



Game Development for the Elderly: Experiences from Usability Tests in the Wild

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Game Development for the Elderly: Experiences from Usability Tests in the Wild

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Abstract—Playing video games can be beneficial for cognitive skills and mental wellbeing, especially for the elderly. Game design and user testing for the elderly is, therefore, an important consideration. In this paper, we present experiences from usability tests of a touchscreen puzzle game with elderly users. As a result of the user tests, we observed some common behaviors. In general, the elderly testers found it difficult to approach the game without instructions and were not able to get the game going using only trial and error. To get started with the game, the testers preferred animated tutorials over detailed written instructions. Additionally, the testers praised pop-up warning messages that appeared when they made mistakes. We also noted that within our test group individuals had somewhat different mental models about the game and its mechanics, which made improving the game design difficult.

Keywords—video games; elderly; user testing

I. INTRODUCTION

The number of elderly people within the population is increasing, and thus the demand for services in physical and mental wellbeing for the elderly is also growing. There are many challenges related to the mental wellbeing of the elderly population. Decreased cognitive capabilities are often a result of age-related impairments. On the other hand, existing literature shows that games can be used to improve mental and physical wellbeing (for example [1], [2]).

Modern game development is immensely data-driven [3]. Game developers collect data in many ways but one of the main processes used to assess the quality of a game product is usability testing [4]. Usability testing is key for assessing how well a game appeals to a certain demographic. As the population ages, usability tests will inevitably become ubiquitous among senior citizens, too.

In this paper, we present observations from usability tests of a digital puzzle game with elderly users. We recruited volunteers to take part in user testing sessions of a digital tabletop puzzle game. In the testing sessions, the think-aloud method for usability testing was used [5].

The current study has a focus on the user interface and usability development using iterative development cycles. These are important considerations in game development because of the need to understand the user experience. The importance of user studies is further highlighted in the context of elderly people - while there exists a plethora

of research on the impairments due to age, it is arguably hard for developers to step into the shoes of seniors.

The overarching research question guiding this work is: *What can be learned from game user tests with elderly participants?* The main research question is further divided into the following subquestions:

- What usability related observations arise from the user tests?
- What game design related observations arise?
- What testing environment related observations arise?

The rest of the paper is organized as follows. Section II presents related work on games for the elderly. Section III presents the employed research protocol and the participants to the study. Results of the study are presented in section IV. Finally, in section V, the results are discussed, and the paper concludes in section VI.

II. RELATED WORK

In general, games are considered stimulating for the brain and gaming can improve cognitive skills, especially in the elderly. Many previous studies have established that games can improve both the mental and the physical wellbeing of elders (for example, [6], [7], [8], [9], [10], [2]). For example, the study by Nouchi et al. found that brain training games can improve executive functions and processing speed [2]. In a similar vein, the study by Russoniello et al. establishes the benefits of games on people with depression [1]. Many studies highlight different health benefits of video games – an extensive review is given in the work by Griffiths [11].

Playing video games is increasingly popular among the adult population. Exact statistics are hard to come by but some estimates can be drawn from the extant literature. The study by Anderson in 2016 found that 45% of people 60 years old or older play video games [12]. As time passes these populations become older, and special care needs to be taken when developing games with this audience in mind.

Game development with the elderly as the user group can be challenging. One reason behind this can be attributed to the age gap between typical software developers and senior citizens. For example, according to the latest Stack Overflow survey, almost 70% of their userbase is 34 years old or younger [13].

TABLE I
PARTICIPANTS IN THE TEST SESSIONS

Test day 1	Test day 2	Test day 3
Woman 61 - 70	Woman 71 - 80	Woman 61 - 70
	Man 71 - 80	Man 71 - 80
	Man 61 - 70	Man 61 - 70

Another consideration is that old age is likely to come with certain conditions such as pulmonary disease, diabetes, depression, or dementia [14]. In addition, one third of people over the age of 65 will have some visual impairment [15] and hearing loss becomes frequent, too [16]. Tremors and lowered reaction time can make the use of digital interfaces difficult [17], [18].

