such as lockdown, staying most of the time at home, social distancing, restricted gatherings and visits, etc., have resulted in many home-dwelling older adults having fewer social interactions and have thus led to lower quality of life.

In the United States, higher depression and increased levels of loneliness were reported among older adults in a study examining the impacts of shelter-in-place orders due to COVID-19 (Krendl & Perry, 2020). Older adults' social life and interaction with others reduced despite their efforts in spending much more time on digital platforms trying to stay connected with the people they cared about. Strategies using information and communication technologies (ICT) to address loneliness among older adults have been implemented in countries including Norway, Portugal and Brazil (Monteiro-Junior et al., 2020). In these three countries, health professionals have been using available technological facilities to deliver mental health support to older adults. Some of these older adults were home-dwelling, while others were nursing home residents.

We acknowledge that social interaction on digital platforms cannot replace physical interaction. However, digital platforms can contribute to the social interaction of older adults to some extent. During the difficult time of the pandemic, social media, such as Facebook, Twitter and Instagram, and instant messaging applications, such as Facebook Messenger and WhatsApp, have been used

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Bong, W. and Bronshtein, I.
Designing Digital Games with for Home-dwelling Older Adults' Social Interaction under Sheltering Measures.
DOI: 10.5220/0010467900570068
In *Proceedings of the 7th International Conference on Information and Communication Technologies for Ageing Well and e-Health (ICT4AWE 2021)*, pages 57-68
ISBN: 978-989-758-506-7

increasingly by older adults for social interaction (Krendl & Perry, 2020; Monteiro-Junior et al., 2020). In Brazil, a psychology team has been providing mental health support through video calling on WhatsApp, while populations in Norway have been encouraged to have more contact with older family members and friends via telephone or video calls.

Another alternative for digital social interaction is playing digital games. Playing digital games is a form of social interaction where two or more older adults, or one older adult with some other people (children, grandchildren, other online players, etc.), play a game on a digital platform together. Doppler et al. (2018) developed BRELOMATE, a television- and tablet-based gaming technology that aimed to promote user engagement and social interaction among older adults. Although almost half of the participants had previously used neither a tablet nor an interactive television, BRELOMATE was perceived as easy and fun to use. A personal reminder information and social management (PRISM) computer system was developed and introduced to older adults with the primary aim of reducing social isolation (Boot et al., 2018). The PRISM system consisted of 11 single-player video games (Chinese Checkers, Crossword, Droplets, Gem Swap, Memory (matching pairs), My Jong (a variant of Mahjong), Solitaire, Sudoku, Tetris, Poker and Word Search). In this study, 150 older adults were assessed in terms of their gaming behavior over an entire year. A clear favorite in game preference was identified (i.e., Solitaire), and the potential for digital games to keep older adults active was observed.

The research literature has shown that playing digital games can contribute to improving older adults' well-being, but the research is still at an early stage (Rienzo & Cubillos, 2020). In addition, there is a clear knowledge gap where digital games that were designed pre-pandemic may not be suitable in meeting the special needs of older adults playing digital games due to the sheltering measures under the pandemic (e.g., digital games having only a single-player mode, digital games requiring other players to be physically together, digital games being difficult to understand without guidance and assistance given in person, etc.).

In this study, we attempt to enhance the social interaction of home-dwelling older adults by designing gaming technologies with and for them. The study focuses on home-dwelling older adults living in Norway, and the game design relates to measures practiced under the COVID-19 pandemic restrictions to protect oneself and vulnerable older adults.

2 METHODOLOGY

We adopt a user-centered design approach (Karat, 1996), which emphasizes involving potential users throughout an iterative system design and development process. Several studies have shown great success by using a user-centered design approach in designing digital games for older adults and delivering outcomes that fulfilled their expectations and needs (Doppler et al., 2018; Doroudian et al., 2020; Sauvé & Kaufman, 2019). By involving older adults throughout the whole process, we intended to gather the user requirements of older adults in playing digital games and design digital games that suit their preferences and needs, with a focus on enhancing their social interaction in a distance setting.

Participants were recruited using convenience sampling (i.e., they were selected to participate because they were easily accessible (Sedgwick, 2013). The inclusion criteria were being aged 70 years or over, being a retiree and being home-dwelling. All activities were conducted remotely (i.e., phone calls and online interviews using Skype, Zoom and Google Meet). The participants were first briefed about the project and then presented with the consent form. Their consent was given prior to participating in the study.

At the beginning of the study, the participants were asked about their demographic background. For ICT skills, they had to rate themselves on a scale from 1 to 10, where 1 is very bad and 10 is very good. In addition, they were asked about their experiences and attitudes to games in general (board games, cards, etc.) and digital games. Examples of questions were: "What is your experience in terms of playing games? (from a child, an adult to now as an older adult)?", "Who do you usually play these games with?", "Can you tell us your positive and/or negative experience in terms of playing games?" and "Has the pandemic affected your social and/or gaming activities?"

