Designing an Online Escape Game for Older Adults: The Implications of Playability Testing Sessions with a Variety of Dutch Players

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Abstract. This study evaluated the playability of an online escape game designed using a User-Centred Design (UCD) process for older adult players aged 65 and older. The participants were 30 Dutch older adults who played the game in pairs on tablets over 15 game sessions. The data were collected through surveys, interviews, and observation field notes. The results indicated that, overall, the players enjoyed the game. They enjoyed the collaborative nature of the game and the game challenges the most. They also thought that the game story is engaging. However, the evaluation revealed that the game controller was a source of frustration and that the goals of several of the game tasks were not clear for the players. Moreover, it seems that the game needs to be customizable so that each pair of players could determine the pace and difficulty level of the game.

Keywords: Older adults · Playability testing · User-centered design · Online escape game

1 Introduction

A transition in the demographic patterns of western societies has resulted in a significant increase of the older adult population. They are consumers of many leisure activities offered by digital technologies. The growing ownership of digital devices by older adults has resulted in an increase in older adults who play digital games (https://www.pewresearch.org/internet/2017/05/17/tech-adoption-climbs-among-older-adults/ and https://ec.europa.eu/eurostat/statistics-explained/ index.php/people_in_the_EU_-_statistics_ on_an_ageing_society). However, older adults (65+), especially non-gamers, still play digital games far less frequently than older adult gamers and younger generations [1]. However, it is unlikely that this is only due to a lack of interest or openness to play digital games. Other factors, such as lack of perceived benefits and shortage of such games explicitly designed to meet older adults' needs, might be some other, more plausible, factors [2].

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Digital games are powerful tools that could help older adults' well-being by engaging them cognitively, emotionally, and socially [1, 3]. The use of digital games by older adults deserves commercial and academic attention, similar to the use of digital games by children [4]. During the past two decades, numerous empirical studies have been conducted on the preferences and motivations of older adults for playing digital games, [e.g. 2–11], but empirical studies on digital games designed for an older adult audience are rare and there are several barriers to the adoption and use of digital technologies, including digital games, by older adults [12]. Mattke, Klautzer, Mengistu, Garnett, Hu, and Wu [12] found that a lack of comprehensive instructions, little incentives to invest their time, and a low value of digital technology in their lives are among these barriers. By including older adults in the design and evaluation of digital games targeted at them, some of these barriers could be addressed. Moreover, understanding the preferences and needs of older adults, as well as acknowledging their limitations and capabilities may result in more enjoyable games that will be used by more people for longer terms [13].

One type of games that may be of interest to older adult game players may be escape games. Escape games, also known as escape rooms, are defined as "live-action team-based games where players discover clues, solve puzzles, and accomplish tasks in one or more rooms in order to accomplish a specific goal (usually escaping from the room) in a limited amount of time" [14, p.1]. Over the past few years, escape games have grown in popularity around the world. Escape rooms first appeared in Japan in 2007 and, in about five years, expanded to other parts of Asia, as well as Europe, North America, and Australia [14]. Escape games are collaborative and require communication, teamwork, delegation, observation, and critical thinking. Often, the rooms are themed and follow a storyline and the puzzles are of different types, including logic, mechanical, spatial, word, and math puzzles [15].

There are several reasons why an online escape game was chosen for this study. First, escape games have grown in popularity around the world, particularly in Europe and North America, attracting diverse players from various age groups. Second, the gameplay of escape games offers opportunities for cognitive and social engagement (see [1, 3] for more information about the impact of digital games on the physical, cognitive and social well-being of older adults). Collaboration and interaction with other players are necessary for completing game tasks in most real-life and virtual escape games. Since one of the main motivations of older adults for playing digital games is social interaction [e.g., 13], it seems that escape games seem may be an appropriate game that would be enjoyable for them to play. Finally, an online escape game would offer opportunities to interact with digital interfaces, use electronic communication, and perform game tasks using a digital device through a enjoyable, collaborative activity.

The purpose of this study was to evaluate the playability of an online escape game designed for older adults with a Dutch audience. The game was created using a User-Centred Design (UCD) process in Vancouver, BC, Canada. The game is based on real-life-escape rooms. Evaluating the playability of the game is important because this is an essential element of player-centered game design. Playability is basically the concept of usability in the context of game design. It is an important quality characteristic of a product or system. Usable systems are efficient, easy to learn, satisfactory in actual use, and not prone to errors [16].

According to Rubin and Chisnell [17], "[u]sability testing employs techniques to collect empirical data while observing representative end-users using the product to perform realistic tasks" (p. 19). In the context of game design and evaluation, playability goes beyond the basic user interface to include other elements of the game experience, such as game play, game story, and mechanics. In this empirical study, we used a qualitative method to observe the players playing the game, administered a questionnaire based on validated heuristics, and interviewed the players about their experience to learn about the extent to which our game is playable by its target audience. We used an iterative process, as we refined the game based on the feedback from the players.

This study aimed to answer the following question: How playable is the online escape game prototype, "A Tale of Tales," for older adults?

2 Literature Review

Globally, the population of adults aged 60 and older has risen from 382 million in 1980 to 962 million in 2017 [18]. Due to the significant social and economic implications of this demographic change, support needs to be provided to seniors to help them age successfully. Digital games have shown several benefits for older adults, including cognitive, psychological, and social benefits [1, 3]. However, older adult non-gamers – that is, people aged 60 years old and older who do not play digital games on a regular basis – have several characteristics that need to be address in game design. For example, many of such players have limited knowledge of game platform technology and are far less motivated to play digital games to the perceived value they associate with it [2]. Furthermore, older adult non-gamers find it difficult to interact with many digital games, due to perceptual, cognitive, and motor limitations [2, 19, 20]. Therefore, games that are specifically designed for this group of players might be more engaging and, thus, successful [21]. Brown and De Schutter [5], among other researchers [e.g. 20, 22, 23] suggested some design considerations for designing games for older adults that emphasize the importance of the players' past as a source of insight to create meaningful games and also their future to ensure the game would be accessible and usable [5]. These findings suggest that the older adult, as the end user, should be included in the design.