Previous work on digital tabletop games for the elderly is scarce. An extant study by Al Mahmud et al. concludes that digital tabletop games as a gaming style appeal to the elderly [19]. However, to our knowledge, there are not many recent studies in the area, and this work addresses this research gap.

III. RESEARCH METHOD AND PARTICIPANTS

The following subsections outline the research setting (protocol) for our study, and the video game itself.

A. Study protocol

This study employs a qualitative research approach based on observing volunteers participating in the user and usability tests [20]. Usability testing is a research approach, where users are involved in order to evaluate the usability characteristics of a system [4]. Overall, four volunteers participated in over seven individual test sessions. The sessions were arranged during three different days, with time for development sprints in between. The participants in the test sessions are described in Table I. The user tests were conducted by the first author in the summer of 2020.

During the test sessions, the think-aloud method [5], [21] was employed to solicit impressions from the participants. Before starting, the users are informed that they are not the subject of the test, but rather the application they are using. The user is given a task and asked to describe their thoughts and feelings as the task is completed. An independent observer participates in the test, taking notes or recording the session. The observer can ask questions to encourage the participant in their commentary. The observer should avoid helping the participants, unless it is not possible to continue the test otherwise, or if it is to prevent the user from quitting. [22].

Three to four testing rounds were performed in each session. In the tasks we started with the minimum knowledge needed to proceed in the game, followed by more game related mechanics in the subsequent rounds. The objective of this protocol was to complete the whole game in one test session. At the end of the session, game-specific questions were asked: What was the purpose of the game, how entertaining was it, how easy was it to

place the road tiles and drive the car, and would they play the game again?

Between the test sessions time was allocated for iterative prototype development based on the participants' feedback [23]. This allowed for some troublesome issues with the game design to be improved while the study was ongoing.

Due to the ongoing Covid-19 pandemic, the testing was conducted either outdoors, or in a lounge of a senior citizens' apartment building. Protective equipment was used when necessary.

B. The Game

For this study a digital tabletop game was created. The objective was to design a game to help maintain the physical or cognitive capabilities of elderly people. A secondary objective for the game was to promote social or health services, which currently are delivered using a specially equipped van to the elderly people living in sparsely populated areas of the South-Savo region.

The game resembles the popular boardgame, Labyrinth. The player places puzzle pieces on the board to advance in the game. The game was designed in the context of the social and health services van, therefore the puzzle pieces form a road connecting houses in the rural areas. The player needs to place the tiles on the board, forming a path to the finish line, and successfully move the car on screen.

The finished user interface and main controls of the game are depicted in Figure 1. The mechanism to place tiles on the board is by drag and drop, and the car is moved using the controls on the bottom of the screen. The game was developed using the Unity game engine.

IV. RESULTS

The following section describes the process of conducting the user tests, and the observations we made from them. A summary of the test outline and results are presented in Table II.

A. First round of testing

The first testing day had only one participant. This test day served partly as a baseline for further test sessions, and partly to test the study protocol itself. The participant was a woman between 61 - 70 years of age, with no previous experience with mobile games. The participant was asked to play four rounds of the game, with more game elements introduced each round.

On the first try, the participant did not see the built-in instructions button in the main menu but instead proceeded to try to play without knowing the objective of the game. When the help menu was introduced to the participant, she had difficulty reading it because of the sunny, outdoor conditions (and reflections on the tablet). On the subsequent game rounds, the participant still had trouble approaching the game. The written instructions (in-game) were not helpful, and the observer had to verbally brief the participant about the mechanics and goals of the game.

