Design, Development, and Evaluation of an Online Escape Game for Older Adults

by

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Abstract

The World Health Organization (WHO) reported that seniors (persons who are 60 years old and older) are one of the fastest-growing populations in the world. Accordingly, maintaining their quality of life has become an exponentially important issue, and digital technologies can help. A large number of older adults have embraced digital technologies. Many others would be open to digital technologies provided that they would see the benefits and become motivated to use these new tools. Older adults can benefit from new technologies in various ways and digital games provide one such way. Older adults represent a growing demographic of gamers. Research has shown that digital games have physical, cognitive, emotional, and social benefits for seniors. They also offer opportunities for lifelong learning and improving digital skills. Nevertheless, older adults are underrepresented as digital game players, and hence, digital games that are designed for them are still rare. Due to age-related changes and different preferences, digital games targeted at older adults have particular design requirements to address their needs and preferences. A user-centred design (UCD) process is an approach that includes older adults in the design process to make sure the game is usable and enjoyable for them. In this project, an online escape game was designed, developed, and evaluated using a UCD process. The game is based on real-life escape rooms that are collaborative adventure games in which a team of players is locked in a room. They need to discover clues and solve puzzles to attain the final goal; i.e., escape the room, usually within a time limit. We performed a needs assessment in real-life escape rooms, created a game concept based on the assessment, designed the game with older adults, and tested two prototypes iteratively with older adults. The findings suggest that the game was usable and enjoyable for older adults. However, it still needs several refinements and further usability and field testing before a larger audience of players can use it.

Keywords: Older adults; seniors; digital games; user-centered design (UCD); usability testing
Dedication

I would like to dedicate this thesis to my parents, Fariba and Aliakbar, my sister, Pegah, and Dr. David Kaufman.
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This thesis would not have been possible without the extraordinary people in my life. I would like to express sincere thanks to my senior supervisor, Dr. David Kaufman, for his thoughtful feedback, support, and encouragement throughout my doctoral studies. I have benefited from David’s mentoring and insights. He provided me with valuable lessons in how to think about research and how to look at our research in aging and digital games. I am forever grateful for his endless support and encouragement that both sustained and inspired me in my doctoral studies. I would also like to appreciate Dr. Stephen Campbell for his precious time reading my thesis and giving me valuable feedback that improved the quality of my work.

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Chapter 1. Introduction

1.1. Background

The World Health Organization (WHO) reported that seniors (persons who are 60 years old and older) are one of the fastest-growing populations in the world and it is estimated that this demographic will be doubled by 2050 globally (WHO, 2015). Similarly, The United Nations (2017) predicted that the number of seniors would rise from 962 million in 2017 to 2.1 billion in 2050, surpassing the number of people aged 10-24. In Canada, seniors aged 65 and older will account for 20% of the population by 2024 and, by 2068, this age group will reach 21.4 to 29.5% of the population (Statistics Canada, 2019b). Currently, the number of older adult Canadians is more than persons between the age of 0-14 (Statistics Canada, 2017). This population shift affects many aspects of societies, including culture and institutions (WHO, 2015). Accordingly, maintaining the quality of life has become an exponentially important issue, as concerns towards cognitive decline, social isolation, and physical problems have increased.

Despite the common perception that older adults are not open to adopting technology or are not able to use it efficiently, Pew Research Center (2019) reported that 96% of older adults (65+) own cellphones and 53% of them own smartphones. Moreover, 70% of older adults are connected to the internet and use it daily (Pew Research Center, 2017). The surge in using technology has been similar in Canada. Statistics Canada (2017) reported that older Canadians represent the fastest-growing group of internet users in the country. The survey found that online activity among people aged between 65 to 74 increased by 16% between 2013 to 2016 (Statistics Canada, 2017). Moreover, the Entertainment Software Association of Canada (2018) reported that 94% of Canadians aged 55-64 own a computer and one-third of Canadians aged 55-64 play video games on a daily basis.

A direct consequence of the above demographic shift and seniors’ growing ownership of digital devices has been a growth in research on aging and digital products targeted at older adults. Many researchers have explored the potential benefits of using technology among older adults, including physical functioning, social connectedness, and cognitive abilities (Schell, Hausknecht, Zhang, Kaufman, Marston, Freeman, &
Despite the studies showing that many older adults use technology, a common belief is that seniors have difficulty accepting new technologies due to lack of openness, age-related changes, and the lack of perceived benefit (Melenhorst & Bouwhuis, 2004). However, today age does not have as huge an effect on the acceptance of new technology as many people believe (Marston, 2013). A study by Broady, Chan, and Caputi (2010) revealed that the attitudes of young adults and their experiences in using digital technologies are similar. More important than age is proper training and providing a supportive environment in a person’s embracing of new technologies. Also, research has shown that seniors are motivated to adopt new communication technologies if they perceive sufficient benefits from them (Melenhorst, 2002).

With regard to older adults, this means allowing them to become familiar with technology by giving them time and encouragement (Broady et al., 2010). Similarly, when designing digital products for older adults, the designers should address age-related characteristics and particular interests and preferences of older adults by include older adults in the design, development, and evaluation processes. In this way, we could also increase the potential of digital technologies for successful aging and enhancement of older adults’ life quality.

1.2. Older Adults and Digital Games

Older adults are consumers of many leisure activities offered by digital technologies, including digital games (e.g., video, computer, online games). Games, digital or non-digital, are often referred to as experiential exercises that involve learning how to learn (Turkle, 1984). Prensky (2001) defined games as “organized play” (p. 119). Heinich, Molenda, Russell, and Smaldino (2001) defined a game as “an activity in which participants follow prescribed rules that differ from those of real-life as striving to attain a challenging goal” (p. 10). Similarly, Salen and Zimmerman (2004) defined a game as a “system in which players engage in artificial conflict, defined by rules, that results in a quantifiable outcome” (p. 80). According to Prensky (2001), the common elements of games are fun, goals, rules, challenge or competition, outcome, and feedback, interaction, representation, or story.
An electronic game, or digital game, is defined as "a software program in which one or more players make decisions through the control of game objects and resources, in pursuit of a goal" (Overmars, 2007, p.3). Digital games can be played on various digital platforms, such as desktop computers, handheld devices, game consoles, etc. The growing ownership of digital devices by older adults has resulted in an increase in older adults who play digital games. The Entertainment Software Association (ESA) found that 66% of men and 58% of women aged 55-66 in the U.S. play video games (ESA, 2019). In the United Kingdom, Pratchett, Harris, Taylor, and Woolard (2005) reported that 18% of people aged 51-65 played digital games. In Finland, Kangas & Lampila, 2006. More recently, Kaufman and his team surveyed 463 older adults in Greater Vancouver (Kaufman, Sauvé, Renaud, Sixsmith, & Mortenson, 2016). They found that in terms of gameplay frequency, most participants (85.6%) had played digital games during the past month, and 88.2% reported playing one day or more per week on average. Over 40% reported playing at least two hours per day when they did play. However, older adults still play digital games far less frequently than younger generations, but, as mentioned earlier, it is unlikely that this is due to a lack of interest or openness. Other factors, such as perceived benefits and shortage of games explicitly designed to meet older adults’ needs, might be more plausible factors.

Games are powerful tools that could help older adults’ well-being. Ijsselsteijn, Nap, de Kort and Poels (2007) identified four areas of design opportunities for games targeted at older adult players. These areas are relaxation and entertainment, socialization, cognitive stimulation, and motor skills training (Ijsselsteijn et al., 2007). However, older adults are still underrepresented as consumers of digital games (Ijsselsteijn et al., 2007). Although, over the past decades, games have been increasingly used in health care and medicine as tools to address physical, cognitive, psychological, and social issues of older adults, these endeavors have been predominantly for physical rehabilitation after falls, strokes, and other conditions (Vasconcelos, Nunes, Carvalho, and Correia, 2018; Gobron et al., 2015; Young, Ferguson, Brault, & Craig, 2010).

The use of digital games by older adults deserves commercial and academic attention, similar to the use of digital games by children (De Schutter, 2011). Nevertheless, there is still scant research on the preferences and motivations of older
adults for playing games. Moreover, digital games designed for an older adult audience are rare. Also, there are several barriers to the adoption and use of digital technologies, including digital games, by older adults. Mattke, Klautzer, Mengistu, Garnett, Hu, and Wu (2010) 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. Therefore, identifying and overcoming these barriers are essential to scholars and designers who work on aging and the older adult population. Including older adults in the design of digital games will facilitate the learning of researchers, developers, and older adult players (Marston, 2012). 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 (Marston, 2012).

1.3. Purpose of the Project

The purpose of this project was to learn about the design and use of an online escape game created with, and for, older adults, based on real-life escape rooms, by employing a User-Centered Design (UCD) process. Escape rooms are collaborative games in which a group of players discovers clues, solves puzzles, and accomplishes tasks in one or more rooms to attain a specific goal (usually escaping a room) within a time limit (Nicholson, 2015). Escape games are typically themed and follow a storyline. The game requires communication, teamwork, delegation, observation, and critical thinking. An online escape game was chosen for several reasons. First of all, escape games have grown in popularity around the world, particularly in North America, attracting diverse players from various age groups. Second, the gameplay of escape games offers opportunities for cognitive and social engagement, which are crucial elements of games that appeal to older adults. Cognitive engagement is an important factor for successful aging. Collaboration and interaction with other players are necessary for completing game tasks in escape games. Since one of the main motivations of older adults in playing games is social interaction (Zhang & Kaufman, 2016; Marston, 2012), escape games seem to be an appropriate game that is enjoyable for them to play. Finally, an online escape game would offer opportunities for older adults to interact with digital interfaces, use electronic communication, and perform game tasks using a digital device through a fun and collaborative activity.
Furthermore, this project aimed to explore the effectiveness of a UCD process to create an online escape game for older adults. Characteristics associated with UCD include iterative design, end-user involvement in the design, the importance of whole user experience, designing based on user experience evaluation, the inclusion of multidisciplinary perspectives and skills, and profound understanding of the end-users, the tasks, and the environments (International Organization for Standardization, 2010). UCD is a common approach to designing digital products. Several UCD frameworks specify the type and level of end-user involvement in the design. In this project, we adapted an established UCD framework for game design and involved older adults throughout the design, development, and evaluation of the game.

We also hoped that this project could provide future researchers and game developers with an escape game structure to be improved and field-tested with older adults. We intended to create the game so that its theme and puzzle contents could be changed, while the skeleton of the game is kept.

1.4. The Guiding Questions

The purpose of this project was to learn about the design and use of an online escape game created with, and for, older adults.

This project was guided by the following questions:

1. How do the needs of older adults in real-life escape rooms inform the design of an online escape room?
2. What are the design requirements of an online escape game for older adults?
3. How playable is the prototype of the online escape game?
4. How effective is a UCD process to design an online escape game for older adults?

1.5. Outline of the Thesis

This thesis has five chapters. The first chapter provides a background to older adult's demographic and its relation to digital technology and digital games. It also discusses the purpose of the project and outlines the guiding questions of it.
Chapter two provides a review of the literature, including an overview of successful aging, age-related changes, digital games and older adults, benefits of playing digital games for older adults, arguments for game-based learning, and designing digital games for older adults. Later in this chapter, an overview of UCD and usability testing and an overview of escape games are discussed.

Chapter three discusses the adapted UCD process as the project framework with examples of game designs that used similar UCD processes. Further, this chapter provides information on data collection, data analysis, the measures taken to ensure credibility, and, finally, the ethical considerations.

Chapter four discusses the results of data collection and game design. In this chapter, the results of the needs assessments, the paper prototype, the first and second playable prototypes are presented. Moreover, the results of the playtesting and usability testing are discussed.

In the fifth chapter, the results are discussed in more detail and with the interpretation of the researcher. Furthermore, the findings are situated within the literature. This includes design recommendations and the effectiveness of our adapted UCD process for creating online escape games for older adults. Finally, my ideas for the next steps of this project is presented in this chapter. This chapter also concludes this thesis and discusses its limitations, as well as the possible future work.
Chapter 2. Literature Review

2.1. Older Adults and Successful Ageing

In recent years, the world has seen a dramatic demographic shift in its population. The number of births has decreased and the proportion of older adults in the general population has grown. Globally, the population of adults aged 60 and older has risen from 382 million in 1980 to 962 million in 2017 (United Nations, 2017). The United Nations predicted that this number would be 2.1 billion by 2050, surpassing the population of adolescents and young adults aged 10-24. In Canada, specifically, it is expected that one in five Canadians will be aged 65 and older in 2024 (Statistics Canada, 2019). This rise in the elderly population has had significant social and economic implications for most countries, including Canada, which has faced several challenges associated with an aging population. Life expectancy in Canada was 82.3 years in 2016. This means that seniors can live 17 years after 'normal' retirement age, which is 65 years old; and that they need to stay healthy to enjoy their lives during this time. Therefore, support needs to be given to seniors to help them age successfully.

The concept of successful aging dates back to mid-twentieth century (Lawton, 1947). The seminal works on successful aging were unidimensional, focusing on the physical or psychological aspects of aging (Schulz & Heckhausen, 1996; Butt & Beiser, 1987) with longevity as the primary concern (Butler, 1985). Perls, Silver and Lauerman (1999) defined successful aging as working after the usual retirement age. Expanding on these traditional views, Rowe and Kahn (1997), developed a multidisciplinary and multidimensional model of successful aging, which is arguably the most widely recognized approach to understanding successful aging. This model is functionally oriented and consists of three principles: (1) maintaining high levels of physical and mental functioning, (2) absence of disease and disease-related disabilities, (3) active engagement with life through social and productive activities (Rowe & Kahn, 1997). The authors believed that the loss of any of these principles could result in more rapid aging or even impaired aging. For Rowe and Kahn (1997), the key to successful aging is personal resilience, which could be promoted by making healthy lifestyle choices, such as social engagement and participating in enjoyable activities that involve physical and mental tasks.
More recently, Bowling and Dieppe (2005), in a literature review of 170 published studies related to successful aging, concluded that normal physical and cognitive functioning and absence of disease are not the only determinants of successful aging, as the biomedical models suggest. Life satisfaction and social engagement also have a significant impact on successful aging. Reichstadt, Sengupta, Depp, Palinkas, and Jeste (2010) found that self-acceptance and engagement in life are central to successful aging. Similarly, Adams, Leibbrandt, and Moon (2011), in a review of 42 studies, found that the most evidence of influence on older adults’ well-being comes from informal social activity. Finally, a survey of over 6300 older Nordic adults showed that (1) the frequency of contact with friends and (2) trust in friends were significantly related to lower levels of depression in older adults (Forsman, Nyqvist, Schierenbeck, Gustavson & Wahlbeck, 2012). This interrelation of factors for successful aging suggests that the social and affective factors are as important as physical health. Furthermore, Bowling and Dieppe (2005) advise against viewing successful aging as a product but suggest that it is a process. Successful aging is a continuum on which each person is positioned at a particular moment based on various factors.