2.1 Designing Digital Games for Older Adults

Previous research on game design for older players has focused on the development of enjoyable game playing experiences and motivating older adults to engage in healthy physical, cognitive and social activities through engagement in play [1–11, 22]. During the past decades, various game design guidelines and recommendations have been developed for creating digital games for older players. For example, Gamberini et al. [22] and IJsselsteijn et al. [24], who focused on digital games for entertainment and cognitive enhancement, offered several recommendations for game challenges and complexity suited for older players, as well as game interface and visual adaptability. Similarly, Vasconcelos et al. [25] focused on the interface design for older adults.

Moreover, Awad et al. [26] offered an affordance-based approach, based on which, it is important that the game adapts to the players' action capability. Finally, De la Hera et al. [27] and Loos et al. [28] reviewed empirical studies on (co)design of intergenerational digital games. The former distinguishing two types of factors are important to take into consideration while designing digital games: player-centric and game-centric factors. The latter concluding that involving older and younger players in the co-design process is a logical condition to foster meaningful play, gaming being a shared play activity for which the players need each other. Brown and De Schutter [5] suggested some design considerations, including the importance of identifying the types of play older adults engaged in in childhood, accommodating for age-related changes, and accommodating for gamily gaming.

2.2 User-Centred Design and the Concept of Usability

Karat [29], defined UCD as "an iterative process whose goal is the development of usable systems, achieved through the involvement of potential users of a system in system design" (p. 38). Similarly, there are several methods to adapt UCD for a given design based on the way the designer involves the end-users, such as focus groups, usability testing, and participatory design [30]. How to adapt a particular UCD method depends on the goals of the developers, the available resources and the context of the development.

The International Organization for Standardization [31] defined UCD as an "approach to systems design and development that aims to make interactive systems more usable by focusing on the use of the system and applying human factors/ergonomics and usability knowledge and techniques" (p. 2). A user-centred design is especially crucial for a game targeted at an underrepresented audience, such as older adults, whose needs and points of view might be drastically different from those of the developers and researchers. An integral element of UCD is usability testing. Usability is defined as "…a quality attribute that assesses how easy user interfaces are to use, making it possible for the customers to develop tasks in a clear, transparent, agile and useful way" [32, para. 1]. The International Organization for Standardization [32] defined usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (para. 11). The most suitable method of testing could be ensured when the test involves representative users who interact with representative scenarios. The conductor of the usability test collects data on the user's success, speed of performance, and satisfaction. As for iterativeness, the more iteration on the testing, the better the product-system [33].

2.3 Evaluating Playability

Several game design scholars (e.g., [34–36]) advocate for an iterative design method that relies on collecting feedback from the players. Iterativeness in this context means designing, testing, evaluating, and redesigning the game throughout the development process. Fullerton et al. [35] encourage designers to create a playable version of the game immediately after brainstorming ideas to receive feedback early in the design

process; otherwise, anticipating *play* would be nearly impossible. Today, "playtesting," which is an integral part of iterative design, is one of the most established ways to include players in the design.

An accepted and widely used method of usability evaluation is heuristics which are design guidelines that serve as evaluation tools for game designers. Heuristics are typically used to evaluate interface usability, but, as mentioned earlier, to evaluate playability, other components should be addressed, as well. These components are game play, game story, and game mechanics. A validated set of heuristics for evaluating playability is *Heuristics for Evaluating Playability* (HEP), created by Desurvire et al. [37]. HEP contains 43 heuristics on four categories. *Game Play* is related to challenges and tasks the player face to win the game. *Game Story* has to do with the story and character development. *Game Mechanics* is related to the structure of the game, i.e., how the game units interact with the environment. *Game Usability* has to do with the interface and the controls the player uses when interacting with the game.

Another validated questionnaire is the Core Elements of the Gaming Experience Questionnaire (CEGEQ) [38]. The authors assert that in order for the gaming experience to not be negative, the Core Elements of the Gaming Experience (CEGE) must be present in a digital game. It should be noted that the CEGE do not determine whether a player will have a positive experience. However, if the CEGE are present, the player will not have a negative experience [38]. In other words, the CEGE questionnaire can give confidence to the designers that their game has the core elements of gaming experience and is, thus, playable and engaging. Two main areas of the CEGE are puppetry – consisting of control, ownership, and facilitators – and the actual video game details, including game play, rules, scenario, environment, graphics, and sound. CEGEQ helps determine the presence of the CEGE during the gaming experience.

In this study, we used both HEP and CEGE items to create our playability questionnaire based on our needs and what were most relevant to our purpose and to the elements of our online escape game prototype.

3 Escape Game Presentation

Adopting a UCD process that was discussed in details by Doroudian et al. [39], an online escape game was created in Vancouver, BC, Canada, called "A Tale of Tales." "A Tale of Tales" is a cooperative puzzle game based on real-life escape rooms. Real-life escape rooms are "live-action team-based games where players discover clues, solve puzzles, and accomplish tasks in one or more rooms in order to accomplish a specific goal (usually escaping from the room) in a limited amount of time" [40, p. 1].

"A Tale of Tales" is primarily intended for older adult players to engage them through elements of real-life escape rooms and the affordances of digital games. It is a two-player game that is played on two screens. The game was designed for multiple platforms, including PC, Mac, and Android operating systems. The theme of the game borrows elements from the story of Alice in Wonderland by Lewis Carroll. The storyline follows a character called "Ink Monster" who lives in a library. The Ink Monster takes the players into the world of the book and the game starts from there. The players must first escape the book, and they encounter the first game environment is a maze

with three portals to different rooms. The players should find these portals, enter them, and solve the puzzles to escape each room. There is no time limit in the game. Once the players are in the maze, one of them is a navigator with a bird's-eye view of the maze and the other player moves inside the maze (see Fig. 1).