We conducted a total of four iterations of design, development and evaluation. During the iterative process, the first and second iterations' prototypes (i.e., wireframes) were created using Figma (a design tool for designing and prototyping user interfaces). The code was written in JavaScript. The wireframes were then further developed into a high-fidelity prototype and hosted on a domain site for the third and fourth iterations. For evaluation, semi-structured interviews together with some testing tasks were conducted with three to four participants in each iteration. The prototype that was developed in each iteration was presented to the participants, and they

were asked to use it. Participants were requested to share a screen if necessary.

Questions such as "What do you think about/ understand from this design?", "What do you think of the game option here?", "What do you think of the option to customize the game?", etc. were asked to obtain their feedback. Follow-up questions were asked to gain more insight from the participants when necessary. Besides getting clarification from the participants regarding their feedback about the prototype, we asked follow-up questions that could relate their feedback about the prototype to their experiences and attitudes in playing digital games. Based on the participants' feedback, we made necessary improvements and developed new features in the next iteration. At the end of each interview session in the second, third and fourth iterations, we also asked for the participants' opinions about playing digital games to see if their attitudes had changed after trying out the prototype.

3 RESULTS

3.1 Participants

Table 1 summarizes the demographic data of the participants. Some participants were invited to participate in more than one iteration. When asking about experiences in playing games in general (digital and non-digital), seven participants stated that they had never played any digital games. P6, P7 and P8 had experience in playing digital games but in different ways. P6 used to play games on her daughter's computer but stopped playing when her daughter moved out to study in another city. Due to her interest in ICT, P7 had been playing digital games with her grandchildren. As one of the youngest participants, P8 had been active on social media and had been playing games on Facebook for some time.

One interesting finding is that P1 misunderstood the term "digital games." P1 claimed that he never really learned ICT as he did not use it in his work before retirement. However, as the interview progressed, we found out that he had been playing Solitaire on his mobile phone. We clarified with him at the end of the interview regarding this. When asked about experiences in playing digital games, he was thinking about computer games and video games that younger adults were playing, such as World of Warcraft, Counter-Strike and Dota.

The scoring system in Solitaire was one of the motivating factors for P1 in playing it. He played Solitaire very often: "*I play whenever I can, as long as I am not eating, making food, doing housework or watching something on television!*" Another reason he loved playing Solitaire was because it was a game that he played a lot during his childhood. He continued playing it on a computer 12 years ago when he was introduced to it. He then switched from playing it on his computer to playing it on his mobile phone.

Similar to P1, many other participants had also played Solitaire when they were children; however, they stopped playing card games as they grew up. P2 claimed that he never really had an interest in any games (both digital and non-digital) due to not having any children and living alone all the time. P3 and P9 used to play board games and cards with their grandchildren when they visited; however, both families had to put this tradition on hold due to the pandemic sheltering measures. P4, on the other hand, did not have this problem as one of her sons and her son's children were living next door. In Norway, children, grandchildren and grandparents were allowed to visit each other during the pandemic, as long as they established a "close contact" relationship (i.e., these are the people they spent most of their time with physically and/or lived in the same household).

P1 enjoyed playing board games ever since he was young. He even took pictures of his board game collection and showed them to us during the interview. Before the pandemic, he had friends visiting and playing these board games with him from time to time. However, this was out of the question considering his health condition and other sheltering measures. His all-time favorite board game was Chinese Checkers, because he could play it with several players. Besides Chinese Checkers, he also enjoyed playing billiards, Ludo and other board games. These were the same games most of the participants grew up playing. In addition to the games mentioned above, Sudoku was reported as another popular game as it could be easily found in newspapers and magazines.

When the idea of playing board games online was presented, P1, P3 and P9 were excited about the idea. P1 had always played Solitaire alone and played board games with other friends physically together. Therefore, he had never considered the possibility of playing games online with other people. The children of P3 had been trying to encourage her to use ICT more, but she was never really interested. They bought her an iPad as a present and wanted her to have more social interaction using ICT. Considering the sheltering measures now, she thought the idea of playing games online could be ideal.

Similarly, P9 has been having less contact with her grandchildren due to the sheltering measures and, therefore, she felt that playing digital games with her grandchildren could be a good solution. Other participants, such as P2 and P10, did not show any excitement, but they commented that it would be great for older adults who liked playing games and/or had grandchildren. P7 and P8, who had been playing digital games for a while, were not particularly excited. However, they were interested in the type of game that would be introduced to them.

Table 1: Demographic information of all participants.

	Age	Gender	ICT skills (1 to 10)	Education (years)	Employment before retirement*	Marital status	Number of children and grandchildren	Participated in iteration	Ever played digital games before?
P1	74	M	2	11	Photographer	Married	2 children, no grandchildren	1, 2, 3	No**
P2	76	M	6	13	Ship broker	Single	None	1	No
P3	82	F	5	11	Housewife	Widowed	2 children, 5 grandchildren	1	No
P4	71	F	2	11	Flower shop owner	Widowed	2 children, 6 grandchildren	1	No
P5	70	M	8	13	Worked with ICT and plants	Single	None	2	No
P6	79	F	4	10	Housewife	Widowed	2 children, 1 grandchild	2	Yes
P7	78	F	7	14	Healthcare	Widowed	3 children, 5 grandchildren	3	Yes
P8	70	M	7	12	Road worker	In a relationship	None	3, 4	Yes
P9	79	F	6	10	Housewife	Widowed	4 children, 10 grandchildren	4	No
P10	79	M	6	12	Truck driver	In a relationship	3 children, 7 grandchildren	4	No

*All participants were retirees.