A similar, related concept is positive aging. According to Lee, Lan, and Yen (2011), there is not a single definition for positive aging. However, researchers in gerontology believe that cognitive and social factors could be more salient than physical well-being in determining seniors’ quality of life and life satisfaction (Kaufman et al., 2016). The decline in cognitive processes is common among the aging population, but the rate is not fixed, and researchers have been exploring interventions to prevent, or at least slow, this decline (e.g., Kueider, Parisi, Gross, & Rebok, 2012). Moreover, social support and social connectedness is a significant determinant of seniors’ quality of life (Ristau, 2011).

Various tools in the digital age were shown to have potential as resources to help with successful aging. For example, assistive technologies (tools intended to increase, maintain, or improve the functional capabilities of a person with a disability), as well as Information and Communication Technologies (ICT), improve quality of life in older adults, improve their physical and mental health, delay the onset of several diseases and reduce the burden of caregiving (Blaschke, Freddolino, & Mullen, 2009). ICTs – email, world wide web, discussion forums, digital games, and other computer-based applications – were shown to have positively impacted life quality of older adults by
Providing a better social support as well as improving their psychological and social well-being (Adler, 2006; White, McConnell, Clipp, Branch, Sloane, Pieper, & Box, 2002). However, older adults may also face several barriers when it comes to using ICT. Some of the most prominent of such barriers in the literature are age-related issues, characteristics of the existing technologies, issues related to older adults' attitude, capabilities, training and support issues, and cost (Quan-Haase, Martin, & Schreurs, 2016; Eastman & Iyer, 2004; Czaja & Lee, 2003; Melenhorst, Rogers, & Caylor, 2001).

Digital games, in particular, have shown several benefits for older adults, including cognitive, psychological, and social benefits (Astell, 2013). However, for several reasons, including the absence of rigorous methodologies, there is no clear conclusion on how these benefits can be realized (Bleakley et al., 2015). More importantly, the designs of most digital games do not meet the needs of many older adults. This is, among other reasons, due to age-related changes. In the following sections, some of these age-related changes are discussed.

2.2. Age-Related Changes

Older adults could be diverse in terms of abilities and experiences. However, the process of aging is generally associated with physical, cognitive, and psychological changes that could significantly affect various aspects of older adults' lives. These changes can limit older adults' ability to participate in certain tasks and activities, including interacting with computer systems, which in many cases are not prepared to accommodate older adults' needs (Czaja & Lee, 2003). In the case of digital games, age-related changes may impose a number of design requirements. Therefore, an overview of some of the most common age-related changes is presented here to understand the needs of older adults better when it comes to digital games. It is important to note that the discussion of age-related changes, despite the changes that are associated with negative decline and decreased performance, many people gain knowledge, wisdom, and profound understanding from life experiences (Hummert, Garstka, Shaner, and Strahm, 1994).
2.2.1. Perceptual and Motor Changes

The most common perceptual changes in older adults are vision and hearing loss that could be problematic in human-computer interaction. For example, reading at close distance and presbyopia (difficulty focusing on near objects) could make it difficult to interact with computer screens (Charness & Jastrzemski, 2009). Charness and Jastrzemski (2009) also stated that sensitivity to color and dynamic visual acuity is diminished in old age, making it even more difficult for some seniors to perform tasks on computer screens. Moreover, visual tasks could be difficult to understand and perform in dim light, especially in the transition from light to dark environments (Schieber, 2006). As for hearing, a common age-related hearing problem is presbycusis (difficulty hearing high-frequency sounds), which could affect older adults’ ability to understand speech (Charness & Jastrzemski, 2009). In human-computer interaction, this can cause problems hearing “beeps” and other computer sounds.

Motor changes could also pose several challenges when older adults want to interact with computers. For example, older adults may have a slower response time, which could make it difficult for them to keep up with the pace of many digital games. Also, changes in motor skills could make it hard to maintain continuous movements and lose flexibility (Mitzner & Rogers, 2010). Such motor decline can dramatically affect older adults’ interactions with computers and, in turn, demotivate them to use computer systems.

2.2.2. Cognitive Changes

Other common types of changes many older adults face are cognitive changes. Computer tasks, particularly digital games, often require high levels of cognitive processing (Czaja & Lee, 2009). Attention span and working memory are the most prominent cognitive abilities that decline with old age, affecting complex routine cognitive tasks like problem-solving and decision-making (Glisky, 2007). The decline in these cognitive abilities makes it hard to perform tasks requiring divided attention and processing a large amount of new information – which are characteristics of many computer tasks (Charness & Jastrzemski 2009). According to Fisk, Rogers, Charness, Czaja, and Sharit (2009), the other cognitive abilities that may diminish with old age, and can affect the way older adults perceive and understand information, are language
comprehension (the ability to understand language information) and spatial cognition (the ability to manipulate patterns and images). Therefore, for interface design, it is recommended that the focus be on simplicity and intuitiveness to minimize the load on memory and cognitive processing.

2.2.3. Psychological and Social Changes

The physical changes that come with old age are more visible and, as a result, people are more aware of them. However, social and psychological changes are often neglected, although they are equally important. An important issue that could affect older adults’ psychological and social state is retirement. Retirement could mean loss of power and social importance for many older adults. This is mainly due to their separation from their social role, which can further result in diminished self-esteem and identity crisis (Sneed & Whitbourne, 2005). The other threats to the psychological well-being of older adults come from their physical and cognitive changes that could affect their sense of independence and autonomy (Bierman & Statland, 2010).

The psychological problems of older adults could also be intensified if their social networks become smaller, because meaningful contact with other people is an important factor for older adults’ mental health. However, several factors prevent older adults from maintaining interpersonal relationships. These factors include the death of family and friends, psychological conflicts, and environmental barriers (Sneed & Whitbourne, 2005).

2.3. Older Adults and Digital Games

Older adults comprise a fair percentage of the users of Information and Communications Technologies (ICTs), including digital games. In 2005, about 1.7 million (18%) of gamers in the United Kingdom were 51 to 65 years old (Pratchett et al., 2005). In another study by De Schutter (2011), it was found that 16.1% of gamers between 45 and 85 years old played computer games for more than 2.5 hours a day, and 29.5% played computer games between one and 2.5 hours a day. Also, 25% of Americans aged 65 and older played digital games in 2015 (Duggan, 2015). Many older adults are active users of digital technologies and can learn and use digital games (Kaufman et al., 2016).
Games could satisfy several older adults’ needs, whether for achieving beneficial outcomes or solely for pleasure (De Schutter and Malliet, 2014; Iversen, Marston, Freeman, & Musselwhite, 2016). Games are well-known for being engaging and promoting the flow experience – the experience that causes the player to lose track of time and be absorbed in playing – and, therefore, there is an intrinsic value to playing games for older adults (Marston, 2013). Zonneveld and Loos (2015) found that playing an exergame intended for older adults’ fitness achieved its goal and, on top of that, provided fun and entertainment for the players who participated in their study. In another study by Hausknecht (2013), about half of 50 older adults who played World of Warcraft believed that the benefits of playing the game include enjoyment, mental exercise, “escape” from daily life, and interaction with other people. Zhang and Kaufman (2016), in five independent meta-analyses, examined the physical and cognitive impacts of digital games on older adults. Their analyses included 36 studies and the results suggested that playing digital games could be effective in improving older adults’ physical balance, functional mobility, executive function, and processing speed. De Schutter and Vanden Abeele (2010) offered eight incentives for why older adults play games that suggest older adults consider social interaction the main motivator for playing games. These incentives are as follows:

1. A way to meet people
2. A mechanism to combat loneliness
3. To stay connected to younger generations
4. To stay connected with children and grandchildren
5. To relax with colleagues
6. To teach, and learn from, grandchildren
7. To compete with their partner/children
8. To overcome challenges with grandchildren

In addition, De Schutter and Malliet (2014) in a qualitative study with 35 older adults aged between 50 to 74 classified older adult digital game players based on
perceived need satisfaction. First of all, they identified five categories of perceived needs:

- **Cognitive needs**: the desire to acquire knowledge, information and skills. Older adults needed cognitive stimulation in playing digital games;
- **Affective needs**: desire to acquire aesthetic, emotional, and enjoyable experience;
- **The need for individuality**: desires such as autonomy, positive self-esteem, status, authenticity, and identity;
- **The need for connectedness**: the desire to maintain contacts with family, friends and the outside world;
- **Escapism**: the desire to run away from the strain of having to fulfill other needs or having to perform other activities (De Schutter & Malliet, 2014).

In the context of need satisfaction, De Schutter and Mallinett (2014) made a distinction between older adults who considered game play as useful and those who considered it as pleasurable. For the first group, playing digital games contributed to improved skills, or it has a connection with more general interests, whereas, for the second group, the game should be fun before anything else. The authors concluded that to understand the gaming preferences and game habits of older adults, we should go beyond asking how games can train the brain and preventing the aging muscles from deteriorating (De Schutter & Malliet, 2014). They went on to state that:

> Older adults should be considered as selective, meaning-seeking media users, whose gaming preferences can be explained based upon their social, cultural and psychological context, who display a wide variety of playing motives, and who obtain varying degrees of gratification through digital game play (p. 84).

### 2.4. Evidence on the Benefits of Playing Digital Games on Older Adults

The age-related declines discussed above are often considered to be the natural consequences of aging. However, evidence from an array of social and cognitive neuroscience studies shows that, with appropriate training and techniques, these changes could be slowed down or even reversed (Green & Bavelier, 2004). Playing digital games could be a tool for cognitive and social enhancement, as it involves multiple cognitive abilities (Zhang & Kaufman, 2016). Many games require progressively
more challenging decision-making and judgment at higher speeds, the regular practice of which could change the neurological systems that support such behaviours. Moreover, digital games often require hand-eye coordination, quick visual response to different locations on the screen, and sustained attention to the game task – all leading to enhancements in visual-spatial skills. Finally, being a leisure, fun activity with several extrinsic rewards, such as high scores and levels, digital games motivate players to complete game tasks in spite of the increasing challenges without being overwhelming (IJsselsteijn et al., 2007).

IJsselsteijn et al. (2007) identified the following areas in older adults’ lives that game could potentially contribute to (1) motivating physical activity, (2) socializing, (3) entertainment and relaxation, and (4) sharpening the mind. In line with these findings, Astell (2013) suggested that digital games could help older adults maintain their well-being by offering social interaction as well as cognitive and physical activities. Hall, Chavarria, Maneeratana, Chaney, and Bernhardt (2012), in a review of thirteen studies, concluded that playing digital games had a significant effect on the physical, mental, and social well-wing of older adults. Moreover, an interesting study by Gerling, Mandryck, and Linehan (2015) showed that digital motion games that are designed for older adults and their specific needs could be appealing to seniors and could increase the self-esteem of older adults (65+) residing in care homes. In a study by Kaufman et al. (2016) on the perceived benefits of playing digital games for older adults, most survey respondents indicated that mental exercise and enjoyment are the benefits for them of playing digital games. Schell et al. (2016), in a mixed-methods study of the social benefits of playing Wii bowling for older adults, found that the older adults who participated in a Wii bowling tournament experienced a significantly increased level of social connectedness and a significantly decreased level of loneliness.

2.5. Arguments for Game-Based Learning

Some of the essential arguments in support of the effectiveness of games for learning, which are also empirically supported by research, are motivation, flow theory, engagement, and immersion. The motivation argument states that games, as a medium for entertainment, can intrinsically motivate learners to stay engaged for an extended time through their motivating features, including incentive structures and activities that learners usually find interesting (Rotgans & Schmidt, 2011).
Relevant to the motivation argument is the engagement argument, which states that games are capable of engaging learners in a variety of ways. Researchers have identified several types of engagement, such as cognitive engagement, affective engagement, behavioral engagement, and sociocultural engagement (Plass, Homer, & Kinzer, 2015). Although it is the design decisions that determine which types of engagement are to be focused on in the game, the goal of all types of engagement in game-based learning should be fostering cognitive engagement (Plass et al., 2015).

The flow argument is based on the flow theory, which proposes that there is a state of mind experienced when an activity absorbs an individual to the extent that the person loses the sense of time and environment (Csikszentmihalyi, as cited in Rooney, 2012). The absorption caused by the flow experience leaves few cognitive resources for the individual to think about, even the awareness of her self in the world (Kiili & Lainema, 2008). Moreover, activities that cause flow experience are almost always immediately rewarding without the expectation of rewards in the future. These activities also maintain a balance between challenges and skills to consistently offer an appropriate level of challenge (Rooney, 2012).

Finally, the immersion argument maintains that games are capable of inducing deep immersion, which is broadly defined as the player’s deep involvement in the game (Brown & Cairns, 2004). The fun factors in games could be used to immerse the players in an active learning environment. Brown and Cairns (2004) identified three levels of immersion: engagement (the lowest and the most easily achieved level), engrossment, and total immersion (the highest and the most fleeting level). There are strong links between the flow theory and the concept of immersion. In both cases, attention is essential, the sense of time is altered, and the use of skills and knowledge is the same; however, “the fleeting nature of total immersion seems to suggest that it is something distinct from flow in this context” (Brown & Cairns, 2004, p. 1300).

2.5.1. Grounding Game-Based Learning in Learning Theories

Kim, Park, and Baek (2009) defined game-based learning (GBL) as a learning strategy “focused on achieving the particular objectives of given educational content through game play” (p. 801). A range of theoretical underpinnings has been proposed to account for the learning that occurs within games. For instance, casual games in which
the player practices a skill in a relatively engaging environment are based on behaviorism (Kebritchi & Hirumi, 2008). Several casual digital games, such as games for language learning, provide opportunities for the player to repeat a series of actions in a fun environment and receive both positive and negative reinforcements in line with behaviorist’s principles. However, digital games have reached a level of sophistication that behaviorism can no longer account for learning that happens through them. Recently, researchers have relied on various constructivist learning theories within constructivism to address game-based learning, because the activities involved in games are usually active, experimental, situated, and problem-based – traits that would make ideal opportunities for meaning and knowledge construction (Boyle, Connolly, & Hainey, 2011).