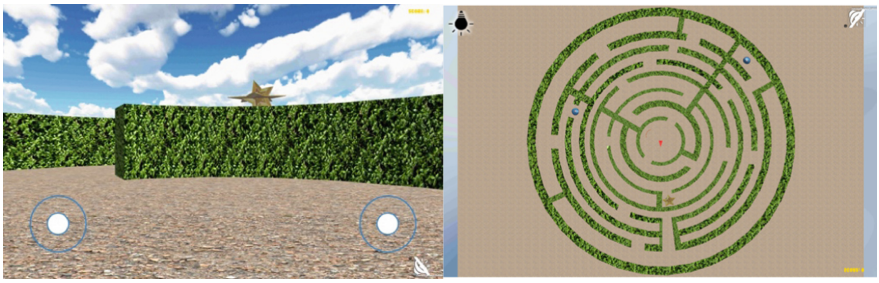

Fig. 1. Player One's view of the maze (left) and Player Two's view of the maze (right)

There are three portals in the rooms that lead to three different rooms. Room One is crossword puzzle with questions directly related to Alice in Wonderland. There are hints on the walls. Player One is inside the room and can explore it and Player Two sees the crossword puzzle's table (see Fig. 2).

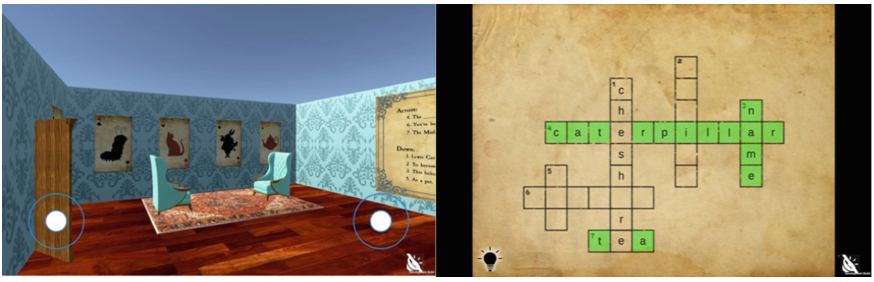

Fig. 2. Room One: Player One's View (Left) and Player Two's view (right)

The second room is a two-part puzzle consisting of a color-ordering puzzle and a clock-setting puzzle based on the tea party passage of Alice in Wonderland. Completing the color-ordering puzzle unlocks the second puzzle (see Fig. 3).

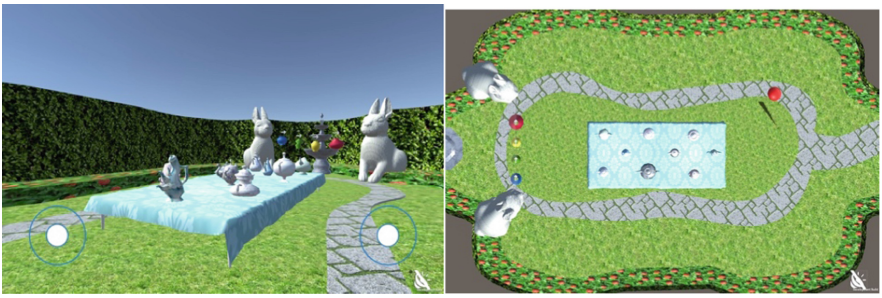

Fig. 3. Room Two: Player One's view (left) and Player Two's view (right)

Finally, the third room involves a matching puzzle in which the players must find the missing words of a short poem by looking at a series of pictures and then find a code to get out of the room (see Fig. 4).

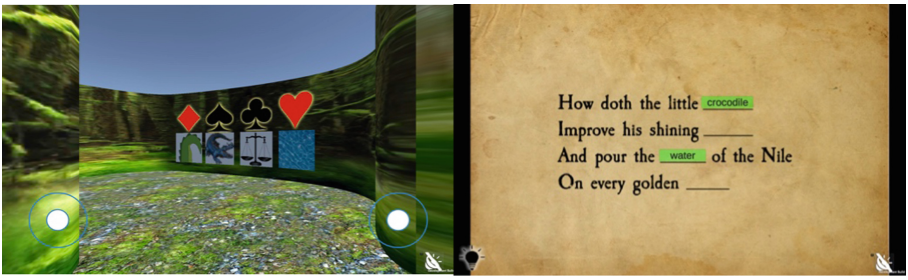

Fig. 4. Player One's view (left) and Player Two's view (right)

In all three rooms, there are code machines that the players must use to get out of the rooms. The codes are letters, numbers, and symbols that are discovered by completing the puzzles in the rooms.

4 Method

An exploratory case study approach was employed in this playability testing study. We relied on multiple sources of data – survey, interview, and observation – to explore the inquiry in its complexity and entirety. This reliance on multiple sources of data facilitated the evaluation within its context, so that the problem was explored through multiple perspectives. Further, multiple sources of data rendered a rich description of the inquiry and strengthened the trustworthiness of this qualitative research. In this project, there were two researchers present at the research site observing and collecting data through multiple methods, including surveys, interviews, and observation. The digital game was translated into Dutch for this empirical study that we conducted in the Netherlands. We used Android tablets in the game sessions. Initially, the controllers in

the Android version were two virtual joysticks: one for direction and the other for movement. We merged the joysticks into one during the playability testing based on the players' feedback and half of the players played the game with a single virtual joystick that performed all the movements.