**P1 answered “no” when asked. However, later in the interview, it was discovered that he had been playing digital Solitaire.

3.2 First Iteration

The prototype produced in this iteration contained a wireframe with a jigsaw puzzle game with options to customize the picture of the puzzle, the background color and the number of pieces in the puzzle (Figure 1). The first page was designed to invite the participant to create their own puzzle, and the remaining pages included features to customize the puzzle game. This prototype was developed prior to conducting interviews with the participants, and thus the chosen game did not reflect the older adults' game preferences.

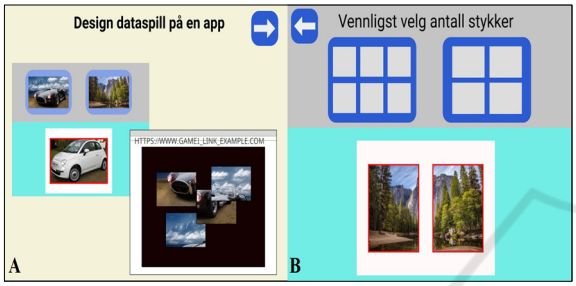

Figure 1: First iteration's wireframe (A) Introductory page, (B) Customization page to choose the number of pieces in the puzzle.

In this iteration, P1, P2, P3 and P4 were invited to participate. All four of them did not understand that the wireframe showed a puzzle game. We acknowledged that the interface itself did not explain much about the game (Figure 1A), in that it only stated, "Design digital game on an app (application)." P2, P3 and P4 managed to figure out that it was a puzzle game after receiving some hints, while we had to inform P1 explicitly. P1 expressed that he had only played puzzle games when he was a child and, therefore, was not so familiar with them.

In terms of customizing games, none of the participants had considered this possibility. P1 had difficulty understanding the customization feature, while the others managed to complete the customization using the available tools. When the wireframe was presented to P1 (from the introductory page to the customization page to choose the number of pieces in the puzzle), he immediately commented that he did not understand without even trying: "*It was too complicated. I did not understand a thing here.*" P2 commented that customization could be useful in many ways, such as choosing the preferred music for a game, while P3 stated that: *"It can be great for new beginner like me, to first start with easy (game difficulty) level, and so on …"*

3.3 Second Iteration

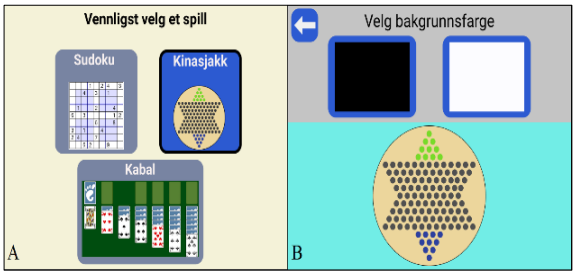

Figure 2: Second iteration's wireframe (A) Introductory page, (B) Customization page to choose the background color of the game.

The wireframe in this iteration started with an introductory page where players were asked to choose a game from a selection of three (Figure 2A). Three favorite games of older adults were identified from the interviews and incorporated into the application (Chinese Checkers, Solitaire and Sudoku). After choosing a game, the users were then able to customize their own game. In addition, we created additional wireframes to demonstrate to the participants and gather their feedback about the possibilities for other customizations. For instance, to choose a picture for the background instead of a solid color, to choose from more than two color choices and to choose an option for video and/or audio calls. Solitaire and Sudoku were not developed further at this stage. We decided to focus only on the design, development and evaluation of Chinese Checkers, since it would require too much time and effort to have the participants involved throughout the development process with three games remotely.

P1, P5 and P6 participated in this iteration's evaluation. Instructions in the wireframe were perceived as easy to understand by all of them, and they appreciated the customization feature. Although they managed to complete customizing their own game, we observed that the participants were missing a feature where they could get a preview look of the selection before confirming their choice: "*Perhaps an OK button could help? I want to see what the selection looks like first, compare the choices, then move to the next …,"* said P5.

Both P5 and P6 commented that the black color for the background of the game was a bit too "extreme" (Figures 2B and 3B). P1, who was a proficient player of Chinese Checkers, pointed out that the wireframe could be improved by having a page to ask the number of players, instead of having two players by default, or limiting the game to having only two players. As illustrated in Figure 3A, the

players were asked to choose a set of pieces, which indicated only a two-player game.

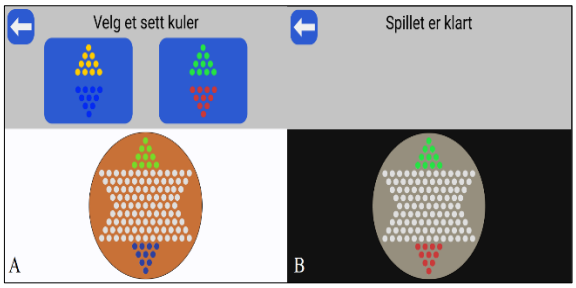

Figure 3: Second iteration's wireframe (A) Customization page to choose a set of pieces, (B) Last page indicating game is ready.