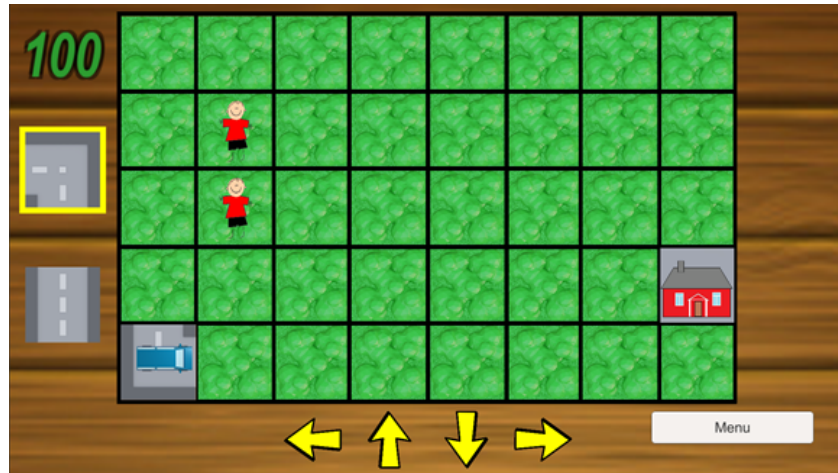


Fig. 1. The finished game user interface. The player's van is on the lower left of the game area, while tiles that can be added to the board to advance the game are on the left side of the screen. The objective of the game is to place the tiles on the board, connecting the player's starting position with the finish line (the house), while picking up randomly located passengers.

B. Second round of testing

Between the first and second testing days, some graphical changes were made to improve visibility, and a tutorial style help section for the game was added. On the second testing day, three volunteers took part in the sessions. The first participant was a woman between 71 - 80 years old, who was somewhat familiar with smartphones and tablets. Participant 2 was a man between 71 - 80 years old, with no touch screen experience. Participant 3 was a 61 - 70-year-old man, with no touch screen experience, but did use a computer 2-3 hours a day.

Participants 1 and 2 proceeded to start the game, ignoring the instructions. Participant 3 did read the instructions first but found the text confusing. It was therefore concluded that the tutorial style help section needs more work.

After the participants started getting grips with the gameplay, we observed that they had very different mental models of the game's context. As the player's avatar is a car, it should run on a road and avoid obstacles. However, one participant did not make this connection and attempted to drive the car on an unpaved surface. Meanwhile, another participant confused the background scenery with the obstacles. These observations did not lead to modifications in the games, as the perceptions of the game were so mixed between participants.

We concluded that the text instructions were not useful, and there should be a video tutorial or an animated screen showing the gameplay. Additionally, some changes to the graphic elements were required, because the participants had trouble distinguishing game elements from the background.

C. Third round of testing

For the third day of testing, the in-game tutorial was further improved. An animation with a hand playing the game was added to illustrate how the road tiles should be placed on the board. The text instructions were still

available but this time with a large font using more of the screen. In addition, a popup screen was added to inform the player if they tried to place tiles on top of each other. The side-by-side comparison of the changes to the game's main screen is shown in Figure 2.

On this day the three volunteers taking part had already volunteered for either the first or the second testing day. Participant 1 was the woman from the first testing day, while participants 2 and 3 were the men from the second testing day.

By and large, we could see that the participants' understanding of the game and road placement improved over the test sessions. The animated tutorial seemed to be useful in explaining how the road tiles were meant to be placed on the board. On the other hand, the participants still struggled with the car controls, which were not illustrated in the tutorial. This issue was not resolved during the development cycle but an animated tutorial (similar to placing the tiles) could be added to fix the problem.

V. DISCUSSION

To answer our first research question *What usability related observations arise from the user tests?* We found that the design of a menu where detailed instructions could be accessed was not a good solution for the elderly participants. Instead, all participants favored a helpful, but more intrusive animation.

To answer the second research question *What game design related observations arise?* We found that, at least in the beginning, an animated hand showing how to move the tiles on the board was helpful, as was the pop-up hint which appeared if the user tried to place a tile in the wrong place. This suggests that instructions should be included inside the game (and within the gameplay).