4.1 Participants

In this study, 30 older adults of 65 years of age and older were recruited from churches senior community centres, partly through the social network of the researcher, and a call in a magazine of an association for older people in the Netherlands (purposive sampling). The 65 age marker was used because of the methodological practicality and the fact that it is the standard retirement age in most countries. There were 16 men and 14 women. The participants were physically mobile and cognitively normal and the participants' demographic information was collected.

4.2 Data Collection Instruments

Survey
Demographic information was collected through a background survey that included items on the participants' age, sex, education, digital skills, and experience with digital games. Moreover, the participants completed a playability questionnaire that was adapted from the Core Elements of the Gaming Experience Questionnaire (CEGEQ) [38] and Heuristics for Evaluating Playability (HEP) [37]. We chose the items from these tools according to their relevance to our escape game and what was most important to us for this particular prototype. Our playability questionnaire included 23 Likert-scale items that were applicable to our game (see Table 2 in Sect. 5.2). These items were divided into three main categories: the design, the control, and the experience of playing the game. The questionnaire also included four open-ended questions about what the players liked most and least about the game, whether they think the game is appropriate for older adults, and if they have any other comments about the game or their experience (see Sect. 5.2).

Observation Protocol
An observation protocol was used to collect field notes on several aspects of the older adults' play, including the ease with which players start the game and operate in it, how they navigate in the game, when they get frustrated and excited during their play, and any relevant comments on the participants' game play (see Sect. 5.4).

Interview
The interviews were carried out after each game session with the pairs of players who played the game together and were guided by an interview protocol with the following questions:

1. Are you going to play these games again? Why?
2. What did you like best about the games?
3. Which elements of the game did you find the most engaging? Why?
4. Describe what worked well for you and what didn't in the game?

5. Which aspects of the games didn't you like?
6. What could have been improved in the game?
7. Do you have any other comments?

All interview sessions were audio-recorded and they lasted an average of 15 min. The interviewer also took notes during the interviews.

4.3 Data Collection Procedure

Most of the game sessions were held in study rooms at Utrecht University but some of them were held in the participants' homes in other places in The Netherlands. The digital game sessions were held one at a time, except for two parallel sessions. The participants played the online escape game in pairs using Android tablets in the same room. There were two research assistants present during the game sessions. A Dutch-speaking person was in charge of most of the communications with the participants, including conducting the interviews and providing help to the participants. The other research assistant was in charge of setting up the escape game, resolving technical glitches, and supervising the game sessions. Both persons observed the digital game sessions and wrote field notes guided by the observation protocol.

The data collection started with the participants' signing a consent form, and they completed the background questionnaire (see Table 1 in Sect. 5.1) and were then briefed by one of the research assistants about what to expect in the game and the session. The participants played the game for an average of approximately 60 min. However, each digital game session lasted approximately 100 min with the survey (see Sect. 5.2) and interview (see Sect. 5.3). Participants were assigned the roles of Player One and Player Two, and they changed roles half-way through the game in order for them to experience both roles in the online escape game. The main difference in these roles was that Player One had to do more game actions and, therefore, used the controllers more often, whereas Player Two was mostly a navigator who had to verbally communicate the routes and other information necessary to complete the puzzles. Once they finished the game, the participants completed the playability survey (see Table 2 in Sect. 5.2) and then each pair sat for an interview that lasted approximately 15 min.

4.4 Data Analysis

The quantitative data collected from the participants through the background survey and the Likert-scale items of the playability survey were entered into separate spreadsheets in a Microsoft Excel. After cleaning and checking for any irregularities, these data were analyzed for descriptives using Microsoft Excel.

The qualitative data collected through the open-ended questions of the questionnaire and the interviews (see Sects. 5.2 and 5.3) were analyzed qualitatively by coding the responses and finding themes. Before the coding process, the responses from the questionnaire were translated from Dutch into English and were entered in a spreadsheet. The Dutch-speaking research assistant who conducted the interviews translated the responses and entered them into a separate spreadsheet. Similarly, the field notes during the testing were categorized and were entered into spreadsheets.

The first step in the coding process was to do a close reading of all the responses. During this process, several categories of codes emerged. Second, these categories were organized in columns with the following headings: "collaboration," "navigation," "controller challenge," "puzzle challenge," "puzzle preferences," "fun highlights," and "other barriers." These were further divided into the themes that emerged in those columns. Whenever a new theme emerged, a corresponding column was added. The categories were then ranked based on their frequency in the responses (see Table 1). The main reason this approach was deemed practical was that the responses were short.

Table 1. The ranking of the categorized responses

Rank	Category
1	Controller challenges
2	Fun highlights
3	Enjoying collaboration
4	Navigation
5	Puzzle challenges
6	Other barriers

5 Results

5.1 Participants Demographics

Table 2 shows the demographic data of the 30 participants. 16 of the participants were men and 14 were women. There were 14 players between 65 to 69 years old, 11 players between 70 to 74, four players between 75 to 79 and 1 player was 80 to 84 years old. Twenty-two players (73.4%) were married or partnered and eight of them (26.6%) were single. Almost half of the players had higher professional education, seven players (23.4%) had secondary education or a lower certificate, five players (16.6%) had vocational education, and four of them (13.4%) had a university degree. Most of the players (76.6%) were living with someone else. As for digital skills, the majority of the players (63.4%) indicated that they are intermediate, 30% were advanced, and 6.6% believed they were beginner. However, it should be noted that most of them did not have a clear assessment about their digital skills. Therefore, their self-assessments were not definitive. Nineteen players (63.4%) had played digital games before, of whom 37% would play once a day, 21% once a month, 16% once a week, and 5% a few times a week.