Constructivist theories assume that knowledge is constructed by the learner, as she tries to make sense of the experiences (Land, Hannafin, & Oliver, 2012). Authentic contexts and authentic tasks are two central themes in constructivism (Barab & Duffy 2012). Many digital games offer this kind of authenticity for players by allowing them to take different roles and complete tasks in a variety of situations (Rooney, 2012). Moreover, the engaging environment of games allows for the development of problem-solving skills, decision-making skills, and social skills (Van Eck, 2007).

**Situated learning**

A constructivist learning theory that is used to underpin game-based learning is situated learning, in which learning is situated in a specific social context (Barab & Duffy, 2012; Prensky, 2001). In situated contexts, the learner recognizes the practical application of knowledge to be able to analyze and solve authentic problems; and in this process, learning occurs (Barab & Duffy, 2012). Situated learning includes apprenticeship, in which the learner is a member of a community of practice where she actively participates and makes contributions to complete a learning task (Barab & Duffy, 2012). Novice members of the community of practice are provided with scaffolds from the expert members.

Games offer many opportunities for situated learning. The virtual world of games immerses the player in a virtual community of practice without the risks and the challenges of the real world (Rooney, 2012). However, a major issue in situated learning as a theoretical grounding for the use of games is the issue of transfer, because, as
Ormrod (1999) argued, inherently situated learning is unlikely to transfer to new situations/contexts. This would be especially the case when the learner has to transfer knowledge/skills acquired in a virtual world to real-world settings.

**Problem-based learning**

Problem-based learning (PBL) focuses on improving learners’ self-directed learning and their higher-order cognitive skills, such as problem-solving, decision making, and effective collaboration (Uden & Beaumont, 2006). PBL focuses on learning rather than teaching, through problem-solving tasks. It draws on scaffolding to support learners in their metacognitive skill development (Uden & Beaumont, 2006). Besides, authentic contexts and authentic tasks are emphasized in PBL to facilitate transfer and because PBL believes context is an important determinant of how a problem is understood and solved (Uden & Beaumont, 2006).

In game-based learning, the game is considered as a problem consisting of sub-problems and tasks to be solved by the player (Van Eck, 2007). It provides opportunities for scaffolding through players’ interaction with other players, the game characters, pre-defined feedback, and the narrative of the game (Van Eck, 2007). Similar to situated learning, using PBL to underpin game-based learning raises the problem of transfer, as the learned knowledge may not be easily transferable to non-game contexts. Another challenge for game designers would be deciding on the amount and the timing of scaffolding in a game, due to the learners’ variables.

**Experiential learning**

Kolb (1984) defined experiential learning as “the process whereby knowledge is created through the transformation of experience” (p. 41). Kolb (1984) viewed learning as a continuous spiral process consisting of four stages: (1) *concrete experience*, where the learner observes an experience, (2) *observation and reflection*, where the learner reflects on that experience, (3) *formation of abstract concepts and generalizations*, where the learner draws conclusions based on her reflection, and (4) *testing implications of concepts in new situations*, where the learner tests her conclusions through further experiences. Therefore, meaningful learning derives from experience, feedback, reflection, and action (Kolb, 1984).
Game-based learning allows learners to immerse themselves in experiences that would otherwise be difficult or impossible in real-life. Notable in this process is the affordance of virtual game environments that allows learners to make mistakes and learn from their mistakes with minimal risks (Rooney, 2012). However, like the previous models, experiential learning raises the problem of transfer due to the inherently artificial game environment. Another challenge is keeping the level of challenge faced by the player appropriate (Rooney, 2012). This challenge is probably rooted in the fact that the level of difficulty of a game should ideally be adapted to the learners’ skills. However, this is very difficult to achieve, since learners’ vary greatly.

2.6. Designing Digital Games for Older Adults

Older adults may encounter electronic devices in different settings. It is commonly believed that older adults are resistant to change and, thus, reluctant to interact with digital devices. However, several studies show that older adults have positive attitudes towards new technologies and are receptive to using computers (Quan-Haase et al., 2016). It seems that a major reason older adults might be unwilling to use technology is that the majority of the new devices and computer systems have not been adapted to meet the specific needs of older adults. As a result of an increase in the ageing population, and its ensuing economic effect, games that are intended for adult players have increased dramatically in the past decades (Bleakley et al., 2015). Nevertheless, there is still a large gap between what older adults demand in games and the commercially available digital games. One reason for this is that older adults are often neglected as consumers of games in the design of digital games.

Playing digital games could enhance the lives of older adults in significant ways. They have the potential to improve their physical and mental health, enhance their social connectedness, and offer them a joyful way to spend their time (Kaufman et al., 2016). However, despite these benefits and the growing population of older adults throughout the world, the people of 65 years old or older are not well-served when it comes to commercial digital games. Due to the prevalence of the physical, cognitive, and psychological changes discussed earlier, it is often difficult for older adults to participate in regular social and leisure activities. This limitation, which includes the majority of commercially available digital games, leaves them with very few options for playing digital games that meet their needs and are enjoyable for them. This limited set of
leisure activities, in turn, may result in further physical, cognitive and psychological decline (Gerling, Schulte, & Masuch, 2011).

According to the literature, 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 (Gerling et al., 2011). During the past decades, various game design guidelines and recommendations have been developed for creating digital games for older players. For example, Gamberini, Alcaniz, Barresi, Fabregat, Prontu, and Seraglia (2008) and Ijsselsteijn et al. (2007), who focused on 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. More specifically, they responded to the design challenges incurred by the physical and cognitive limitations of older adults and their limited computer literacy. Moreover, De Schutter and Abeele (2008) discussed the appropriate content and themes that would appeal to an older audience and a meaningful play.

Vasconcelos, Silva, Caseiro, Nunes, and Teixeira (2012) in a paper that reports the analysis and design of a tablet-based gaming platform for older adults, called CogniPlay, that focused on cognitive training, identified 10 “rules of thumb” for game design targeted at older players. These rules, which guided our game design, are as follows:

1. **Using direct input devices**: direct input devices, such as tablets and smartphones, to potentially ease the interaction between older adults and technology and, in turn, lowering their anxiety towards technology.
2. **Mobility**: portable devices that can be used anywhere allows older adults with physical limitations to play the game in their comfortable environment and preferred position.
3. **Senior-adapted interface**: by designing an interface that accommodates age-related changes experienced by older adults, the interaction with the game would be more rewarding.
4. **Expandability**: the platforms allows for the inclusion of new games to accommodate new preferences and needs of older adults as the demographic changes.
5. **Variety**: Providing more than one game/theme, so that the older adults can choose their favorite ones and swap among them to prevent boredom and maintain their interest.

6. **Customization**: The game could be adapted to a specific individual through the use of familiar pictures, videos, or sounds to enhance user experience.

7. **Instant feedback**: By receiving quick feedback in a game, the player becomes aware of their actions. Therefore, they know when they succeeded or failed and why.

8. **Engaging goals**: To keep the player’s focus on the objective of the game, there should be clear goals. Goals are challenges that keep the player engaged.

9. **Immediate rewards**: The player should be immediately rewarded in the game at all times. Rewards can promote a healthy competition, which is greatly appreciated by older adult players.

10. **Social interaction promotion**: Older adults prefer games that promote social interaction. This is due to the undermined social network in mature life. Therefore, multi-player, collaborative games are better suited to them.

It is not clear whether these rules apply to other types of direct-input devices. However, they were relevant to this project, since we were developing the online escape game for tablets and, thus, these rules were considered a good starting point to guide the design.

In another game development project for older adults, Awad, Ferguson and Craig (2014) tried to determine the game principles that need to be adopted to create an enjoyable game experience for older adults in what they called “an affordance-based approach,” in which “the user’s action capabilities have been taken into account” (Awad et al., 2014, p. 2). They maintained that:

[For] gaming to work with older adults, the perceived affordance, or opportunity for action, of the game needs to give the player a meaningful indication about what actions are possible, and what they should do next given their own personal action capabilities (Awad et al., 2014, p. 2).

Based on Awad et al.’s (2014) affordance-based design, it is important that the game designed for older adult players adapts to the player’s action capability. For example, the visual elements in the game should be presented in a way to guide the
player’s actions, so that the player always knows what to do next. Moreover, in line with Vasconcelos et al.’s (2012) rule, Awad et al. (2014) emphasize the importance of different rewarding techniques to maximize the player’s engagement with the gameplay.

Gerling, Schulte, Smeddinck, Masuch, and Ifip (2012) discussed the effects of age-related changes on the structural elements of games and offered recommendations to address these issues. The age-related changes they focused on were cognitive impairments (including reduced attention span), the decline in motor skills, and chronic illnesses that affect physical abilities and mobility. The structural elements they discussed were a combination of structural models of game offered by Adams (2010) and Fullerton (2008). Gerling et al. (2012) developed an extended model by combining the two models. In both models, games are considered complex systems featuring various sets of mechanics to give a unique experience to the player. These mechanics are affected by input from players. Through the interaction model, the player’s input turns into actions that are interpreted by the core mechanics of the game. Actions are a part of procedures that are rooted in the rules of the game (Gerling et al. 2012). Figure 1 shows the extended model of digital games.

![Figure 1](Image)

**Figure 1** The extended model of digital games (based on Adams and Fullerton). Reprinted with permission from Gerling et al. (2012).

Here, the effects of age-related changes on the structural elements of the above model, as discussed by Gerling et al. (2012) are presented. These recommendations were applied to the design of SilverPromenade, which was created by Gerling, Schulte, and Masuch (2011).
Players and resources: The designers should remember that their target players have minimal gaming experience. Research suggests that older adults are interested in engaging in game play as well as being a spectator to other’s play and commenting on it. Therefore, the designers should address this by designing interesting graphics or, depending on the context, fostering completion and collaboration in multiplayer games. As for resources, i.e., attention span and sensorimotor skills, the game should allow the older adult player with limited cognitive resources to remember relevant information.

User interface: The use of input devices might be limited when it comes to older adults. Many of them may have difficulty holding controllers and pressing buttons at the same time. Moreover, parallel player’s input could be difficult for older adults (e.g., pushing more than one button at a certain point or performing complex point-and-click operations). Further, the graphic user interface should be adjusted to meet the needs of older adults.

Core mechanics: core mechanics are internal processes and requirements of digital games, namely, procedures, rules, objectives, and conflict (Gerling et al. 2012). Core mechanics define both the challenges of the game and players’ interactions with the game. To master a game, players must learn several aspects of its core mechanics. The decline in memory and attention span affects information processing and, thus, learning the core mechanics of a game is challenging. Therefore, game actions should be easy to understand. In addition, designers should avoid quick sequential reactions and parallel input to lower the cognitive load and address the limitations of sensorimotor skills. Also, objectives should be very clearly defined and communicated to the player.

Outcome: mastering a game may be lengthier and more challenging for older adults due to their age-related impairments. This should be kept in mind when defining the outcomes of the game. One way to address this is for the game to provide the player with feedback based on their individual skills.

Barros, Leitão and Ribeiro (2014), in their report of the design and evaluation of the smartphone application, Dance! Don’t Fall, which intends to promote exercise and prevent falls in older adults, provided design recommendations that are useful for game
design, as well. Their recommendation focused on navigation, interaction, and visual design.

For navigation design, Barros et al. (2014) recommend that:

- Panorama controls should not be used when designing for older adults, because developing a mental model of panorama controls may be difficult for them.
- Home screen menu can be used as a safe point of return, so that the player understands all the options, hierarchies, and the system structure.

For interaction design, Barros et al. (2014) recommend that:

- Include a “back button” as a safeguard for older adults.
- Take advantage of scrolling if applicable.
- Minimize the use of keyboard.
- Use wordings that suit older adults’ semantic fields.

For visual design, Barros et al. (2014) recommend that:

- Provide large spacing between items.
- Use icons along with texts.
- Avoid positioning interactive elements too close to the edges of the touchscreen.

2.7. User-Centred Design

2.7.1. Definition

Over the past decades, User-Centered Design (UCD) approaches have been integral to several industries, such as medicine, aviation and software development (Preece, Rogers, & Sharp, 2002). The term user-centered design (UCD) was first used by Norman (1986), who suggested that a good design places the user at the center of it and gives the designer the role of a facilitator who makes sure the user can use the product in an intended way with minimum effort to learn how to use it.

The idea is that, since the purpose of the product is to serve the user, the needs of the users should dominate the design. Karat (1996), offered another definition for
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, Abras, Maloney-Krichmar, and Preece (2004) defined UCD as “a broad term to describe design processes in which end-users influence how a design takes shape. It is both a broad philosophy and variety of methods” (p. 12). Finally, International Organization for Standardization (2010) 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” (International Organization for Standardization, 2010, p. 2). The characteristics associated with a UCD process include iterative design process, involvement of the users in the design, the importance of whole user experience, designing based on user experience evaluation, inclusion of multidisciplinary perspectives and skills, and profound understanding of the end-users, the tasks, and the environments (International Organization for Standardization, 2010).

The various definitions mentioned above indicate that there is not a single agreed-upon definition for UCD. Karat (1997) suggested that “we consider UCD an adequate label under which to continue to gather our knowledge of how to develop usable systems. It captures a commitment to the usability community supports—that you must involve users in system design—while leaving fairly open how this is accomplished” (p. 34). Therefore, it could be inferred that this lack of a single definition for UCD is, in fact, an advantage. It also makes UCD more of a concept, for which Gulliksen and Göransson (2001) identified a set of principles that guided our design. These principles are as follows:

- Early focus on users and tasks. The designer must understand the users, their cognitive behavior, attitudes and the characteristics of their work tasks.
- Active user participation throughout the project, in analysis, design, development and evaluation
- Early prototyping to evaluate and develop design solutions
- Continuous iteration of design solutions
- Multidisciplinary design teams
- Integrated design
It is necessary to note that 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 (Gulliksen et al., 2005). In other words, the spectrum ranges from UCD methods that consult the end-users at the beginning of the design to learn about their needs and later involve them in usability testing of the product to UCD methods where the end-users are partners with the designers and are deeply influence the design throughout the development of the product (Abras et al., 2004). How to adapt a particular UCD method depends on the goals of the developers, the available resources and the context of the development.