In terms of additional customization, all the participants had different ideas of choosing a picture instead of a solid color for the background and being provided with two, four or more colors to choose from. One thing that all of them agreed on was to have the option for video and/or audio calls. P1 preferred to have a solid color for the background, while P5 and P6 thought the option of choosing a picture as the background was good as long as the players were provided with set options and did not have to find their own pictures. P5 informed us of his experience in finding the right pictures from his tablet and mobile phone to send to friends and family; he always found it challenging browsing the thumbnails. Options of choosing a color should be restricted to four, according to P5, two was good enough for P1 and P6, while more than four color options appeared to be overbearing for all of them.

The participants stated they would love the ability to talk to the other player(s) as it could offer the possibilities for more active social interaction. If they felt comfortable showing their video to the other player(s), then they could also choose to turn on video. "*Yes, I would like to talk to the person I am playing with, either she is my granddaughter or a friend who I already knew. If she is a new friend, and after playing the game for a while with her, maybe I want to know how she looks like …,*" expressed P6.

When asked their opinions about playing the digital games after presenting the prototype, P1 was particularly excited and wanted to try out the final version. P5 and P6 appeared more convinced that playing digital games could be suitable for them. They would like to play digital games with others if they were asked to.

3.4 Third Iteration

Figure 4 displays the prototype in this iteration. This was a high-fidelity prototype, where the Chinese Checkers game was developed with moveable pieces. The application was named "*Spill Sammen,*" which means "*Play Together.*" There were two symbolic buttons on the top left corner (a square and a round button). They represented starting a new game and the turn of players who shall move their piece, respectively. The square button usually represents stop or start a new game, while the round button refers to the game in progress. The players could move their pieces by first clicking the piece they wanted to move; this piece would then be colored yellow in the middle (refer to the red piece with a yellow dot in Figure 4). The players could then click on the hole where they wanted to move and place the "yellow-dotted" piece.

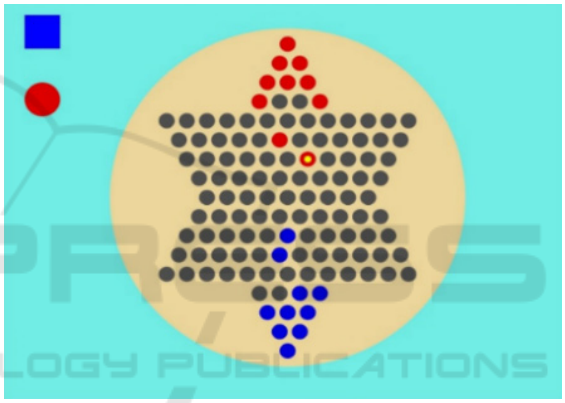

Figure 4: Third iteration's application.

The participants in this iteration were asked to use a tablet or mobile phone to evaluate the prototype so that they could have a more genuine feeling of using the application on a mobile device. P1 used his mobile phone, while P7 and P8 used a Samsung tablet. In order to test if the design was intuitive and easy to understand, we did not brief the participants on how to play the game. Instead, we only asked them to try playing the Chinese Checkers game while they were performing the testing tasks with us.

All participants managed to move the pieces and play the game. A few usability issues were identified during testing. First, by coincidence (since the players could customize and choose a set of pieces), the choice of pieces' colors could be identical to the colors of the buttons of "Start a new game" and "Player's turn." As shown in Figure 4, both blue and red colors of buttons and pieces were identical. Such a situation confused the players. In addition, P1 and P7 suggested moving the positions of these buttons.

These two buttons should not be placed too close to each other, and the "Player's turn" button should be placed in between the players.

The symbolic buttons were perceived differently by the participants. P8 was used to playing digital games and, therefore, he understood the button "Start a new game," while P1 and P7 needed some time to figure this out. All of them understood what the round button meant, as they noticed the change of the round button's color when they moved their pieces. Despite being able to play the Chinese Checkers on *Spill Sammen*, the participants advised us to add more text for explanation. For example, the players could be informed with text instruction when it was their turn to move a piece.

P1 felt that the Chinese Checkers game was not suitable to play using his mobile phone. Due to the screen size, it was challenging to perform the touch gestures to move the pieces. On the other hand, P7 and P8, who were playing the Chinese Checkers game on their tablets, did not face this problem.