Table 2. Demographics of the players

Characteristics	Category	Frequency (n)	Valid percent (%)
Sex	Female	6	20.0
	Male	24	80.0
	Total	30	100.0
Age	65–69	14	46.6
	70–74	11	36.6
	75–79	4	13.4
	80–84	1	3.4
Relationship status	Married/Partnered	22	73.4
	Single/Divorced	8	26.6
Education level	Lower than secondary school	3	10.0
	Secondary school	4	13.4
	Vocational education	5	16.6
	Higher professional education	14	46.6
	University	4	13.4
Do you live alone?	Yes	7	23.4
	No	23	76.6
Digital skills	Beginner	2	6.6
	Intermediate	19	63.4
	Advanced	9	30.0
Have you played digital games before?	Yes	19	63.4
	No	11	36.6
Frequency of playing digital games	Once a month	4	21.0
	Once a week	3	15.7
	A few times a week	1	5.3
	Once a day	7	37
	Other	4	21.0
	Total	19	100.0

5.2 The Playability Survey

The Likert-Scale Items

Table 3 below shows the results of the Likert-scale items from the usability questionnaire. With regard to the design of the game, most respondents (80%) liked the visuals of the game; however, most of them thought the art design was not appropriate for them. Moreover, almost all of them agreed that the graphics are appropriate for this kind of game, but they didn't like the animations in the game. As for the instructions and hints, most respondents found the instructions in the game difficult to follow, but most of them indicated that the help offered in the game was helpful. Finally, most respondents reported that they had difficulty understanding the rules of the game.

Table 3. The Likert-Scale Items from the playability questionnaire

Category	Item	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Design of the game	I liked the way the game looked	0	2	3	11	13
	I did not understand the rules of the game	0	3	6	14	7
	The graphics were appropriate for the type of the game	0	1	1	16	12
	I didn't like the animations of the game	0	1	1	12	16
	The art design was not appropriate for me	0	1	8	12	10
	The game display was optimal with respect to the size of the screen	0	0	4	10	15
	I couldn't follow the instructions of the game	0	5	4	16	5
	The help offered in the game was useful	0	0	1	11	17
The Control of the Game	The game was easy to play	0	0	12	11	1
	I did not have a strategy to win the game	2	10	10	5	1
	It was easy to navigate the interface of the game	3	8	11	5	2
	The learning content was too difficult for me	12	11	5	2	0
	The feedback was useful to me	0	1	2	18	9
	The game required quick response, which was a challenge for me	4	9	11	6	0
Overall Experience	I enjoyed playing the game	0	1	2	15	11
	I would like this game to be more competitive	1	5	21	2	1
	The learning content was interesting to me	1	2	10	16	1
	I got bored playing this game	11	11	9	1	9
	I would play this game again	1	5	3	14	8
	I was frustrated while playing this game	12	11	5	2	0
	I learned something new while playing this game	4	3	9	10	5
	The game tasks were complicated for me	7	17	4	1	0
	The game motivated me to keep playing	1	3	5	17	5

As for the control of the game, half of the respondents couldn't decide if the game was easy to play but the other half found it easy to play. Most respondents either didn't have a strategy to "win" the game or were undecided about it. Some respondents found the interface of the game easy to navigate, but a larger number found it difficult. Almost all of them found the game feedback useful. Finally, the majority of the respondents reported that the game required actions that were too quick for them.

In terms of overall experience, most respondents enjoyed playing the game and only a few of them were bored with it. The majority of them said they would play the game again; however, they wanted it to be more competitive. Only two players reported frustration during the game. Half of the respondents believed they learned something new. Almost all of them thought the game tasks were not too complicated for them. Finally, most of them believed that the game motivated them to keep playing.

The Open-Ended Items

The usability questionnaire included four open-ended questions that were intended to complement the Likert-scale items. The responses to these questions were entered in a spreadsheet and categories were given to issues in the responses. Here are the main issues the players wrote about in the questionnaire.

- *Collaboration to achieve a shared goal was the most enjoyable element of the game play for the players.*

The word "collaboration" stood out in the responses. Most respondents indicated that they enjoyed the collaborative nature of the game and "playing together" was the best thing they liked about this game. One player said, "I liked the playing together. It was original and challenging." Moreover, some respondents reported that they liked the challenges in the game tasks and that solving the puzzles was very engaging.

- *The virtual controllers and, thus, moving in the game was a source of frustration.*

The players referred to the difficulty of moving in the game, mainly due to the two virtual joysticks. One player said, "navigating was difficult. Going to different directions was very inconvenient with two joysticks." It seems that the players had the most difficulty with movement inside the maze. The same difficulty was reported, to a lesser extent, in the rooms, too. Some other players indicated that the speed of movements was too fast for them.

- *The players believed that the game is appropriate for their age.*

The players believed that the game is appropriate for their age, as it mostly kept them engaged and the game tasks had the right amount of challenge in most cases. But they also referred to the speed of the game and the controllers as factors that could be modified to better tailor the game to older adults. Some of them also asked for more diverse puzzles in the rooms.

- *The players voiced a need for more instructions and hints.*

The players believed that the instructions in the game were not sufficient. They thought their play experience could be improved if there had been more hints and instructions throughout the game. Some of them thought the goals of each puzzle should be made clear from the beginning. Others believed that it was almost impossible to finish the game without physical help from someone who knows the game.

5.3 Results of the Interviews

After they were finished playing the game, each pair sat for an interview to respond to ten questions regarding their experiences in the game. The responses were coded and organized in a spreadsheet and then themes emerged from the categories of codes. In this section, these four themes are presented.

- *The Players Would Play the Game Again, if There Are More Themes and Puzzles*

The players liked the game and most of them said they would play the game again. However, they requested more diverse game stories and puzzles. Also, they wanted different levels of difficulties to choose from. Some of the players said that it is important that both players be engaged throughout the game, rather than one player having fewer tasks to do and the other player being overloaded.