In addition to how to adapt UCD for a particular development, the developer-researcher should identify the user. According to Eason (1987), there are three types of users: primary, secondary, and tertiary. Primary users are those who will use the product. Secondary users are those who will occasionally use the product or those who use it through an intermediary. Tertiary users are those who will be affected by the use of the product (Abras et al., 2004). In this game development, each of these users was identified prior to the design. Our primary users appeared to be cognitively normal older adults aged 65 and older; our secondary users are teenagers and young adults, and our tertiary users are future researchers and developers who would be interested in using the game assets to create their own escape game.

2.7.2. The Advantages and Disadvantages of UCD

Preece et al. (2002) identified several advantages and disadvantages of UCD. By employing a UCD method, the product would be more efficient, effective, and safe. However, UCD could be a costly process (Preece et al., 2002; Vredenburg, Mao, Smith, & Carey, 2002). Moreover, while UCD emphasizes user’s satisfaction, developing the product through it could be more time-consuming than other methods. In UCD, users develop a sense of ownership for the product, but the development requires more team members and a wide range of stakeholders. Also, products developed through UCD often integrate into the environment quickly; however, translating data into design might be difficult. Last but not least, the collaborative process of UCD generates more solutions to design problems, but the product might be too specific for general use and, thus, not readily transferable to other users (Preece et al., 2002).
2.7.3. The Concept of Usability in UCD

An integral element of UCD is usability testing. A well-known definition of *usability* is offered by Nielsen (2003), who suggested that “usability is a quality attribute that assesses how easy user interfaces are to use, making it possible to the customers to develop tasks in a clear, transparent, agile and useful way” (para. 1). He further identified five quality components of a usable product-system, namely, learnability, efficiency, memorability, errors, and satisfaction (Nielsen, 1993). The International Organization for Standardization (2013) 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). Usable products increase productivity, enhance the quality of the user’s performance, reduce the cost of support and training, and boost user satisfaction (International Organization for Standardization, 2013).

Therefore, usability is an important quality characteristic of a product-system. Usable systems are efficient, easy to learn, satisfactory in actual use, and not prone to errors (Nielsen, 1993). According to Rubin and Chisnell (2008), “[u]sability testing employs techniques to collect empirical data while observing representative end-users using the product to perform realistic tasks” (p. 19). There are two main factors to be considered when conducting usability testing: (1) ensuring that the most suitable method possible is used; and (2) ensuring that an iterative approach is used (Koyani, Bailey, & Nall, 2003). The most suitable method could, to a large extent, 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 (Diah, Ismail, Ahmad, & Dahari, 2010). In the next chapter, adapting UCD for game design and examples from the literature are discussed.

2.8. Escape Games

Escape rooms, also known as *escape games*, 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” (Nicholson, 2015, 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 (Nicholson, 2015). 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 (Pan, Lo, & Neustaedter, 2017).

Some common escape room themes are escaping a prison, escaping a haunted house, exploring an Egyptian tomb, and a heist. The puzzles need to be connected to the theme of the room and their purpose should be understandable with the available information within the room and the storyline that the players know (Wiemker, Elumir, & Clare, 2015). According to Wiemker et al. (2015), an escape room puzzle’s composition uses the following game loop:

1. A challenge to overcome (e.g., finding the code to open a locked box)
2. A solution that may be concealed (e.g., correct code)
3. A reward for overcoming the challenge (e.g., the content of the box)

Wiemker et al. (2015) argued that escape rooms are experiential, requiring various set of skills and knowledge to play and are, therefore, appealing for promoting collaboration and team building. They further maintained that escape rooms encourage creative and critical thinking in players, since solving the puzzles often requires multiple approaches to knowledge (Wiemker et al., 2015). Moreover, the authors offered a list of skills that a team need to possess in order to succeed in escape rooms. Table 1 shows these skills and their use in escape rooms.

<table>
<thead>
<tr>
<th>Skill</th>
<th>The Skill’s Use in Escape Rooms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Searching</td>
<td>Hiding a clue or an object is a common tactic.</td>
</tr>
<tr>
<td>Observation and discernment</td>
<td>Rooms can hide clues via obfuscation. Knowing what is important and what is not is key.</td>
</tr>
<tr>
<td>Correlation</td>
<td>Ability to relate clues to the correct puzzle. Sometimes requires a leap in logic.</td>
</tr>
<tr>
<td>Memorization</td>
<td>For remembering sequences of numbers or symbols.</td>
</tr>
<tr>
<td>Math</td>
<td>Sometimes with no pen and paper. Shape algebra is common.</td>
</tr>
<tr>
<td>Words</td>
<td>Anagrams, cryptograms, anything with letters.</td>
</tr>
<tr>
<td>Pattern Recognition</td>
<td>Clues can form of a pattern: i.e., sequence of numbers. Inductive reasoning is useful here.</td>
</tr>
<tr>
<td>Compartmentalization</td>
<td>Needed to break up and visualize a room into individual parts.</td>
</tr>
</tbody>
</table>
Due to the diverse skills escape rooms demand from the team of players, there is a need for a player to take the role of the leader. The leader should be a team member who is good at correlation, compartmentalization, and guiding other members to work on different things in the room (Weimker et al., 2015). In this way, all players would ideally be engaged and can contribute to the team.

In a typical real-life escape room experience, before the game begins, the players meet the “game master” who explains the rules of the game and the backstory. The players may watch a video or read a passage. Then the door is closed and the countdown begins (Nicholson, 2015). The gameplay involves exploring the room, looking everywhere for clues. Usually, the clues are numbers, pictures, and symbols. After finding some clues, at some point, the players discover puzzles and figure out ways to solve them. There might be some directions as to how to solve the puzzles. The solution to one puzzle would lead to something else. It might be a code to open a lock, the key to another puzzle, or just a red herring. The group of players work together and share the information they have found. There is usually a way for the team to receive hints when they are stuck. It might be a staff who is in contact with the team via walkie talkie.

2.8.1. Escape Rooms as an Extension of Pervasive Games

Escape rooms are similar to pervasive games, as both types of games include a theme that bridges real-life and alternate reality, although attempts to blur the two worlds is less in escape rooms (Shakeri, Singhal, Pan, Neustaedter, & Tang, 2017). Pervasive games are a new form of digital games that combine hybrid interfaces, mobile devices, wireless networking, and location-aware technologies to extend the gaming experience to the physical realm (Kasapakis & Gavalas, 2015). Therefore, the players are no longer limited to their devices and their experience of the game is interwoven with the real world (Benford, Magerkurth, & Ljungstrand, 2005). Silva and Delacruz (2006) identified three main characteristics for pervasive games: “(a) they use mobile and location-aware interfaces, (b) they bridge physical and digital spaces, and (c) they transform the city space into the game board, rather than taking place solely in a simulated computer environment” (p. 232). Pervasive games have several subgenres, including alternate reality games (ARG), treasure hunts, and assassination games (Stenros, Waern, & Montola, 2012).
Montola, Stenros, and Waern (2009) noted that “there is a twofold dynamic between the playful and the ordinary that provides pervasive games a reason to exist: Both play and ordinary life can benefit from the blurring of the boundary” (p. 21). In other words, “pervasive games can take the pleasure of the game to ordinary life” and, at the same time, “take the thrill of immediacy and tangibility of ordinary life to the game” (Montola et al., 2009, p.21). Therefore, the ambiguity in pervasive games brought about by blurring the boundary between ordinary life and the world of the game would make pervasive games a uniquely fun experience for players (Stenros et al., 2012).

The physical activities in pervasive games include moving to a particular location, inspecting artifacts, taking pictures, recording videos, interacting with other players (Avouris & Yiannoutsou, 2012). The virtual activities, on the other hand, include interacting with simulators and characters, solving puzzles and riddles, and online communication (Avouris & Yiannoutsou, 2012). The embodiment of game experiences in the physical context of the player also makes them subject to contextual coincidences such as changes in weather conditions, mistaking non-players for players, and unpredictable social interactions in the game space (e.g., street, bus etc.) – which have all been reported as the highlights of the games (Stenros et al., 2012).

Moreover, pervasive games “empower the players to see their everyday surroundings through ludic lenses, transforming the quotidian city into a fun exciting site” (Stenros et al., 2012, p. 341). Specifically, since the activities in these games might not be possible or tolerated, in real-world, players can play them to question societal norms. In this way, pervasive games, including escape games, empower players by various game challenges that demand the player to go beyond their comfort zone; and also by providing insight about different social situations in their surroundings (Montola et al., 2009).

2.8.2. Research on Escape Rooms

The literature on escape rooms is quite scant. The few reported studies on escape rooms are limited to describing the game, investigating collaboration in it, and exploring its potential for learning. Nicholson (2015) administered a survey to 175 escape room facilities worldwide to learn about the different styles of escape rooms and the puzzles they offer. He found that the puzzles are mainly logic, spatial, mechanical,
word, or math. Moreover, according to Nicholson (2015), the most common presentation of the puzzles was path-based models (45%), sequential models (37%), and open models (13%). In path-based models, there are multiple sequential paths where solutions from each path lead to solving the final puzzle. In sequential models, the puzzles follow a linear sequence. In open models, players can solve several puzzles concurrently to find clues for the final puzzle. Nicholson’s (2015) survey also provided information about the age of the players: 37% of the players were adults of 21 years old or older, 19% of the players were corporate groups, 19% young adults, 14% intergenerational groups, and 11% “night couples.” Finally, Nicholson (2015) has offered some design recommendations for escape room designers. First, he suggests that escape rooms offer games for all types of players with different experience levels. Second, escape rooms should be replayable, so that the same players can play the game multiple times. Finally, escape room designs should match the local culture where the game is being played.

Carman Neustaedter and Rui Pan have explored collaboration and learning in escape rooms with their colleagues. In a study that involved observation and interviews with 38 players, Pan, Lo, and Neustaedter (2017) tried to understand how groups of players collaborate in escape rooms, how the design of escape rooms affects collaboration, and what opportunities escape room presents as learning environments. Their findings suggest that escape rooms offer opportunities to practice several collaboration skills, but those skills may not be generalizable to collaborative situations outside the game environment. These skills include practice moving in loosely and tightly coupled group work, gathering situational and workspace awareness, practice communication skills, and practice developing a shared mental model (Pan et al., 2017). Moreover, Pan et al. (2017) found that escape rooms offer opportunities for players to practice leadership skills and different social dynamics. Finally, escape rooms provide players with opportunities to face, and deal with, conflicts and, in doing so, they may learn conflict resolution skills (Pan et al., 2017).

In another study, Shakeri et al. (2017) explored the design of a distributed escape room in which two separate escape rooms were connected through audio and video links, as well as shared artifacts. The authors found that audio connection between players in the two rooms created feelings of social presence, while video connection further enhanced the already established connection and helped players to share
knowledge and artifacts (Shakeri et al., 2017). Therefore, Shakeri et al. (2017) concluded that audio is a great option to connect remote players in a distributed escape room. Also, a video connection could be utilized for promoting curiosity and sharing artifacts and for using similar, and dissimilar, artifacts as part of the puzzles (Shakeri et al., 2017).

In a small-scale study of a prototype of our online escape game, Doroudian and Kaufman (2018) explored intergenerational interactions and perceptions. The data were collected from surveys and focus group interviews with five intergenerational pairs of older adults and young adults (10 players). Doroudian and Kaufman (2018) found that their online escape room could facilitate intergenerational interaction and could create interaction dynamics in which expertise is distributed. Moreover, playing the game resulted in the alleviation of older adults’ perception that playing collaborative games with younger players could be intimidating. Moreover, the intergenerational collaboration in the escape game seemed to have reduced the negative attitude of young adults who believed that older game partners are inadequate and not fun to play games with (Doroudian & Kaufman, 2018).
Chapter 3. Methods

3.1. Introduction

By adopting a user-centred design (UCD) process, this project created an online collaborative escape game for older adults and examined its usability. The online escape game intended to provide a social, fun experience for its target players, older adults. Therefore, their gameplay and the several design aspects of the game were studied and the game was refined. This chapter explains the theoretical background, the project design, and the data analyses deployed to carry out the project. For this project, a UCD framework was adopted because of the importance of the end-users’ needs, the iterativeness of UCD, and the opportunities it offers to the researcher to collect appropriate and sufficient data to develop in-depth descriptions. In this chapter, our UCD process, the data collection procedures, and data analysis will be discussed.

3.2. Adopting UCD for Game Design

The overview of UCD, as discussed in the previous chapter, revealed that users (who are, in this case, players) are not merely the objects of the study, but active agents within the design process. Another tenet of UCD is the iterativeness of the design process, where each iteration informs the redesign of the next prototype based on the observation of the users and their feedback. These fundamental tenets, among others, make UCD an appropriate approach to designing digital games because, in designing games, it is essentially a conversation between the designer – who is challenging the skills and the creativity of the player – and the player, who actively participates in this challenge. A player-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. In this section, an overview of player-centred game design is presented, as well as a few examples from the literature.

Despite utility applications in other industries, game design does not intend just to minimize the cognitive load of the user and make the product-system as simple to use as possible. The reason is that games seek to achieve a well-balanced difficulty. Further,
game design involves designing entertainment experiences and interaction design because games are expected to be challenging and entertaining with meaningful gameplay. As a result, the UCD methods may need some modification when applied to game design (Pagulayan, Keeker, Wixon, Romero, & Fuller, 2003).

Although there is no consensus on how to adapt UCD for game design, some researchers involved the players from the early stages of the design process (Sykes, 2006). One approach that is used in the early stages of the design process is focus group testing. A marketing-oriented approach, focus group testing involves asking a group of target players about their attitudes and preferences towards a given game concept or game element (Yee, 2006). Focus groups might not be an appropriate approach to evaluate game concepts or game quality, but they could be useful in generating game ideas.

Several game design scholars (e.g., Sykes, 2006; Fullerton, Swain & Hoffman, 2004; Pagulayan et al., 2003) favour a drastically different approach than focus group testing. They believe in 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. (2004) 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.