However, we noticed that the participants formed different mental models of the game and its context, making it hard to form conclusions about the game design. As the participants all made slightly different interpretations of

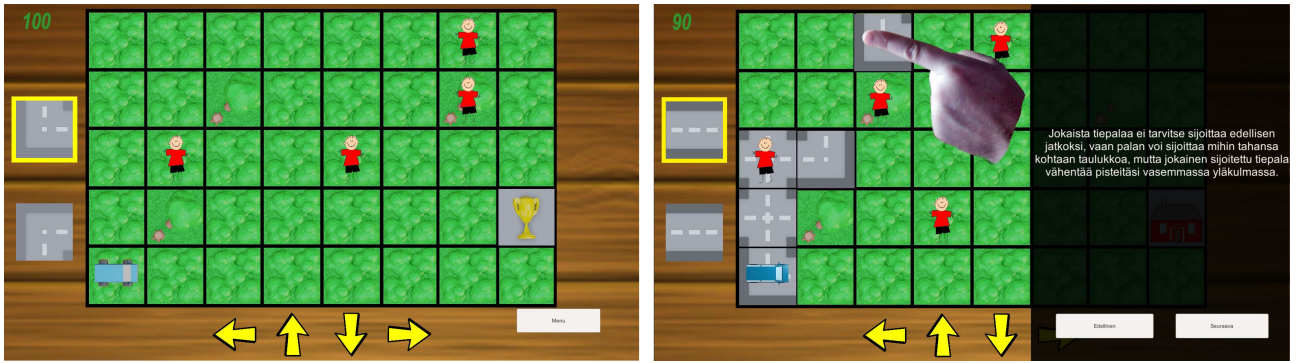


Fig. 2. Side-by-side comparison of the changes to the game screen after the first two testing rounds. An animated hand shows how to place tiles on the board, and a pop-up screen contains the written instructions. In addition, the car (bottom left) was re-drawn to be more distinctive against the background, and one road tile was placed beneath it.

TABLE II
SUMMARY OF THE TEST SESSIONS, DEVELOPMENT STEPS, AND TEST OUTCOMES

Test session	Development tasks	Test outcomes
First test day	Objective: Iron out the test protocol and identify usability issues	Issues: Reflections on the tablet screen made it difficult to read text instructions. Additionally, the font size was too small.
Second test day	Objective: Fix usability issues from the previous test	Issues: Text-based tutorial accessible from the menu did not seem intuitive enough.
Third test day	Objective: Fix usability issues from the previous test and confirm that improvements work. Confirm the usefulness of the animated tutorial and pop-up hints.	Observations: The new, animated in-game tutorial was perceived well. Pop-up hints allowed participants to quickly figure out what they had done wrong. Issues: The car controls require a tutorial too.

the game, it is hard to form strong conclusions without more prototyping and more impressions from testers. In general, we feel that to be easy to pick up the game should incorporate some real-life context. The participants were confused about which real-life rules to follow or not (for example, driving 'over' a passenger to pick them up vs. obstacles that need to be driven around).

Finally, to answer the third research question *What testing environment related observations arise?* Because the tests could not be arranged in a dedicated space, there were some issues with lighting and its' effect on the graphics. The participants could not see the texts clearly, and reflections made it hard to see what was on the screen.

The limitations of this study warrant some discussion. In the end, there were only four volunteers taking part in the testing. Unfortunately, it was hard to recruit willing volunteers, possibly due to the Covid-19 pandemic. However, some guidelines suggest using only three to five (for example Nielsen [24]) participants for user testing, while others say to use only one (see Medlock et al. [25]). As we consider the results to be exploratory rather than strong conclusions, observations can be made from qualitative experiments with a small number of participants.

VI. CONCLUSION

The goal of this study was to create a game that provides cognitive challenges for elderly people. Prior research has established that games can help prevent the age-induced decline in mental capabilities, and this study

explores games for elderly users in practice. Specifically, we conducted user testing with a digital puzzle game, which had been designed with the various age-induced impairments in mind.

In this process, we discovered some key points related to the game design, user interface, and external conditions during user testing. We found that to get started with the game, animated tutorials and pop-up notifications when the user makes mistakes are helpful. On the other hand, the elderly participants had trouble distinguishing the correct contextual information about the game's interface, leading to mixed mental models of the game and its context.

As the population ages, the different solutions for maintaining mental and physical wellbeing become more and more important. Extant literature is abundant with considerations for digital user interface design with the elderly users in mind but less focus has been given to user-centric game development for the elderly. In future work, these avenues should be explored more.

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