- *Finding solutions for the puzzles with a partner was the most fun element of the game play.*

Almost all participants believed that the collaborative nature of the game and striving for a shared goal was the most enjoyable part of their play experience. This in line with the finding of the survey. From their elaborations on this, it can be inferred that they liked the verbal interaction and the trial-and-error process to find codes and figure out the goals of the puzzles.

- *The Difficulty with Navigation Negatively Affected the Players' Play Experience*

As they indicated in the survey, the participants also expressed their dissatisfaction with the two virtual joysticks, even with the single virtual joystick. Most of the complaints regarded the fact that using both hands at the same times for direction and movement was difficult. Some players believed that the difficulty was due to lack of experience and it could be resolved with practice, while others thought that this kind of controller didn't work for them due to their motor skill limitations. Some other participants thought that the problem was mostly the fast speed rather than the controllers.

- *The Multiple Objectives of the Game Tasks Were not Clear to the Players*

The respondents believed that they couldn't figure out the purpose of the puzzle on their own without the research assistant's help when they were "stuck." What they mean was that when they were encountered with a new task, they looked for assistance. Overall, it seems that the players did not engage with the "clue finding" part of the rooms very much. Their comments suggest that they preferred to skip the exploratory stage in each room and get to solving the puzzles.

5.4 Results of the Observation

During the game sessions in this phase, the research assistants collected field notes guided by an observation protocol that focused on several aspects of the players' interaction with the game. The protocol focused on the ease with which players start the game and operate in it, instances of frustration, instances of excitement, difficulty navigating the game, and any relevant observation that could be important for improving the game.

According to the observers' notes, the players didn't have difficulty starting the game, except in one case. However, the players seemed frustrated on several occasions during the game. Most prominently, they were frustrated when trying to use the virtual joysticks to move in the maze. This is in line with the results of the usability survey and the interviews. Another source of frustration was making mistakes inside the rooms. This was especially the case in the second room when they would get the color order wrong. The third source of frustration was when the navigator made mistake in finding the correct route to the rooms. Finally, the design of the third room seemed to have frustrated the players, since they had to move between two places often to figure out the final code.

A difficulty that was observed frequently during the game session was identifying the portals in the birds-eye view of the maze. It seemed that the portals, which were in star and ball shapes, were not conspicuous enough for older adults. Moreover, when they were done with one room and wanted to find the next room, they had difficulty identifying the correct room.

The observation data shows that, at some point in any of the three rooms, the players did not know what to do. In the first room, some players did not know how to access the code after solving the crossword puzzle. The code was visible by pressing on a light switch. In the second room, most players did not know what the purpose of the puzzle is, so a research assistant had to explain it to them. In the same room, half of the players did not know they can, and should, move the clock handles. In the third room, where there are four pictures on the wall that correspond to card suits above them, most players did not know how to figure out the code based on the suits and the order of the pictures.

6 Discussion

This study aimed to evaluate the playability of an online escape game designed with, and targeted at, older adults. Following the recommendations in the literature (e.g., [24, 41]), we decided to use direct input devices for the playability testing of the game. Direct input devices, such as tablets, allow older adults with mobility issues to place the tablet in a position that is comfortable for them. They also provide a more intuitive way of interaction with a digital device compared to indirect input devices like laptops.

The participants of this study were all Dutch and most of them were between 65 to 69 years old. However, they were quite diverse in terms of education level and their experience with digital games.

The results of the evaluation suggest that the players were satisfied with the overall interface design of the game. They also found the game feedback useful, and enjoyed playing the game in general. The game seemed to have kept them motivated to keep playing. Most of them indicated that they would play the game again. However, it should be noted that many respondents might not have been able to keep playing the game during sessions without the help given by the research assistants, including hints and sometimes even helping them with the controllers. An interesting finding was that, although the players found the game tasks not too complicated, the majority of them reported that they did not understand the rules of the game. Based on the interview responses, it seems that what they described as "not understanding the rules" was in fact a game task: finding clues. The players were reluctant to spend an extended amount of time figuring out what to do and find clues with their partner.

This is in line with Gamberini et al.'s [23] observation that older adult players need more help using materials throughout the game. Overall, these findings suggest that the players did not engage in the clue finding part of the rooms. Perhaps in an untimed game session happening in the players' natural play context (e.g., their homes), this could be different. After all, the game is designed to be played at leisure and without a time limit. Moreover, the presence of the research assistants could have made the players rely too much on their help. Therefore, the decision to put more hints in the game is a difficult one because discovery and trying out different possibilities is a core element of escape room gameplay that fosters collaboration and social interaction between the players.

The results also indicate that the players found it difficult to move in the game, mostly due to the controllers, the pace of the game, and inefficient communication with the game partner. Using the virtual joysticks turned out to be the most significant source of frustration for players. This finding is in line with that of Aison et al. [9], who found that older adults had difficulty using controllers and joysticks and they cited it as the most common factor distracting them from game enjoyment. Inefficient communication could be another reason for the failure to navigate the game with ease. Since the players see different views of the game, communicating what they see and what information to give is essential to navigating the game with ease. However, the observational data shows that some players were not efficient in this regard. It should be noted that the double virtual joysticks were replaced by a single joystick after holding half of the game sessions. This refinement was helpful, as we observed less frustration in the players. However, it seemed that the problem still persisted to some extent.

The results of this evaluation suggests that the players enjoyed the collaborative nature of the game more than succeeding in it. This finding confirms Altmeyer and Lessel's [42] statement that socializing is a core motivator for older adults. It seems that older adults play digital games more to communicate and maintain social contact than to succeed in the game. They are also more inclined to help each other and promote positive relations than to compete with each other [42]. The players followed up on their response by indicating that achieving a shared goal with their game partner was something they liked the most in their experience.