Playtesting is a process to measure the game's playability. The concept of usability in game design is often called playability. Järvinen, Heliö, and Mäyrä (2002) provided the following definitions for gameplay and playability:

[Gameplay is] the time period during which a game imposes its rules and its environment on the player. During gameplay, the player is able to develop skills and strategies to work for the game's goal(s) within the rules. When the product under evaluation is not game (in the sense of having rules and goals), we discuss 'interaction' instead of gameplay.

[...]  

[Playability] refers, on one hand, to the guidelines regarding how to implement the necessary elements (such as rules) to give birth to a desired
sort of game play or social entertainment. On the other hand, ‘playability’ is
developed here to function as a similar evaluation tool and research
discipline as usability. Playability is, in this sense, a collection of criteria
with which to evaluate a product’s gameplay or interaction (p. 17).

Therefore, the designer must note the important between the two concepts, as
explained by Kücklich (2005):

While increasing the usability of a media technology usually means making
its functionality as accessible as possible to the user, playability often
depends on withholding certain options from the player. It is quite crucial in
many games that the player does not have access to the full range of
options the game offers initially, but only after the player has invested some
time in the game. The playability of a game is actually increased by this
strategy of deferral, because it challenges the player to spend an increased
amount of time playing the game (p. 241).

Nevertheless, due to the close connection between usability and playability, they
can benefit from each other when it comes to evaluation. Usability methods could be
used for games when the goal is to improve player’s satisfaction and reduce their task-
based failure and error frequency (Charles et al., 2005).

There are several other paradigms to involve players in the player-centred game
design, which are similar to the ones discussed above. For example, Botero,
Kommonen, Oilinki, and Koskijoki (2003) identified three main strategies,
namely, brief, use, and context. In the “brief” strategy, users are usually abstractions and
the communication between the designers and the users is minimal. For example, a
designer might choose to refer to previous research that worked with his or her target
players. In the “use” strategy, the users are involved in various stages of the design to
evaluate the prototype game and provide input to the designers. In the “context”
strategy, the users and their social contexts are integral elements of the design.
Choosing the right strategy depends to a large extent on the design team’s resources as
well as the complexity and goals of the game. In the next section, a few examples of
player-centred design are presented.

3.2.1. Two Examples of Player-Centred Design in the Literature

The first game development project to be discussed is The Secrets of
Biblioland, a serious game which was created using a player-centred design. A serious
game is defined as:
[A] game, a mental contest, an interactive computer application, a digital game, a simulation, a virtual environment, and a mixed reality/media, applied in serious context such as education, government or corporate training, health, public policy, and strategic communication objectives. Moreover, they are used to impart skills/knowledge/attitude or to deliver information, using the fun elements to engage learners (Mestadi, Nafil, Touahni, & Messoussi, 2018, p. 1).

The Secrets of Biblioland is a prototype of an interactive educational game aiming to support students in higher education in understanding issues related to information resources, referencing, construction of bibliographies, and plagiarism (Moschini, 2006). The idea of the game was conceived in response to the challenges Moschini (2006) observed in the research method classes taught at London Metropolitan University. Instructors observed students’ difficulties in evaluating appropriate literature and constructing bibliographies. Therefore, they decided to create an adventure game that engages students to explore ancient and contemporary libraries to discover information about different resources, look for different referencing techniques and systems, and the temptation of plagiarism (Moschini, 2006).

Moschini (2006) and the design team investigated a UCD approach in which the primary audience of the game (students) and its secondary audience (relevant tutors) participated in the development of the game. More specifically, they involved students and tutors in the interface design evaluation, character design, and the evaluation of the learning outcomes. Their iterative approach included surveys, focus groups, prototyping, and playtesting to evaluate the game concept and further developments of the prototype. Their design process went through several phases: (1) understanding the target audience, (2) understanding the audience’s educational needs, (3) evaluating perceptions of game-based learning, (4) user-led game-design and prototyping, (5) playtesting, evaluation of the pilot and future developments.

The second example is the player-centred design framework proposed by e-Media Lab and the Centre for User Experience Research, K.U.Leuven (Vanden Abeele et al., 2012). This framework is called P-III, which stands for player-centred, iterative, interdisciplinary, and integrated; and is a method for design and creation of serious games. It was developed over five years of research on the development of serious games. Therefore, according to Vanden Abeele et al. (2012), P-III is shaped, tested, and refined through several research projects and is, thus, a bottom-up framework.
P-III framework is characterized by four main pillars: (1) player-centred design, (2) iterative development, (3) interdisciplinary teamwork, and (4) integration of play and learning.

P-III uses various methods to involve the target players in the design. These methods range from ethnographically-inspired inquiries early on in the design to participatory design sessions and user tests during and later at the end of the design process. P-III’s iterative development evolves over three main phases, namely, concept design, game design, and game development. The focus of the concept design is to use the understanding of the target player and the problem to figure out what the game should be. In the Game design phase, the developed concept is transformed into a detailed game, which will be input for the game developers and the media artists. Finally, the game development phase involves defining milestones and testing prototypes until a final prototype is evaluated. Figure 2 illustrates the three phases of P-III.

Figure 2  An illustration of the P-III framework. Reprinted with permission from Vanden Abeele et al. (2012).
The last two pillars of P-III, i.e., interdisciplinary teamwork and integration of play and learning, are interrelated. Designing an effective serious game that is both fun and able to achieve its educational goals, instructional and game designers should collaborate and bring their expertise to the design. Further, a successful serious game should offer "a seamless blend between the game fantasy and core mechanics on the one hand, and learning principles on the other" (Vanden Abeele et al., 2012, p. 84). This is the fourth pillar (integration of the play and learning) and its prerequisite is interdisciplinary teamwork.

With these models in mind, the research team adapted a UCD process to develop an online escape game for older adults. Although the game in this project is not educational, it is a game targeted at a group of players with unique characteristics and needs. Moreover, one of the game’s goal is cognitive engagement and promoting social interactions through playing the game. Therefore, P-III was decided to be an appropriate UCD framework for the design of our game. The P-III-adapted design will be discussed in the following sections.

3.3. Data Collection

The data collected in this project started with needs assessment and continued throughout the design process and, finally, the usability testing sessions. We relied on multiple sources of data to explore the inquiry in its complexity and entirety. This reliance on multiple sources of data facilitates the exploration of my questions within their context, so that the problem is explored through multiple perspectives. Finally, multiple sources of data render a rich description of the inquiry and strengthen the trustworthiness of this qualitative research. In this project, there were at least two researchers present at the research site observing and collecting data through multiple instruments, including surveys, interviews, and observation.

3.3.1. Participants

The participants consisted of 34 mobile and cognitively normal older adults, aged 65 and older, who were recruited from Simon Fraser University’s senior programs. The age marker of 65 was used because, methodologically, it is a practical way to identify old age. It is also the age that many countries (including Canada and the United States) and
social institutions recognize as the age of retirement (Statistics Canada, 2019a; National Academy of Social Insurance (NASI), 2013). There were 20 women (59%) and 14 men (41%). The participants’ demographic information was collected, including their experience of playing digital games and escape games. This information is discussed in chapter four.

### 3.3.2. Data Collection Instruments

**Surveys**

Demographic information was collected through background surveys that included items on the participants’ experiences with digital games and escape rooms. The background surveys are presented in Appendix A, B, and C. Moreover, a playability survey was completed by the participants who took part in the playtesting session (Appendix D). This survey contained both open-ended and close-ended items and focused on the players’ reactions to the first prototype as a whole and also on the different aspects of the game, including game play, game story, mechanics, and usability. This survey was developed by the design team in collaboration with us, the research team. It was adapted from Heuristics for Evaluating Playability (HEP), which is a validated heuristics created by Desurvire, Caplan, and Toth (2004). 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. Our adapted playability survey does not include all 43 heuristics. The participants completed the survey after playing the game with their randomly assigned game partner.

Moreover, the participants who played the second prototype during the usability testing completed a usability survey that was adapted from the Core Elements of the Gaming Experience Questionnaire (CEGEQ) (Calvillo-Gámez, Cairns, Cox, & Bernhaupt, 2010) (Appendix E). 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 (Calvillo-Gamez et al., 2010).

Two main areas of the CEGE are puppetry – consisting of control, ownership, and facilitators – and the actual video game details, including gameplay, rules, scenario, environment, graphics, and sound. CEGEQ helps determine the presence of the CEGE during the gaming experience. We shortened the CEGEQ to include 23 Likert-scale items that were applicable to our game and most relevant to our purpose (Appendix E). These items were divided into three main categories: the design, the control, and the experience of playing the game. The questions were worded both positively and negatively in order to avoid response bias. The usability survey 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.

**Observation protocol**

Observational techniques help researchers collect *firsthand* data on a range of issues being studied. Observation allows the researcher to learn about things the participants “may be unaware of or that they are unwilling or unable to discuss in an interview or focus group” (Westat, 2010, p. 66). In all phases of this project, observation was one of the main data collection instruments.

During the first phase, in which the players played real-life escape rooms, the escape rooms were equipped with camcorders to film the participants’ activities. The researcher and two research assistants observed the footage in order to have multiple perspectives. In this stage, our observation was semi-structured and was guided by the observer’s focus on (1) players’ interaction with other players and (2) players’ interaction with the room. These behaviours included the topics of interactions, signs of frustration and excitement, and patterns of collaboration in each puzzle. The observers’ notes were collected in the form of field notes.

For the usability testing in the third phase, we prepared an observation protocol (Appendix F) 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, and when they get frustrated and excited during their play.
Interviews

Interviewing provides a different kind of data from observation. It allows the researcher to hear the participants’ stories and, hence, access their perspectives. In other words, it is chosen as a data collection method to obtain unique information or interpretation. It is also appropriate “when interpersonal contact is important and when opportunities for follow-up of interesting comments are desired” (Westat, 2010, p. 64), which was the case in this project. Therefore, interviewing was used because, first, the focus was on understanding the participants’ experience in escape rooms; second, the data from interviews were used for triangulating with the other data; and third, the interview data provided rich descriptions about the participants that supported the findings and would allow the reader to decide if the findings are transferable (Merriam, 2002).

The focus group interview technique was chosen for several reasons. First, focus groups allow for natural patterns of conversation, which helped us learn about the participants’ group dynamics and the patterns of their interaction. This was especially helpful in the first phase, where groups of four and six players collaborated in each game session. Second, the exchange of views among the interviewees is an opportunity for the participants to learn from each other. Third, focus groups are ideal for producing insights that result from group interaction. Finally, the “group effect” and the “therapeutic effect” in focus groups make the participants be more expressive and show less inhibition (Carey, 1994).

In the first and the third phases of the project, the interviews were conducted in semi-structured focus groups after each game session guided by interview protocols. All interview sessions were audio-recorded. The interview questions in the first phase were centred around the players’ experience, interaction with other older adults and how to improve escape games for a better play experience (Appendix G). In the game development phase, two interview protocols were used for the playtesting of the first prototype (Appendix H) and the usability testing of the second prototype (Appendix I). The questions were on the players’ experience with the prototype games and possible improvements in the game. The playability interview was a larger focus group with all 12 players in it. However, the usability interviews were carried out with pairs of players who played the game together.
3.4. Project Design

In order to design a collaborative online escape game for older adults that involves these particular players in fun activities requiring social interaction and cognitive engagement, we adopted a UCD process that is in line with the P-III framework discussed in the previous section, since it follows similar principles and is consisted of the same three main phases. Regarding user involvement, our UCD falls somewhere in the middle of the user as abstraction versus participatory design spectrum in terms of user involvement. More specifically, the users in our design had mostly the role of informants, rather than co-designers.

DeSmet et al. (2016), in a meta-analysis of 61 studies that evaluated 58 serious games for healthy life promotion that were designed using participatory design processes (which are all subcategories of UCD), found that participatory design does not lead to games with higher effectiveness. However, the games that involved the target players as informants (i.e., users who are asked for input and feedback) rather than co-designers (i.e., users as equal partners in the design) have been more successful (DeSmet et al., 2016). More specifically, when the participatory design was applied to game dynamics and game challenges, the game was more effective than when it was applied to game aesthetics. The authors concluded that “[i]nvolving users in user testing and informant roles may be more beneficial than as co-designers” (DeSmet et al., 2016, para. 70).

Therefore, in this framework, we first involved the end-users in a needs assessment phase in real-life escape rooms and then defined the game concepts based on their gameplay and feedback. Second, the research and the design teams came up with game ideas and designed game tasks. We followed up by creating paper prototypes and discussing the game tasks with older adults to receive their feedback. This phase was completed by creating a design document. The third phase started with art and software development and a playable prototype of the game. The prototype was played by a group of older adults whose play was observed and their feedback was elicited to refine the prototype. Finally, we carried out a usability testing on the second prototype to further refine the game and to evaluate the extent to which the game met the needs of the end-users and could achieve its defined goals. Figure 3 shows our UCD design process.
In the following sections, each phase of the process will be discussed in detail and a presentation of the game will be given.

3.4.1. Phase I: Game Concept

Phase one was game concept. In this phase, a comprehensive needs assessment was carried out on the players that led to a set of input for game concept definition. Since the characteristics and needs of older adult players could be very different from those of the researchers and the design team, we, the researchers, first needed to understand the end-users of our proposed game. On the other hand, escape
rooms, as a type of collaborative, adventure game was uncharted territory for us. We needed to learn about escape games, as well as the ways the older adult player responds to it. Therefore, we decided to analyze both the players and the game. We carried out the needs assessment in real-life escape rooms because, first, we wanted to base the online escape games on real-life escape rooms’ game play, and, second, we could not find any online escape game that matched the affordances we had envisioned for our game. Therefore, although some of the needs in real-life escape rooms are not applicable to an online escape game, we believed that performing the assessment in real-life escape rooms could give us useful data to help us make informed decisions on the initial game concept.