After their completion in testing the application, we asked them about their opinions of playing the digital game. Similar to the second iteration, P1 expressed that he could not wait to use the final version of the application when it was fully developed. P7 was more convinced than before, while P8's reaction was simply neutral as he was already an experienced online gamer. He, however, expressed that this study could help many other older adults who were new to playing digital games: "*Many of my friends did not even want to hear me talking about digital games. But this approach (referring to choosing games that were already familiar to older adults) and simple design could perhaps make digital games more attractive to them!*"

3.5 Fourth Iteration

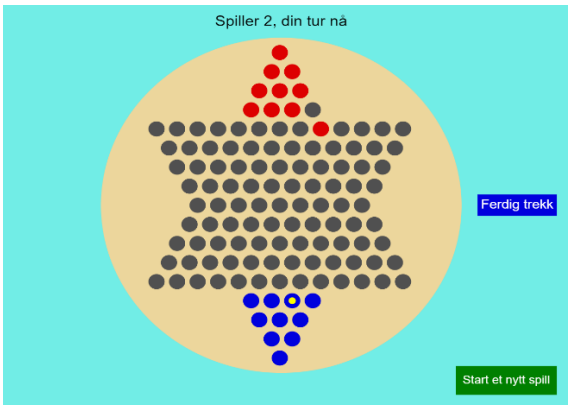

Figure 5: Fourth iteration's application.

The Chinese Checkers in this iteration was improved mostly in instructions and colors. As illustrated in Figure 5, we added textual instructions, such as "Player 2, your turn now *(Spiller 2, din tur nå),*" "Finish movement *(Ferdig trekk)*" and "Start a new game *(Start et nytt spill).*" The color of the "Start a new game" button was changed so that it had a different color from other buttons. However, we kept the colors of the "Finish movement" button the same as the colors of the pieces. The colors of this button reflected whose turn it was to make a move.

P8, P9 and P10 were invited to participate in this iteration. P8 was testing *Spill Sammen* on his mobile phone, while P9 and P10 were using tablets. We asked them to move their pieces and play the game with us. All three participants managed to play the Chinese Checkers game without any problem. After performing the testing task, all participants mentioned that they were positive about playing the digital game. P9 expressed her willingness to use *Spill Sammen* with her grandchildren. The second wave of the pandemic was taking place when this evaluation was conducted; sheltering measures were even stricter than before and, therefore, she could neither visit nor be visited by all of her grandchildren. P8 and P10 were happy to see the design and development of *Spill Sammen*. They commented that it would benefit older adults who had to be sheltered at home during the pandemic as well as in the winter when it could be cold and slippery outside for many older adults.

4 DISCUSSION

The four iterations of the user-centered design approach included 10 older adults in the process of designing, developing and evaluating the prototypes. Most of the participants were positive about playing the digital games, especially when their social lives were restricted due to the COVID-19 sheltering measures. Through their user involvement, we received constructive feedback in designing digital games for home-dwelling older adults. In addition, we reflected and discussed the research process using a user-centered design approach where all activities involving them had to be conducted remotely.

4.1 Design Guidelines

Prior studies have gathered their findings in designing digital games with and/or for older adults and presented them as design considerations (Al Mahmud et al., 2012; Boot et al., 2018; Ijsselsteijn et al., 2007; Marston, 2013). Using the findings from this study,

we present a list of design guidelines where the game technologies were targeted to enhance older adults' social interaction under sheltering measures. The guidelines are presented in Box 1 and discussed below.

Box 1: Design guidelines.

1. Use text and images that are easy for older adults to understand.
2. Create an easy introduction to start the game.
3. Provide games that older adults can relate to.
4. Offer more than one game.
5. Propose a gaming mode that requires more than one player.
6. Include options for text chat, audio and video functionality.
7. Allow players to customize the game (speed, color, difficulty level, etc.).
8. Ensure the players are well-informed.
9. Maximize the playable and touchable area to assist older adults' touch gestures.
10. Keep older adults motivated.

1. In this study, the participants indicated their appreciation regarding simple instructions, both in the form of text and images. In the third iteration, the design of Chinese Checkers was based on other existing digital games: a square symbolic button to stop and start a new game and a round symbolic button for the game in progress. However, there was room for improvement. Despite being able to play the game, all participants that evaluated the prototype expressed their wishes to have more text for clearer instructions. In the next iteration, we put more text for instructions as recommended by the participants. Words such as "Player 1, you may start," "Player 2, your turn now" and "Start a new game" were added (Figure 5). These results further support the design of Foukarakis et al. (2011) in an adaptable card game, when they used clear, simple text and images to cue the older players whose turn it was to play or to clarify what action was required.

2. In the first iteration, when the prototype was presented to the participants, all participants had problems understanding the prototype. Although they had experiences playing puzzle games, the design appeared unclear to them and therefore they needed help to figure out what it was. P1 was immediately skeptical when he was presented with a design that he found difficult to understand, and he was not interested in trying further. We therefore suggest making the design easy to understand, especially on the very first introductory page of the games. This kind of approach is more crucial when the games are introduced to older adults who have little or no experience in playing digital games, which is consistent with the findings of Zhang et al. (2017), who recommended providing clear guidance in helping older players to better understand the purpose of the game.

3. Solitaire was reported as the most preferred game among 150 older adults in Boot et al. (2018)'s study, and the current study supports their findings. According to the participants, Solitaire was one of the common card games played during their childhood. When P1 found out that Solitaire was available on desktop computers and mobile phones, he chose to play it on these devices as well. Boot et al. (2018) reflected on the popularity of Solitaire being due to the game's familiarity, its shallow learning curve and its inclusion of familiar materials (i.e., cards). These factors could motivate older adults to play digital games (Cota & Ishitani, 2015), and we discuss more about these factors in the last guideline.