Another finding was that, although the players indicated they would play the game again, they had some conditions to be motivated to do so. Specifically, they said they

would play the game again if they know they will encounter something new each time. They also expressed their preference for being able to customize the speed and difficulty level of the game. Finally, it is worth noting that the results of the survey and interview results contradicted our observation in some cases. Most notably, it seems that some players were frustrated with different aspects of the play; however, they did not reflect this frustration in their survey and the interview responses.

Based on these findings, this evaluation provided sufficient data to conclude that the game is playable in terms of interface design and fostering collaboration to achieve shared goals. However, it still needs improvements in some areas, including game control, providing cues as to what the player needs to do next, and more clear objectives for the game tasks, such as the puzzle in room two.

7 Conclusion and Limitations

This evaluation aimed to answer the research question on how playable our online escape game is. The findings revealed that the game requires refinements and further playability testing and field testing before publication. Our findings suggest that older adults prefer puzzles with clear goals that are explicitly stated at each stage in the game. They would also like to know all the actions they have to do in their roles in the game. The players also prefer to be able to customize the game to match their pace and abilities. They respond better to direct-input devices and need controllers that require simple actions. The evaluation also showed where the game needs further improvement for it to be ready for distribution to a broader audience. Despite these issues, they greatly appreciated the social and collaborative aspects of playing this game. Most older adults enjoyed the game and stated that they would play it again.

Furthermore, although we did not empirically measure the impact of the game on social interaction in this evaluation, the game was designed with emphasis on facilitating social interaction for older adults. Our observation suggests that the game did facilitate social interaction among our players, since navigating and solving puzzles depended on verbal communication. It also seems that they enjoyed this interaction because, first, the interview responses tell us that the collaborativeness of the game was a positive highlight of the players' experience and, second, based on our observation, they had a good time chatting with each other during and after the game sessions. That being said, it is necessary to empirically evaluate the impact of the game on promoting social connectedness in older adults, as well as in intergenerational players.

A limitation of this study was the contrived context of our game sessions. The players played the game in the same room in presence of two research assistants who provided hints and guidance during the game. In addition, the fact that some of the respondents personally knew one of the research assistants who was present during the game sessions might have affected their behavior or their responses. These are important factors that could have affected the results significantly. Therefore, further field-testing of the game is required to validate these findings and make sure the game could achieve its goals.

References

1. Zhang, F., Kaufman, D.: Physical and cognitive impacts of digital games on older adults: a meta-analytic review. J. Appl. Gerontol. **35**(11), 1189–1210 (2015)
2. Brown, J.A.: Digital gaming perceptions among older adult non-gamers. In: Zhou, J., Salvendy, G. (eds.) ITAP 2017. LNCS, vol. 10298, pp. 217–227. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-58536-9_18
3. Loos, E., Kaufman, D.: Positive impact of exergaming on older adults' mental and social well-being: in search of evidence. In: Zhou, J., Salvendy, G. (eds.) ITAP 2018. LNCS, vol. 10927, pp. 101–112. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-92037-5_9
4. De Schutter, B.: Never too old to play: The appeal of digital games to an older audience. Games and Culture **6**(2), 155–170 (2011)
5. Brown, J.A., De Schutter, B.: Game design for older adults: lessons from a life course perspective. Int. J. Gaming Comput. Med. Simul. (IJGCMS) **8**(1), 1–12 (2016). https://doi.org/10.1177/1555412010364978
6. Nap, H., Kort, Y., IJsselsteijn, W.: Senior gamers: preferences, motivations and needs. Gerontechnology **8**(4), 247–262 (2009)
7. Brown, J.A.: Let's play: understanding the role and meaning of digital games in the lives of older adults. In: Proceedings of the International Conference on the Foundations of Digital Games, pp. 273–275. ACM (2012)
8. Loos, E., Zonneveld, A.: Silver gaming: serious fun for seniors? In: Zhou, J., Salvendy, G. (eds.) ITAP 2016. LNCS, vol. 9755, pp. 330–341. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-39949-2_32
9. Aison, C., Davis, G., Milner, J., Targum, E.: Appeal and interest of video game use among the elderly (2002). http://www.booizzy.com/jrmilner/portfolio/harvard/gameselderly.pdf
10. Aarhus, R., Grönvall, E., Larsen, S.B., Wollsen, S.: Turning training into play: embodied gaming, seniors, physical training and motivation. Gerontechnology **10**(2), 110–120 (2011)
11. Loos, E.: Exergaming: meaningful play for older adults? In: Zhou, J., Salvendy, G. (eds.) ITAP 2017. LNCS, vol. 10298, pp. 254–265. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-58536-9_21
12. Mattke, S., Klautzer L., Mengistu T., Garnett J., Hu J., Wu, H.: Health and well-being in the home: a global analysis of needs, expectations, and priorities for home health care technology. Rand Corporation Pittsburgh (2010). http://www.rand.org/pubs/occasional_papers/OP323.html
13. Marston, H.: Older adults as 21st century game designers. Comput. Games J. Whitsun **1**(1), 90–102 (2012)
14. Nicholson, S.: Peeking behind the locked door: a survey of escape room facilities (2015). White Paper. http://scottnicholson.com/pubs/erfacwhite.pdf
15. Pan, R., Lo, H., Neustaedter, C.: Collaboration, awareness, and communication in real-life escape rooms. In: Proceedings of the 2017 Conference on Designing Interactive Systems, pp. 1353–1364 (2017)
16. Nielsen, J.: Usability Engineering. Academic Press, Boston (1993)
17. Rubin, J., Chisnell, D.: Handbook of Usability Testing, 2nd edn. Wiley Publishing, Indianapolis (2008)
18. Department of Economic and Social Affairs Population Division, United Nations. World Population Ageing 2017. United Nations, New York (2017). https://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2017_Highlights.pdf