In this phase, we collected data through observation of older adults’ game play and focus group interviews to learn about their experience and their needs. Sixteen older adults participated in real-life escape rooms in Vancouver, British Columbia, Canada. They were commercial escape rooms offered by SmartyPantz Entertainment Corp. In this stage, which took four weeks, three groups of older adults – two groups of six older adults and one group of four older adults – played in two different escape rooms with a one-week interval. The rooms were called Spies & Lies and Morning Never Comes. The time limit to escape each room was 45 minutes. Two groups played Morning Never Comes first and Spies & Lies second, whereas the last group played the rooms in the reverse order. The reason was to address any possible difference in the participants’ reactions based on which room they play first. Figures 4 and 5 show these rooms. SmartyPantz Entertainment Corp.’s (n.d.) website described Spies & Lies room as follows:

**Spies & Lies:** It’s 1946 and the war has finally ended, but your mission has just begun. As war criminals flee to all corners of the globe, you are sent by the RCMP Special Branch to break into a crooked private eye’s office and discover the identity of a nasty Nazi so that he can be brought to justice. It’s not as simple as it seems, though. The detective’s office is locked up tight and even if you make it in, you’ll have to slip out undetected. Can you find the information before he returns? (SmartyPantz, n.d., para. 1).
SmartyPantz Entertainment Corp.’s (n.d.) website described *Morning Never Comes* room as follows:

**Morning Never Comes**: You have been brought in to help with the paranormal investigation of an old, abandoned house. If the rumours are true, the victim of a grisly murder haunts the study, and no one survives past midnight. The doors have been locked behind you, and it soon becomes clear that you are not alone. If you’re going to get out of the house, you’ll have to find a way to break the curse before the clock strikes midnight and you become the spirit’s next victim. While the paranormal may be involved, this room is more “Disney creepy” than pants-wetting scary. It’s also lower on the difficulty scale, so you’ve got a relatively good chance of keeping your head come midnight (SmartyPantz Entertainment Corp. (n.d., para. 1).
In both rooms, the players were required to find clues and solve puzzles collaboratively to find the key and get out of the room. However, they were drastically different in theme, environment, and difficulty of game tasks. *Morning Never Comes* was darker with predominantly word and textual puzzles. *Spies & Lies*, on the other hand, had several puzzles involving numbers and ordering and with a broader range of props. Consequently, we reasoned that, by playing both rooms, the players would gain a broader range of experience with escape rooms. Moreover, their game play in the two rooms would give us more insights for our online escape game design.

The escape rooms were equipped with video cameras, making it possible for the researcher and two research assistants to observe the players. The observation was semi-structured, guided by a set of behaviours, including players’ topics of interaction, signs of frustration and excitement, and collaboration in each puzzle. After playing both escape rooms, each group sat for a focus group interview to discuss their experience playing the escape rooms and tell the researchers about the highlights of their experience and how the rooms could be improved. Each focus group took about 15 minutes.
3.4.2. Phase II: Game Design

The second phase was *game design*, which took four weeks. In this phase, we were joined by the game design team, which consisted of five master student studying game design and media arts at Centre for Digital Media (CDM) in Vancouver, BC. The first step was sharing our findings of the needs assessment and defining the game concept together. Later, we held brainstorming sessions with them to come up with game tasks and game themes. This was followed by a focus group session with six older adults who had played real-life escape rooms in the first phase to receive feedback and make changes if necessary. We reasoned that the older adults who participated in the first phase could help us overcome the limitations they perceived in the real-life escape rooms. The next step was the creation of storyboards and paper prototypes to have a concrete vision for the game.

Several puzzles were discussed during this stage and we finally decided on three puzzles for the three rooms in the game: a crossword puzzle, an ordering puzzle, and a matching puzzle. In the next chapter, each of these puzzles will be discussed with screenshots from the game. The outcome of this stage was reviewed by the supervisors of the research team and the design team. After receiving their feedback, a game design document was written (Appendix K). The design document is a 20-page document outlining the visual design, research on the art style, user interface, various visual elements of the game, game characters, and game tasks. Finally, in this phase, the digital arts for the game were created and the skeleton of the game was constructed in the Unity game engine.

3.4.3. Phase III: Game Development

Phase three was *game development*, which took eight weeks. With all the data from the previous stages and our goals in mind, the design team created a playable prototype over eight weeks using the Unity game engine. Each week, the research and the design teams would meet to discuss the progress and receive feedback on the design.

When the prototype became ready, we played the game before testing it with 12 older adults, six of whom had participated in the focus group in phase two. They played
the game in pairs. Each pair played the game for approximately one hour. Midway through the game, the participants switched their role, so that both players could have the full game experience. In this phase, we used observation, survey, and focus group interviews to collect data on the usability testing of the initial prototype. Two researchers observed the players and took field notes. Following data analysis, one iteration was done on the first prototype to improve the design elements and the gameplay. These improvements included the speed of the game, communication between the players, and difficulty of the game tasks.

The refined prototype was tested for usability and playability with 12 older adults who had never played the game before. They played the game in pairs over a session that took approximately 90 minutes. The same data collection procedures were employed and one more iteration was performed based on the results to create the final prototype. This time, the refinements addressed the controllers, the reward system, a feature that would allow the players to save their game, and resolving technical glitches.

3.5. Data Analysis

3.5.1. Quantitative Analysis

All data collected from the participants were entered into a Microsoft Excel file into separate spreadsheets. This set of data included the background survey items and the Likert-scale items of the usability survey. After cleaning and checking for any irregularity, these data were analyzed for descriptives using Microsoft Excel.

3.5.2. Qualitative Analysis: Coding of Data

Open-ended questions on the usability survey

The usability survey contained four open-ended questions. These questions were intended to allow participants to comment on what they liked best, what they liked least, the appropriateness of the game for older adults, and any other thoughts they would like to express regarding the game or their experience. The first step was analyzing the responses to each question by a close reading of all the responses in a Microsoft Excel spreadsheet. During this process, several categories of codes were recognized. Second, in a separate spreadsheet, these categories were organized in columns with headings.
such as interaction, navigation, and challenge. 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. The main reason this approach was deemed practical was that the responses were short and related to one or two ideas. In-depth responses were very rare. In many cases, the respondents had used words or short phrases such as “the puzzles,” or “the navigation,” as things they liked or disliked about the game.

**Interview responses**

There are several techniques suggested by various qualitative researchers that are best suited for qualitative analysis of focus group data. The analytical technique used for this project was constant comparison analysis because there were multiple focus groups. I analyzed the focus group data one group at a time, so the results from each focus group were used to assess the meaningfulness of the emerged themes in an attempt to reach data saturation.

Strauss and Corbin (1998) identified three main stages for this technique, namely, open coding, axial coding, and selective coding. The analysis of the focus group interviews started with preparing the data, which involved transcribing the audio recordings. Second, the data were chunked into small units (open coding). Then a code was assigned to each unit to create categories (axial coding), and, finally, themes were developed for each category (selective coding). According to Saldaña (2015), a theme is an outcome of coding, categorization, and analytic reflection, not something that is, in itself, coded. In performing the three stages of constant comparison analysis, I also followed Clarke and Braun’s (2014) approach that specifies the following six steps:

- Familiarizing oneself with the data
- Generating initial codes
- Looking for potential themes
- Defining and naming themes
- Writing the report
Field notes

In the first phase, the footage of the game sessions in the real-life escape rooms were observed and field notes were written based on the observation. The observations were guided by questions that focused on the players' interaction with each other and with the room. Analysis of the field notes involved entering the notes into spreadsheets and creating categories based on them.

As for the field notes in usability testing in the third phase, they were guided by an observation protocol. The analysis involved entering the data in a spreadsheet, with each item of the protocol having a column. Then, the responses were ranked based on frequency and a table was created to show the ranked responses.

3.5.3. Ensuring Trustworthiness

There is an inherent subjectivity in qualitative approaches and puts a great emphasis on the active role of the researcher in data collection and interpretation (Baxter & Jack, 2008). Therefore, various measures should be taken to ensure the trustworthiness of the findings of qualitative research. Trustworthiness is defined by four criteria, namely, credibility, transferability, dependability, and confirmability. In the context of qualitative research, credibility is the most important criterion, because it addresses the extent to which the research findings are a true (or a plausible) representation of the collected data (Shenton, 2004).

To minimize the threats to credibility, various measures were considered. One of my primary concerns was to be credible by following ethical practices and interpreting the data as accurately as possible. My ethical considerations are discussed in the next section. Beyond ethics, reflexivity was done throughout the research by engaging in critical self-reflection regarding biases, assumptions, and interpretations (Tracy, 2013). Furthermore, triangulation was done by (1) following an established research method, (2) using multiple sources of data, and (3) performing a member check by verifying the accuracy of the interview transcripts with the participants, and employing research assistants to observe the game sessions (Merriam, 2002). The interview and the observation data were later matched for a more accurate interpretation. In addition to the above measures, a research assistant who was involved in the data collection reviewed
the data analysis procedures and confirmed the trustworthiness of the results. Finally, the limitations of the project and suggestions for future directions are discussed.

3.6. Ethical Considerations

Tracy (2013) divides research ethics into three main categories: *procedural ethics*, which includes universal and necessary ethical actions for all research; *situational ethics*, which has to do with reasoned considerations for ethical issues that arise in a specific context; and *relational ethics*, which means “being aware of one’s own role and impact on relationships and treating participants as whole people rather than as just subjects from which to wrench a good story” (Tracy, 2013, p. 245). Several measures were taken for the above categories by continually reflecting on my decisions and their impacts. First, prior to conducting the project, two ethics applications were approved by SFU’s Office of Research Ethics in which the key ethical issues as identified by Patton’s (2002) were addressed, including explanation of purpose, promises and reciprocity, risk assessment, confidentiality, informed consent, data access and ownership, and data collection boundaries. Second, as for situational and relational ethics, I did my best to be transparent about the procedures of the project, allowing the participants to withdraw from the project at any time, keeping my promises, putting relationships and communal well-being my top priority, and valuing mutual respect and dignity.
Chapter 4. Results

As mentioned in chapter three, a total of 34 mobile and cognitively normal older adults participated in this project. They consisted of 20 women (59%) and 14 men (41%). They were recruited from the SFU 55+ program and long-term care facilities in Vancouver, BC. The data collection techniques consisted of administering a demographic questionnaire at the start of the game sessions in all phases of the project, conducting a usability survey and focus group interviews following the game sessions, and collecting field notes by observing the game sessions. In the first phase, 16 older adults played real-life escape room games in two groups of six players and a group of four players. In the second phase, six older adults participated in the design focus group for the online escape room. These participants were recruited from the first phase. In the third phase, 18 older adults played two prototypes of the online escape game comprising an initial prototype and a refined version of the game. In this chapter, the results of the data analysis from these phases are presented.

4.1. Phase I: Game Concept

This phase took place at SmartyPantz, a commercial escape room facility in Vancouver, BC. In this phase, a comprehensive needs assessment was carried out with older adult players that led to a set of inputs for game concept definition, as well as a set of initial design recommendations for the online escape game. The data collection techniques in this phase consisted of a demographic questionnaire, focus group interviews, and taking field notes by observing the video recordings of the participants’ game play. The following sections present the results of demographic information, the focus group interviews, and our observation.

4.1.1. Demographic and background characteristics

Before participating in the escape room game, each participant was given a questionnaire asking them to provide demographic and background information, as well as their experience with escape rooms and their expectations from playing the game. The data from these questionnaires were analyzed using Microsoft Excel and the descriptive statistics are presented in Table 2. The results show that 62.5% of the
participants were women and 37.5% were men. Moreover, 69% of the participants were between 65 to 69 years old. Two people were between 70 to 74 and two people were between 75 to 79 years old. There was only one person between 80 to 84 years old. Almost all (94%) participants reported that they had not previously played an escape room. As for their expectations of playing escape rooms, 43.7% said they expect to have "some kind of fun," while 37.5% either did not comment or were not sure what to expect. Further, 12.5% wrote "new experience" as their expectation from playing the game and only one person indicated that they expected "some kind of learning."

Table 2 Participant demographics in phase one

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Category</th>
<th>Frequency (n)</th>
<th>Valid Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Female</td>
<td>10</td>
<td>62.5</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>6</td>
<td>37.5</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>16</td>
<td>100.0</td>
</tr>
<tr>
<td>Age</td>
<td>65-69</td>
<td>11</td>
<td>68.7</td>
</tr>
<tr>
<td></td>
<td>70-74</td>
<td>2</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>75-79</td>
<td>2</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>80-84</td>
<td>1</td>
<td>6.2</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>16</td>
<td>100.0</td>
</tr>
<tr>
<td>Experience with Escape</td>
<td>Yes</td>
<td>1</td>
<td>6.2</td>
</tr>
<tr>
<td>Rooms</td>
<td>No</td>
<td>15</td>
<td>93.7</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>16</td>
<td>100.0</td>
</tr>
<tr>
<td>Expectation from Playing</td>
<td>Fun</td>
<td>7</td>
<td>43.7</td>
</tr>
<tr>
<td>Escape Rooms</td>
<td>New Experience</td>
<td>2</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>Learning</td>
<td>1</td>
<td>6.2</td>
</tr>
<tr>
<td></td>
<td>Not Sure/No Comment</td>
<td>6</td>
<td>37.5</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>16</td>
<td>100</td>
</tr>
</tbody>
</table>

4.1.2. Focus Group Interviews

At the end of each game session, participants participated in a focus group interview to discuss their experiences in the escape rooms. Therefore, a total of six focus groups were held. The focus groups were audio-recorded and the recordings were transcribed for further analysis. The responses were then coded and themes emerged from the categories of codes (Saldana, 2015). The major themes covered aspects such as the design of the room, the process of solving the puzzles, collaboration, and the challenges they faced in the game. Here, the major themes are discussed with quotes from the responses given by the focus group members.
1. **Older adults had fun solving the puzzles together in a themed room.**

The interview responses indicated that all older adults who played the escape rooms in this project found it “interesting” and “a fun experience. A woman said:

I had no clue what to expect. It was very interesting. And first, just looking around, wasn't sure what to do as I don't think any of us were. But it was very, very interesting, yes. And it was nice to try and puzzle it out, see what the next steps would be.

Another woman noted that the experience as a whole was “very enjoyable.” A man agreed with her and added that he “had a lot of fun figuring out what the clues mean and helping other solve the puzzles.” In line with these comments, a woman said that:

The fact that we didn’t know anything about the room and its story made it challenging, but in a good way. A cool feature of the game for me was constant discovery with each puzzle and clues.