4. To ensure that different preferences of diverse older adults can be met, it is essential to offer them more than just one game. In this study, our prototype offered three games (i.e., Chinese Checkers, Solitaire and Sudoku). They were identified based on the participants' experiences in playing games. Most participants grew up playing the former two, while Sudoku was commonly provided in newspapers and magazines. PRISM games offered older players 11 games (Boot et al., 2018). While Solitaire was reported as the most preferred, other games were almost equally liked by the players. Zhang et al. (2017) identified the diverse preferences of older adults when it came to puzzles; some preferred word puzzles, while others enjoyed sorting or math puzzles more.

5. In order to foster social interaction among older adults while playing games, we propose to design games that require more than one player. Some participants in this study were excited about the idea of digital games, as it can be an alternative to physical board games and/or cards that they used to play with their grandchildren and visitors before the pandemic. In addition, instead of simply playing or beating the game, older players in Doroudian et al. (2020)'s study were reported to enjoy more the collaborative nature of a game. This is in accord with our findings, where most of the participants expressed that they would appreciate the social interaction aspect in gaming more than just completing a task or gaining high scores. P1 and P3 wanted to play digital games so that they could spend time socializing with others as they were used to doing before the pandemic.

Games such as Sudoku and Solitaire, which are usually played in single-player mode, can also be

modified so that they can be played by more than one player. This modification can be interpreted as a new rule or method to play the game, which can appear exciting to older adults. Mubin et al. (2008) pointed out the potential of having a new add-on to existing games for older adults so that they could have a better player experience.

6. As the games require more than one player, and the games are targeted to enhance social interaction among older players, it is recommended to include the options for text chat, audio and video functionality. These functionalities can be embedded into the gaming technologies, both in the game itself and outside of the game interface, to foster more social interaction between older players. Doroudian et al. (2020) reported that the participants had a good time chatting with each other during and after the game sessions. While designing a multiplayer online escape game for older adults, Zhang et al. (2017) observed that the communications among players were not well organized and, therefore, recommended providing a chat and/or video function.

7. Offering customizable fonts or icons can provide a more satisfying player experience for older adults, according to previous studies (Al Mahmud et al., 2012; Doroudian et al., 2020; Mubin et al., 2008) and a review by Rienzo and Cubillos (2020) in playability and player experience in digital games for older adults. Building on this finding, we started the first iteration with a prototype that incorporated a customization feature. While the participants in this study appreciated the customization feature, it should nonetheless not burden them. In the second iteration, the participants expressed their concerns when the customization offered too many options and/or required them to "do a lot." P5 liked the idea of choosing a picture as the background of the game, but it should not require him to select his own picture.

8. One of the usability heuristics for the user interface design by Nielsen (1995) is the visibility of system status, which emphasizes that "*the design should always keep users informed about what is going on, through appropriate feedback within a reasonable amount of time.*" Older adults playing a multiplayer online escape game were reported as needing clear instructions and feedback from the gameplay (Zhang et al., 2017). Similarly, the participants in the current study appreciated very much when they were well informed about the game status when using the application, for instance, feedback of whose turn it was to move a piece when playing the game, an introductory page to select a game between Solitaire, Sudoku and Chinese Checkers, and so forth. When performing customization, a preview feature and "OK" button could help in clarifying to the older adults concerning the status of the application and their selection, as pointed out in the second iteration.

9. Due to weaker muscle control, some older adults struggle with performing touch gestures (Iancu & Iancu, 2020). We observed that the touch gesture required to move the pieces in the Chinese Checkers game was difficult for P1, as he was using his mobile phone and it was a much smaller screen as compared to a tablet device. In order to address this issue, we recommend providing another layout for mobile phone players. The empty spaces around the Checkers board (Figure 4) could be removed to make the playable and clickable area bigger for the mobile phone version. Another approach is to suggest that players use a tablet device for this particular kind of game.

10. All in all, the design of digital games should keep older adults motivated while playing them. Several studies have proposed factors in keeping older players motivated, which include all the above-mentioned design guidelines. In addition, participants in Doroudian et al. (2020)'s study expressed that they would play the game again if they encountered new things every time they played. A review by Cota and Ishitani (2015) pointed out other factors such as familiarity and ease of learning for the games. Older adults gained familiarity via playing the games when they were younger. Ease of learning can be related to the level of complexity; older adults tend to enjoy easier games that do not require much of their mental effort. The findings of this study are in line with those of previous studies, especially when the older adults were either new or inexperienced in playing digital games.

Rewards can be a form of motivation as well. Both Cota and Ishitani (2015) and Zhang et al. (2017) suggested rewards, such as unlocking stages, offering players higher and/or further levels and giving more information. Rewards to help older adults solve puzzles could make digital games appear more attractive to them, thus motivating them further in playing.