19. Astell, A.: Technology and fun for a happy old age. In: Sixsmith, A., Gutman, G. (eds.) Technologies for Active Aging: International Perspectives on Aging (Book 9), vol. 9, pp. 169–187. Springer, New York (2013). https://doi.org/10.1007/978-1-4419-8348-0_10
20. Loos, E.F., Bergstrom, J.R.: Older adults. In: Bergstrom, J.R., Schall, A.J. (Eds.) Eye Tracking in User Experience Design, pp. 313–329. Elsevier, Amsterdam (2014)
21. Loos, E.F.: Designing meaningful intergenerational digital games. In: Proceedings of the International Conference on Communication, Media, Technology and Design, Istanbul, 24–26 April 2014, pp. 46–51 (2014)
22. Gerling, K.M., Schulte, F.P., Masuch, M.: Designing and evaluating digital games for frail elderly persons. In: Proceedings of the 8th International Conference on Advances in Computer Entertainment Technology. Association for Computing Machinery, New York, NY (2011)
23. Gamberini, L., Alcaniz, M., Barresi, G., Fabregat, M., Prontu, L., Seraglia, B.: Playing for a real bonus: videogames to empower elderly people. J. Cyber Therapy Rehabil. **1**(1), 37–48 (2008)
24. IJsselsteijn, W., Nap, H.H., de Kort, Y., Poels, K.: Digital game design for elderly users. In: Proceedings of 2007 conference on Future Play, pp. 17–22. ACM and Wiley, New York (2007)
25. Vasconcelos, A., Silva, P., Caseiro, J., Nunes, F., Teixeira, L.: Designing tablet-based games for seniors: the example of CogniPlay, a cognitive gaming platform. In: Proceedings of the 4th International Conference on Fun and Games, pp. 1–10 (2012)
26. Awad, M., Ferguson, S., Craig, C.: Designing games for older adults: an affordable based approach. In: 2014 IEEE 3rd International Conference on Serious Games and Applications for Health (SeGAH), pp. 1–7 (2014)
27. De la Hera, T., Loos, E.F., Simons, M., Blom, J.: Benefits and factors influencing the design of intergenerational digital games: a systematic literature review. Societies **7**(3), 18 (2017)
28. Loos, E., de la Hera, T., Simons, M., Gevers, D.: Setting up and conducting the co-design of an intergenerational digital game: a state-of-the-art literature review. In: Zhou, J., Salvendy, G. (eds.) HCII 2019. LNCS, vol. 11592, pp. 56–69. Springer, Cham (2019). https://doi.org/10.1007/978-3-030-22012-9_5
29. Karat, J.: User centered design: quality or quackery? Interactions **3**(4), 18–20 (1996)
30. Gulliksen, J., Boivie, I.G.B., Persson, J., Blomkvist S., Cajander A.: Key principles for user-centred systems design. In: Seffah, A., Gulliksen, J., Desmarais, M.C. (eds.) Human-Centred Software Engineering - Integrating Usability in the Software Development Lifecycle, pp. 17–37. Springer, Dordrecht (2005). https://doi.org/10.1007/1-4020-4113-6_2
31. International Organization for Standardization: ISO 9241- 210: Ergonomics of Human-centred System Interaction – Part 210: Human-centred Design for Interactive Systems. International Organization for Standardization, Geneva (2010)
32. International Organization for Standardization: ISO/TS 20282-2:2013 Usability of Consumer Products and Products for Public Use — Part 2: Summative Test Method. International Organization for Standardization, Geneva (2013)
33. Diah, N., Ismail, M., Ahmad, S., Dahari, M.: Usability testing for educational computer game using observation method. In: Proceedings of the 2010 International Conference on Information Retrieval & Knowledge Management (CAMP), pp. 157–161 (2010)
34. Sykes, J.: A Player-centred approach to digital game design. In: Rutter, J., Bryce, J. (eds.) Understanding Digital Games, pp. 75–92. Sage, London (2006)
35. Fullerton, T., Swain, C., Hoffman, S.: Game Design Workshop: Designing, Prototyping, and Playtesting Games. CMP Books, Gilroy (2004)

36. Pagulayan, R.J., Keeker, K., Wixon, D., Romero, R., Fuller, T.: User-centered design in games. In: Jacko, J., Sears, A. (eds.) Handbook for Human–Computer Interaction in Interactive Systems, pp. 883–906. Erlbaum, Mahwah (2003)
37. Desurvire, H., Caplan, M., Toth, J.: Using heuristics to evaluate the playability of games. In: CHI 2004 Extended Abstracts on Human Factors in Computing Systems, pp. 1509–1512 (2004)
38. Calvillo-Gámez, E.H., Cairns, P., Cox, A.L.: Assessing the core elements of the gaming experience. In: Bernhaupt, R. (ed.) Evaluating User Experience in Games. HIS, pp. 47–71. Springer, Cham (2010). https://doi.org/10.1007/978-1-84882-963-3_4
39. Doroudian, A., Hausknecht, S., Kaufman, D.: Creating an online escape room game for older adults: needs assessment, design process, and usability testing. In: Zhou, J., Salvendy, G. (eds.) ITAP 2018. LNCS, vol. 10927, pp. 516–525. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-92037-5_36
40. Nicholson, S.: Peeking behind the locked door: a survey of escape room facilities. White Paper. (2015). http://scottnicholson.com/pubs/erfacwhite.pdf
41. Wood, E., Willoughby, T., Rushing, A., Bechtel, L., Gilbert, J.: Use of computer input devices by older adults. J. Appl. Gerontol. **24**(5), 419–438 (2005)
42. Altmeyer, M., Lessel, P.: The Importance of social relations for well-being change in old age – do game preferences change as well? In: Positive Gaming: Workshop on Gamification and Games for Wellbeing (2017). http://ceurws.org/Vol-2055/paper2.pdf