The responses also indicated that the players enjoyed the themes of the rooms, appreciating that each room had its unique theme and the puzzles were based on that theme. This apparently had made the puzzle more engaging for them, because they know everything follows the logic of the theme. However, they reported that the storyline of the rooms was not a helpful element, because “sometimes the information to remember and follow was overwhelming.” Finally, the participants seemed to have enjoyed the collaborative nature of the game. A man said, in this regard, that “escape room is meant to be cooperative and not competitive. And I think that really worked well with our group. For me, the cooperation in doing the game was the best part of it.” Another woman said:

I could see us actually working together and how we could work together and work on something in a more systemic way. I thought that we are quite scattered to start with. At first, it was everybody going around the room for themselves. We just kind of going in and then figuring out what. And then I could see other people starting to work with each other and help each other; and everybody was very helpful. I was thinking, "Well, we’re pretty scattered so I don’t think we are actually going to get this one," but I could see that things started to come together. People were starting to focus on things and work together as a team and so we finally got out.

It should, however, be noted that some participants were not happy with being in a large group. They preferred working with one or two partners, rather than six people. In
line with this, some of them suggested that having a "leader" and "assigning tasks to members" would be a good idea and save the team a lot of time.

2. Some design elements of the rooms hindered progress.

More than two-thirds of the participants believed that some of the design elements of the rooms hindered their progress. The most common complaint about the room, *Morning Never Comes*, was the lighting. Almost all participants found the room “too dim.” A woman commented that “the books were really hard to read because of the poor lighting.” Another agreed and said:

I understand it’s got to be dark. I know you have to have an atmosphere. You have to have that spooky kind of room and all that kind of stuff, but even if there was light in the corners, it was not very helpful because there are texts to read in each puzzle and you can’t move things around.

A male participant thought that poor lighting “kind of prevented some of the engagement.” He believed that the dim lighting of the room pushed him out of the game, because he could not be as useful as he wanted to be.

Another major complaint about the design of the rooms was the small text. Most of the participants reported that they had difficulty reading texts that were integral to finding a clue or solving a puzzle. This problem was reported for both rooms. One participant noted that “there were so many clues that involved finding a book or reading a letter. However, the fonts were often too small for me, even though I had my glasses on.” Another participant believed that “tiny notes were easy to ignore.”

Finally, almost all participants believed that the designs of the rooms offered too many possibilities that made the game difficult. For example, a woman said, “when you’re looking for something and you don’t know what it is, everything’s got a possibility.” Another participant agreed and added, “when you are looking for clues, you want to know what is *playable* and what is just a prop in the room.” Similarly, a woman noted that a lot of time was wasted playing with artifacts that turned out to be irrelevant to the puzzles.

3. Easier communication with the staff for hints

One of the major themes in the focus group interviews was communication with the help providers, who, in this case, was a staff member in the escape room facility who
could see the players via a camera and could connect with them through a walkie talkie device. The help provider would either step in to give hints when she saw the players were stuck or just answer the players’ questions regarding clues and/or puzzles. It seems that, in each team of players, one person was responsible for communicating with the help providers. One such participant said, “[the help provider] can see that we were floundering at the very beginning [laughs], I thought it was time to give us the first clue that would put us on the right track. And she did that. So, I think that was good.” However, all the other participants who communicated with the help provider thought that her speech was “difficult to hear” or “unintelligible sometimes.” One woman believed that the help provider stepped in too early and gave too much information at the beginning.

4. Demand for more diverse puzzles

A major theme in the focus group interviews was a lack of diversity in the rooms’ puzzles. This was especially prominent in the Spies & Lies room, where most of the puzzles involved numbers and basic math. A man, for example, believed that “there were too many numerical clues.” Similarly, a woman noted that “we wasted a lot of time finding numbers and then figuring out the right order to open the box.” Another woman agreed to add that “most of the puzzles were basically finding numbers and ordering them.” Yet another man said, “[the puzzles] were less complicated [than those of the other room], but very numerical. The keys were related to numbers a lot.” Participants in the other focus groups voiced similar opinions. A woman believed that “there were numbers all over the place. I was like ‘oh my god, this is going to be boring.’”

The lack of diversity in the puzzles was not limited to the numerical puzzles. In the Morning Never Comes room, participants believed that too many puzzles were related to books. A man said:

After the first two puzzles, I was kind of easy to guess that the next puzzle has probably something to do with the books – which is okay but I don’t like that much predictability. And I didn’t have my reading glasses, so it was a little bit frustrating, too.

5. Time limit as a hindrance and a source of frustration

The rooms in which the participants played had a 45-minute time limit in which they had to escape the rooms. This time limit was a major complaint in the focus group
interviews. A man stated that “There was several moments when we thought we should sit down and come up with some plot but I didn't feel we had the time to do that.” Similarly, a woman said:

I definitely felt the time pressure. It was quite intense in the last ten minutes, because if we could [solve the last puzzle] we could get out and it would have been a success, but the time limit made me get stuck somehow.

Another woman complained about the time constraint, saying that “we had found the solution to the last puzzle, but we needed time to order the books [i.e., implement the solution] and we ran out of it. It was so frustrating.” A man noted that:

We went into the room and we didn't know anything about any of the puzzles and the clues whatsoever. So, for a while, we were just looking around trying to figure out what to do. Just touching things and trying different object. And that took a lot of time. I think because there are no instructions or anything (and I know it’s part of the game), 45 minute was too short.

In the same vein, a woman said “I think the frustration was the time limit and the number of clues that we have to work our way through. It was too much for me.” Comments like this were seen in all focus groups by almost all participants. The time constraint was reported as a problem and a source of frustration especially in reference to the Morning Never Comes room.

6. Participants preferred guided team work and one-on-one interaction.

Another major theme was a preference for guided team work and one-on-one interaction. Most participants talked about lack of direction and indecisiveness when they entered the escape rooms. They said that the team members were “scattered” around the room with “everyone doing their own thing.” This lack of direction not only wasted a lot of time, but it was also frustrating to many participants. They voiced a need for a “lead” or one or two people who would be “in charge” and assign others different tasks. In this regard, a woman said:

Then it was the issue of leadership. Team needs a leader. We are all strangers and very quickly given some instructions and go for it. So I’m wondering if something could be built in that you’re going to need a team. What does a team have? The team has somebody to lead and -- So there might be something built in to an exercise to determine roles because we were very Canadian although you being the leader.
Another woman believed that the lack of leadership in her team of six people was intentional and the team members tried to be accommodating and polite. She said, “I think we all really tried to take not so much leadership out of politeness or because we were equally clueless whatever; but we tried to work independently.” On the other hand, a man noted that “the challenge would be how should we pick a leader. When everyone sees the same things in the room they have never been into, picking a leader would be a random thing and I’m not sure it could help. Perhaps the leader could be in charge of answering the walkie-talkie.”

4.1.3. Observation

In this phase, the game sessions were video-recorded with the escape room facility’s built-in cameras. However, there was no sound recording, so we missed that information. Nonetheless, watching the footage of the games was a useful source of data that complemented the focus group interview data. The observations were semi-guided and performed by three researchers (the author of this document and two other research assistants). It was mainly guided by focusing on two types of interactions during the game play: players’ interaction with other players and players’ interaction with the room. In this section, the results of our observation are presented.

Players’ interaction with the rooms

One of the most prominent patterns we observed in both rooms was players wandering around the room in the first five to 10 minutes. This is quite a long time considering the 45-minute time limit. During this time, most people did not touch the artifacts in the room. It seemed that they only observed the rooms and different things in them. In the Morning Never Comes room, the main elements of the room were a coffee table, a dresser, and two bookshelves. After the initial observations, the players would gather around these artifacts and touched different pieces in/on each of them. In the Spies & Lies room, the main elements were an office desk, a radio table, and a cabinet for archiving documents. Similar to the other room, the players would gather around these objects and tried to discover clues.

In both rooms, while some participants would spend short time touching and observing the objects, others would spend a very long time trying to make sense of the objects and possible relevance to the game. In one case, a man spent almost the whole
time on a large radio. Some players were bystanders, watching others interact with the different artifacts in the room. When someone would find a clue, people would circle that person. Then they would point at a given thing and start doing the task based on the clue. It seems that the participants spend much time searching for objects. Sometimes, frustration was apparent as they would shake their heads or raise their hands. Another issue that we observed was that most participants have difficulty reading in the room. In the Morning Never Comes, it seems that the difficulty came mostly from the dim lighting of the room and, in Spies & Lies, it was due to the small font of the texts. Finally, when they would find something, on several occasions, we observed that they forgot where they put the found object and, therefore, had to search for it again.

**Players’ interaction with other players**

As mentioned above, initially, the players were dispersed, wandering around the room. The observable interaction typically started when they would come across something that looked like a clue. At that point, they would gather around the person who found it and discussed it. The next most common pattern of interaction between the players was two or three people talking and working on a puzzle. In the Morning Never Comes, this was observed when they were looking for information in books and also working out the Ouija board puzzle. In the Spies & Lies, it was finding numbers in the cabinet and solving a puzzle on a typewriter. These were moments when they appeared to be most engaged with each other.

A significant observation was the fact that most of the time, the older adults would interact in pairs, rather than all of them working together. In both rooms, when they were not working on clues/puzzles independently, they were seen talking with each other over a puzzle in pairs. This is in line with their responses in the focus group interview that they prefer one-on-one interaction. Moreover, it was quite common to see that one person was left out and was not engaged in the interactions. Also, while frustration seemed to be mostly individual, the players would visibly celebrate every success during the game. All in all, it seems that most of the interpersonal interactions among the players were verbal and the footage of their game sessions only showed, to a certain extent, their pattern of engagement with each other. It appears that the participants were most engaged with each other when they were searching for either
numerical or textual information in the room; or when they were ordering objects, numbers, or letters to find a code.

4.2. Phase II: Game Design

The data in the first phase helped us to come up with an initial concept for an online escape game, as well as some design ideas which are discussed in chapter five. In this phase, which took four weeks, our research team was joined by the game design team – consisting of five student developers and student media artists at the Centre for Digital Media (CDM) – to design game tasks, prepare a “paper prototype,” and create a design document for the online escape game. During the initial meetings with the design team, we shared the results of the needs assessment and presented the game concept. We also held brainstorming sessions and discussed possible outlines for the game. Later, the project overview, the mission statement, and the goals and objectives of the project were written with the design team. The outcome of this endeavour was a project charter that outlined the goals, objectives, affordances, and constraints, as well as a timetable for the project. Table 3 below shows the goals we set for the project in the charter. The main goals in order of priority were engaging older adults to use technology; proving a fun, social, interactive experience that offers opportunities to mitigate the cognitive, psychological, and social limitations of older adults; creating reusable assets for future game development; and providing an educational experience in the literary setting of the game.

Table 3 Goals and objectives of the online escape game design project

<table>
<thead>
<tr>
<th>Priority</th>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>To provide a social interactive experience</td>
<td>Through exploring collaborative multiplayer puzzles and tasks.</td>
</tr>
<tr>
<td>2</td>
<td>To empower and engage older adults to use technology.</td>
<td>Through the use of convenient and accessible devices such as the computer,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and tablet. The project aims to deliver an engaging prototype developed in</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13 weeks, based on Escape Rooms.</td>
</tr>
<tr>
<td>3</td>
<td>To provide a fun experience to the older adult in a familiar literary setting that have educational, cognitive and social benefits</td>
<td>By using the theme of Alice in Wonderland and providing occasional learning moments through the experience.</td>
</tr>
</tbody>
</table>
4.2.1. Designing Game Tasks

One of the first issues we decided on was the theme of the game. After our discussions of the types of puzzles to use, it was decided that a literary theme would best suit the puzzles. More importantly, a theme that most older adults are familiar with would lower their stress and encourage them to engage with the game. Therefore, Alice in Wonderland was chosen as the theme of the game. The next step was defining the affordances of the game. The affordances that we envisioned for the game were social engagement, cognitive challenge, emotional benefits, and self-efficacy. Each of these challenges had implications for the design. We discussed these implications with the design team and created an outline. Table 4 shows the affordances we defined for the game and their effects on the game design.

**Table 4  The initial affordances of the proposed online escape game**

<table>
<thead>
<tr>
<th>Affordance</th>
<th>Effect on the Game Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social engagement</td>
<td>Prototype should allow for players to collaborate during the game to complete the game tasks.</td>
</tr>
<tr>
<td>Cognitive challenge</td>
<td>Puzzles should range in difficulty, starting with easy tasks and incrementally moving to more difficult ones. Players should start in an environment with little cognitive challenge before they get into the rooms and then the tasks.</td>
</tr>
<tr>
<td>Emotional benefits</td>
<td>The game should be fun. The mood should be light and humorous. The players should feel accomplished and at the same time be challenged.</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>Rewards should be provided for success, e.g., points, badges, positive feedback during play.</td>
</tr>
</tbody>
</table>

4.2.2. Game Design’s Focus Group

The design team held a focus group with six older adults who had participated in the real-life escape rooms in the first phase of this project to discuss the game design with them and receive their feedback on various elements of the game. Figure 6 shows photos of this focus group. Rather than asking specific questions, our team just discussed the game and showed a presentation of the game ideas we had come up
with. After the focus group, the design team outlined several design recommendations. These recommendations suggested that older adult players:

• prefer puzzles that they are familiar with in some way.
• want to be active throughout the game.
• want to know their role in the game from the start.
• want to know their tasks immediately
• want to be rewarded throughout the game and not just at the end.
• want to have unlimited time to play the game.
• prefer a literary theme that they are familiar with.
• prefer that the puzzles do not be too dependent on the theme.
• prefer voice chat over other options for communication.

![Figure 6 Game design focus group meeting](image)

Based on the needs assessment results, the brainstorming, and the focus group with the older adults, we conceived the game as a two-player game that consists of a maze with three rooms inside in different places in the maze. One player is inside the maze and the other player, who has a bird’s-eye view of the maze, navigates the first player (See Figure 16 in the next section). The players would communicate through voice chat, as this was their preference and is in line with Shakeri et al.’s (2017) recommendation. Initially, the voice chat was decided to be through Skype, which would run in the background. It was decided that a literary theme for the game that is well-
known to a wide range of age groups would be beneficial. Therefore, we chose *Alice in Wonderland*. However, we only used some ideas from the story in the puzzles and the visuals.