4.2 Remote User-centered Design

Before the pandemic, research activities using user-centered design could be conducted face-to-face (Al Mahmud et al., 2012; Doppler et al., 2018; Doroudian et al., 2020; Sauvé & Kaufman, 2019). In this study, all interviews and evaluations had to be conducted via phone calls or online meeting platforms such as Skype, Zoom and Google Meet. While performing

the evaluation, participants were requested to share a screen if necessary. Challenges occurred when the participants were not familiar with these platforms. When the participants had an extra device (such as a tablet or laptop) at home, they preferred to first talk over the phone to be guided through the process. Once they had learned how to use the online meeting platform, they felt comfortable and confident in using it for the rest of conversations and performing the evaluations.

We noticed that some of the participants had low self-confidence in using ICT tools (e.g., P1 and P4). Although we did not meet them in person, from our observations on how they managed to use a mobile phone, tablet or laptop, we can conclude that they had rated themselves too low in terms of their ICT skills. A possible explanation for this might be that they had rarely used ICT previously in their work. A similar trend was observed when the other participants performed the testing tasks. At first, they were uncertain if they could perform the gaming tasks. However, with guidance and encouragement, most of the participants managed to complete the tasks; they were surprised and excited with this outcome!

This finding suggests that older adults need encouragement, both when designing ICT for them and while designing ICT with them. We have reflected upon this as a design guideline in the previous section, and providing older adults with encouragement is even more important when all research activities involving them had to be conducted remotely. In addition, we would like to highlight the importance of giving regular breaks to older adults while conducting remote research with them. For some cases, we needed to break the interview and testing into a few sessions to ensure that they were not worn out.

All in all, in spite of the challenges in using a user-centered design approach in this study, the outcomes yielded positive feedback from the participants. Most of the participants' attitudes toward digital games have changed to more positive after witnessing that digital games could be easy to learn and understand, and the design was made to suit their desires. P1, who had been involved in the most iterations, commented, "*I never thought that I could do something like this (referring to playing the Chinese Checkers game digitally on his tablet with us). Yes, just let me know when I can play it with my friends!*"

4.3 Limitations

The major limitations of this study are its recruitment method (i.e., convenience sampling) and the small number of participants. Convenience sampling cannot constitute probability sampling/random sampling, which involves some form of random selection of the population members (Sedgwick, 2013). It should, therefore, be noted that the participants in this study are not representative of the older generation in Norway.

We acknowledge that the number of participants was small, and it was challenging to recruit participants with greater variation in terms of demographic characteristics. Older adults are a diverse user group. As pointed out by Al Mahmud et al. (2012) in their reflection of designing games with and for older adults, 65 years old is not equal to 80 years old. In this study, the age of participants ranged from 70 to 82, with an average age of 75.8. We had some challenges in recruiting older adults above 80 years old. A few older adults above 80 years old that we approached appeared skeptical when we briefed them about the project, or when they were presented with the consent form where the project was described in detail.

Another limitation is that we have yet to evaluate the participants' social interaction, despite the fact that the aim of the study was to enhance the social interaction of home-dwelling older adults. Due to the sheltering measures and restricted resources, the user-centered design process took a longer time and more effort. Time and effort were spent on setting up the remote backdrop, in addition to actual data collection. This was also the reason why the participants were asked to rate their own ICT skills, instead of other methodologies, such as using a questionnaire. Therefore, we suggest evaluating the social interaction aspect as part of future research.

5 CONCLUSION AND FUTURE WORKS

This paper has demonstrated a four-iteration user-centered design study that aimed to enhance the social interaction of home-dwelling older adults living in Norway by designing gaming technologies with and for them. Both the game design and the research process reflected the sheltering measures practiced under the current COVID-19 pandemic in Norway to protect oneself and vulnerable older adults (i.e., staying at home most of the time with restricted home visits). All research activities involving the 10 older participants had to be conducted remotely, and the game technologies were designed for social interaction at a distance.

Through the research process, we produced an application, *Spill Sammen,* with three favorite games of older adults (Chinese Checkers, Solitaire and Sudoku). Only the Chinese Checkers was fully developed at the time of writing. We reflected on the findings and proposed a list of design guidelines for designing digital games for older adults. The older adults were positive in using the application and would like to use it to play games with other players.

Further research will include continuing to develop *Spill Sammen* and implementing features such as providing text, audio and/or video functionality. We would like to improve the prototype and use it to conduct focus group interviews remotely (i.e., two or more older adults can be online together and play a game). In addition, we shall evaluate the impact of home-dwelling older adults playing digital games in relation to their social interaction. We have yet to explore the ways home-dwelling older adults could use *Spill Sammen* by themselves and the impact of this in relation to their social interaction.

In addition, we will explore gaming technologies focusing on intergenerational play, where the user-centered design approach is extended to include children and grandchildren as end users. Previous studies have demonstrated promising results of playing intergenerational digital games (De la Hera et al., 2017; Li et al., 2019; Loos et al., 2019). Some participants in this study who had grandchildren expressed their interest in playing *Spill Sammen* with their grandchildren. Last but not least, such digital games need not be limited to home-dwelling older adults, but they can also benefit older adults living in nursing homes.

ACKNOWLEDGMENTS

We would like to thank all participants for their enthusiastic participation despite the sheltering measures and the fact that all activities had to be conducted remotely.

REFERENCES

Al Mahmud, A., Shahid, S., & Mubin, O. (2012). Designing with and for older adults: experience from game design. In *Human-Computer Interaction: The Agency Perspective (pp. 111-129)*: Springer.

Antonucci, T. C. (2001). Social relations: An examination of social networks, social support, and sense of control.

Boot, W. R., Moxley, J. H., Roque, N. A., Andringa, R., Charness, N., Czaja, S. J., Rogers, W. A. (2018). Exploring older adults' video game use in the PRISM computer system. *Innovation in aging*, 2(1).

Bowling, A. (2009). The psychometric properties of the older people's quality of life questionnaire, compared with the CASP-19 and the WHOQOL-OLD. *Current Gerontology and Geriatrics Research*, 2009.

Bowling, A., Banister, D., Sutton, S., Evans, O., & Windsor, J. (2002). A multidimensional model of the quality of life in older age. *Aging & mental health*, 6(4), 355-371.

Cohen, S., & Janicki-Deverts, D. (2009). Can We Improve Our Physical Health by Altering Our Social Networks? *Perspectives on Psychological Science*, 4(4), 375-378. doi:10.1111/j.1745-6924.2009.01141.x

Cota, T. T., & Ishitani, L. (2015). Motivation and benefits of digital games for the elderly: a systematic literature review. *Revista Brasileira de Computação Aplicada*, 7(1), 2-16.

De la Hera, T., Loos, E., Simons, M., & Blom, J. (2017). Benefits and factors influencing the design of intergenerational digital games: a systematic literature review. *Societies*, 7(3), 18.

Doppler, J., Gradl, C., Sommer, S., & Rottermanner, G. (2018). Improving User Engagement and Social Participation of Elderly People Through a TV and Tablet-Based Communication and Entertainment Platform. Paper presented at the *International Conference on Computers Helping People with Special Needs*.

Doroudian, A., Loos, E., Ter Vrugt, A., & Kaufman, D. (2020). Designing an Online Escape Game for Older Adults: The Implications of Playability Testing Sessions with a Variety of Dutch Players. Paper presented at the *International Conference on Human-Computer Interaction*.

Foukarakis, M., Leonidis, A., Adami, I., Antona, M., & Stephanidis, C. (2011). An adaptable card game for older users. Paper presented at the *Proceedings of the 4th International Conference on PErvasive Technologies Related to Assistive Environments*.

Iancu, I., & Iancu, B. (2020). Designing mobile technology for elderly. A theoretical overview. *Technological Forecasting and Social Change*, 155, 119977.

Ijsselsteijn, W., Nap, H. H., de Kort, Y., & Poels, K. (2007). Digital game design for elderly users. Paper presented at the *Proceedings of the 2007 conference on Future Play*.

Karat, J. (1996). User centered design: quality or quackery? *Interactions*, 3(4), 18-20.

Krendl, A. C., & Perry, B. L. (2020). The impact of sheltering in place during the COVID-19 pandemic on older adults' social and mental well-being. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*.

Li, C., Hu, J., Hengeveld, B., & Hummels, C. (2019). Story-me: design of a system to support intergenerational storytelling and preservation for older adults. Paper presented at the *Companion Publication of the 2019 on Designing Interactive Systems Conference 2019 Companion*.

Loos, E., de la Hera, T., Simons, M., & Gevers, D. (2019). Setting up and conducting the co-design of an intergenerational digital game: A state-of-the-art literature review. Paper presented at the *International Conference on Human-Computer Interaction*.

Marston, H. R. (2013). Design recommendations for digital game design within an ageing society. *Educational Gerontology*, 39(2), 103-118.

Monteiro-Junior, R. S., Carneiro, L. S., Barca, M. L., Kristiansen, K. M., Sampaio, C. A., Haikal, D. S. A., . . . Deslandes, A. C. (2020). COVID-19 pandemic: a multinational report providing professional experiences in the management of mental health of elderly. *International Psychogeriatrics*, 32(10), 1153-1156.

Mubin, O., Shahid, S., & Mahmud, A. A. (2008). Walk 2 win: towards designing a mobile game for elderly's social engagement. *People and Computers XXII Culture, Creativity, Interaction* 22, 11-14.

Nielsen, J. (1995). 10 usability heuristics for user interface design. Nielsen Norman Group, 1(1).

Organization, W. H. (2020). Health care considerations for older people during COVID-19 pandemic. Retrieved from https://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/publications-and-technical-guidance/vulnerable-populations/health-care-considerations-for-older-people-during-covid-19-pandemic

Rienzo, A., & Cubillos, C. (2020). Playability and Player Experience in Digital Games for Elderly: A Systematic Literature Review. *Sensors*, 20(14), 3958.

Sauvé, L., & Kaufman, D. (2019). User-centered design: An effective approach for creating online educational games for seniors. Paper presented at the *International Conference on Computer Supported Education*.

Sedgwick, P. (2013). Convenience sampling. *Bmj*, 347, f6304.

Zhang, F., Doroudian, A., Kaufman, D., Hausknecht, S., Jeremic, J., & Owens, H. (2017). Employing a user-centered design process to create a multiplayer online escape game for older adults. Paper presented at the *International Conference on Human Aspects of IT for the Aged Population*.