### 4.2.3. Paper Prototype and the Design Documentation of the Game

The design team created storyboards and a design document (Appendix J) that described all the game elements for the first prototype, including the game setting, the puzzles, and the mechanics of the game. An excerpt from this pamphlet is shown in Appendix J. A decision was made by the team to make the game playable on Android smartphones, tablets, PC, and Mac operating systems. Communication between the two players would be through a voice chat feature. Initially, the voice chat was through Skype. The online escape game was given the title, ‘A Tale of Tales,’ and was described as follows:

*A Tale of Tales* is a cooperative puzzle game based on escape rooms that we intend to design and develop as an online escape game that fits the needs of older adults and engages them through elements of real-life and online escape rooms and puzzles, and interactive storytelling. The chosen subject theme for the first chapter of the game borrows elements from the story of Alice in Wonderland and Through the Looking Glass by Lewis Carroll. A unique storyline involving the story thief – the Ink Monster – will lead the players to explore the escape room through virtual worlds, puzzles and interactions with characters (Appendix J).

Figure 7 below shows the initial plot of the game. A similar game plot was shown to the players during the playtesting and the usability testing of the game as part of the guidance.
As shown in the idea map of the game below (Figure 8), the initial concept of the game starts with a cinematic episode that includes a character called “Ink Monster” who lives in a library. The Ink Monster takes the player into the world of a book and the game starts from there. The players should escape the book in which they are trapped. In the prototype game, there is only one book to choose from and it is Alice in Wonderland. 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 be able to escape the book. There is no time limit in the game.
We envisioned three rooms for the game, each with a different type of puzzle involving textual, numerical, ordering, and identification puzzles that require collaboration between the two players to be solved. In all rooms, the players are required to find a code. This decision was informed by the results of the needs assessment in phase one, the affordances of the game, and the capacity of the design team. The two players will see different screens and they need to collaborate through the voice chat feature to help each other complete the puzzles. The first room contains the least complicated puzzle. It is a crossword puzzle that, upon completion, results in the final code that the players can use to escape the room. The second room is more complicated than the first room. It
consists of two parts. The first part is a memory puzzle in which the players should remember the correct order of four colours. The second part is setting a clock based on the hours written on the wall to get the final code and escape the room. In the third room, the players need to figure out the missing words of a poem based on the pictures they see on the wall. Then, they must order four signs based on the poem to get the code and escape the room. Figures 9, 10, and 11 below show the flow of each room for player one and player two with details. For larger pictures, please, see Appendix J.

Figure 9  The flow of room one (crossword room) for player 1 and player 2

---

65
Figure 10  The flow of room two (tea party) for player 1 and player 2

Figure 11  The flow of room three (Cheshire Cat) for player 1 and player 2
Figure 12  A sample storyboard of the online escape game, *A Tale of Tales*
4.2.4. Arts and Software Design

After the design documentation, the design team developed the initial 2D and 3D digital arts and software for the game. This process involved creating several drafts that we discussed in meetings and improving them based on the team’s feedback. Eventually, the digital representations of the rooms were created (Figures 13, 14, and 15) and the skeleton of the game was constructed through the Unity game engine. As depicted below, the elements of the rooms are all based on the characters and the story of Alice in Wonderland. Please, see the visual design document in Appendix K.
4.3. Phase III: Game Development

The last phase of the project, which took eight weeks, involved developing the online escape game, *Tale of Tales*. This phase started with creating the first playable
prototype of the game. Later, this prototype was tested with 12 older adults. Six of these older adults were the ones who participated in the real-life escape rooms and the other six were new to the project. The game was refined based on the results of the first playtesting and a second prototype was completed. This version of the game then went through a usability testing with 12 older adults who had not played the game before. Therefore, a total of 24 participants took part in this phase. Finally, based on the results of the usability testing, the game was refined for the second time and the final prototype was completed. In this section, the results of these stages will be presented.

4.3.1. Developing the First Prototype of the Game

The first prototype of the game was developed with the Unity game engine. In this prototype, the players were connected via the internet. In the first set of screenshots (Figure 16), you can see the view of the maze the players see in the game. Player one is inside the maze and has two controllers — one for direction and the other for movement. Player two has a bird's-eye view of the maze and navigates Player one. These screenshots belong to the tablet version of the game.

![Figure 16: View of the maze from player one POV (left) and player two POV (right)](image)

In Figure 17 below, you see Player one’s view of the first room. In this puzzle, Player one is inside the room. They can see the crossword puzzle items, some hints on the wall and a machine to insert the final code to get out of the room.
Figure 17  Player one’s view of the first room

Figure 18 below shows Player two’s view of the same room. There is a crossword puzzle table that this player should complete. The two players collaborate to complete the puzzle.

Figure 18  Player two’s view of the first room

The second room, Tea Party, is an ordering puzzle in a garden with a dinner table in the middle of it. There are tea pots of various shapes on the table and some buckets of paint hanging from a rope between two giant rabbits. Figure 19 shows each player’s view of this room.
The second puzzle is comprised of two parts. In the first part, Player One can tap on the teapots to see a colour spewing out of each pot. Player two sees four colours and the two players should eventually tap on four teapots in the correct order. When they achieve this goal, Player one would see several “hours” on the wall and Player Two would see a clock with adjustable hands (Figure 20). The task here is to adjust the clock according to the hours on the wall to get a code that would open the door.

Finally, the third room includes a matching puzzle in which the players must collaborate to complete a poem based on corresponding pictures. When the poem is complete, they can find the code to get out of the room. Figure 21 shows screenshots of this room.
4.3.2. The First Playtesting

The first playtesting took place at the CDM with 12 older adults. Both the design and the research teams were present during the test session. This initial playtesting was carried out to explore the target players' responses to the game and to collect data for the next iteration of the game. It focused on the playability of the game, including the mechanics and the players’ response to the overall gameplay, as well as the puzzles. The data collection instruments for this playtesting were demographic and playability questionnaires.

The platform for the game consisted of PC laptops and a few tablets that were assigned to some players who had the navigator roles (player 2). The main controllers were a mouse, keyboard, and touchscreen, although they rarely used the touchscreen. As their first task, the players completed the background survey and then they were randomly assigned to six pairs. Before they started to play, a brief presentation was delivered to them, explaining the project and the prototype game. After the presentation, the players played the game in different rooms: six players in Room A and their game partners in Room B. Research assistants and the game developers were present in both room to answer questions and resolve possible technical difficulties. The game session was 60 minutes long. When the game session was over, only half of the players had gotten into the last room and only two pairs had finished the game. The other half were either stuck in, or just out of, the second room.
Demographic and background characteristics

Table 5 reports on the sex and age of the players, as well as their experience with digital games and real-life escape rooms. The number of female participants, at 66.6%, was higher than male participants (33.3%). Except for one participant who was between 75-79 years old, all other participants were between 65-74 years old. As for their game experience, all except one person reported having experience with digital games. Half of these people said they play digital games a few times a week and the other half played them either once a week or once a day. Finally, concerning their experience with real-life escape rooms, since six participants had already participated in the last two phases of this project, they had experience with escape rooms, but the other half did not have any experience with real-life escape rooms.

Table 5  Participant demographics in the playtesting of the 1st prototype

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Category</th>
<th>Frequency (n)</th>
<th>Valid Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Female</td>
<td>8</td>
<td>66.6</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>4</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>12</td>
<td>100.0</td>
</tr>
<tr>
<td>Age</td>
<td>65-69</td>
<td>7</td>
<td>58.3</td>
</tr>
<tr>
<td></td>
<td>70-74</td>
<td>4</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>75-79</td>
<td>1</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>12</td>
<td>100.0</td>
</tr>
<tr>
<td>Experience with Digital Games</td>
<td>Yes</td>
<td>11</td>
<td>91.6</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>1</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>12</td>
<td>100.0</td>
</tr>
<tr>
<td>Frequency of playing Digital</td>
<td>Once a week</td>
<td>3</td>
<td>30.0</td>
</tr>
<tr>
<td>Games</td>
<td>A few times a week</td>
<td>5</td>
<td>50.0</td>
</tr>
<tr>
<td></td>
<td>Once a day</td>
<td>2</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Experience with Real-Life</td>
<td>Yes</td>
<td>6</td>
<td>50.0</td>
</tr>
<tr>
<td>Escape Rooms</td>
<td>No</td>
<td>6</td>
<td>50.0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>12</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Results of the playability survey

As discussed in the literature review, playability is “a collection of criteria with which to evaluate a product’s gameplay or interaction” (Järvinen et al., 2002, p. 17). It is a game evaluation tool consisting of four components: functional, structural, audiovisual, and social playability (Järvinen et al., 2002). For this project, at this stage, we created a
questionnaire based on the Heuristics for Evaluating Playability (HEP) instrument, which is a validated instrument created by Desurvire et al. (2004). The survey (Appendix D) consisted of 17 closed-ended items on three features of playability – game play, storyline, and mechanics – and the overall evaluation of the players. Almost all items are Yes/No questions with space for an explanation of the response.

Table 6 below shows the results of the close-ended items of the playability survey. Instead of the Likert Scale, the design team developed the items as Yes/No questions with space for further elaboration for the response. Therefore, since the participants had the option to explain their responses in the survey, their explanations were also reported here when necessary. The majority of the items focused on the game play feature. The most positive feedback in this category related to the clarity of the goal of the game, with 83% reporting that the goal of the game was clear, followed by the theme of the game, with 75% reporting that they found the Alice in Wonderland theme interesting.

Similarly, 75% of the players believed that the challenges in the game were a positive experience. The same percentage of the players found the duration of the game “just right” and reported that they did not have difficulty understanding the puzzles. Only half of the players thought there are sufficient tutorials on how to play the game.

The most negative feedback related to “navigation” and "figuring out the next step during the game," with 66% reporting that they had difficulty navigating the game and not knowing what to do next. Based on the players’ further explanation, it seems that this difficulty had to do with the controllers and the speed of the movements in the game. Moreover, 58% of the players thought that they were not rewarded for their progress during the game. It seemed that escaping the rooms by finding the codes was not a sufficient reward for the players. They expressed their need to be rewarded throughout the game for their progress, too. Some of them suggested a scoring system that gives them points after completing each task in the game.

As for the game story feature, all players were comfortable with the involvement of the storyline in the puzzles and 92% of them understood the game storyline without difficulty. Further, 75% of the players reported that they were interested in the storyline. With regards to the game mechanics feature, 83% of the players had difficulty
communicating with their game partner. This is because we used Skype’s voice chat to connect the game partners and it proved to have several problems as an external program running at the same time with the game. Besides, talking over each other was a complaint expressed by several players. Moreover, 66% reported that they had difficulty with the controllers and the same percentage believed that the game speed does not match their pace. Overall, 92% of the players found the game fun and 75% of them said that they would play the game again.

Table 6  The playability survey results

<table>
<thead>
<tr>
<th>Feature</th>
<th>Item</th>
<th>Category</th>
<th>Frequency (n)</th>
<th>Valid Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Game Play</td>
<td>Did you find the Alice in Wonderland theme interesting to you?</td>
<td>Yes</td>
<td>9</td>
<td>75.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>3</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>Was the goal of the game clear?</td>
<td>Yes</td>
<td>10</td>
<td>83.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>2</td>
<td>16.6</td>
</tr>
<tr>
<td></td>
<td>Were there sufficient tutorials in the game?</td>
<td>Yes</td>
<td>6</td>
<td>50.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>6</td>
<td>50.0</td>
</tr>
<tr>
<td></td>
<td>Did you feel rewarded for your progress during the game?</td>
<td>Yes</td>
<td>5</td>
<td>41.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>7</td>
<td>58.3</td>
</tr>
<tr>
<td></td>
<td>Do you think the challenges in the game were a positive experience?</td>
<td>Yes</td>
<td>9</td>
<td>75.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>3</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>Did you encounter any difficulties in navigating in the game?</td>
<td>Yes</td>
<td>8</td>
<td>66.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>4</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>Did you encounter difficulties understanding what to do next?</td>
<td>Yes</td>
<td>8</td>
<td>66.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>4</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>Did you have any difficulty understanding the puzzles?</td>
<td>Yes</td>
<td>3</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>9</td>
<td>75.0</td>
</tr>
<tr>
<td></td>
<td>What do you feel about the duration of the game?</td>
<td>Too short</td>
<td>3</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Just right</td>
<td>9</td>
<td>75.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Too long</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Game Story</td>
<td>Did you understand the game storyline without difficulty?</td>
<td>Yes</td>
<td>11</td>
<td>91.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>1</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>Were you interested in the storyline?</td>
<td>Yes</td>
<td>9</td>
<td>75.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>3</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>Were you comfortable with the involvement of the storyline in the puzzles?</td>
<td>Yes</td>
<td>12</td>
<td>100.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Feature</td>
<td>Item</td>
<td>Category</td>
<td>Frequency (n)</td>
<td>Valid Percent (%)</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------------------------------------------------------------</td>
<td>----------</td>
<td>---------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Mechanics</td>
<td>Did you have any difficulty in communicating with your partner?</td>
<td>Yes</td>
<td>2</td>
<td>16.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>10</td>
<td>83.3</td>
</tr>
<tr>
<td></td>
<td>Did you have any difficulty with the controllers?</td>
<td>Yes</td>
<td>8</td>
<td>66.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>4</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>Did the game’s speed match your pace?</td>
<td>Yes</td>
<td>4</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>8</td>
<td>66.6</td>
</tr>
<tr>
<td>Overall Experience</td>
<td>Overall, was this game fun?</td>
<td>Yes</td>
<td>11</td>
<td>91.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>1</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>Would you play this game again?</td>
<td>Yes</td>
<td>9</td>
<td>75.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>3</td>
<td>25.0</td>
</tr>
</tbody>
</table>

**Results of the Focus Group Interview**

The players participated in a short focus group interview to talk about their experiences playing the game (see the interview protocol in Appendix H). They were asked five questions that were intended for the players to give us richer data about different aspects of the game’s playability. The focus group was audio-recorded and the recording was transcribed. The responses were entered in Microsoft Excel and categorized based on the questions. They were mostly short and focused on one or two aspects of the game.

1. **The most engaging elements of the game**

   Most players thought that the crossword puzzle was the most engaging part of the game. One reason a few of them mentioned was the familiarity of the puzzle and the fact that they knew what they needed to do throughout the puzzle. Also, the hints on the wall motivated them to explore the room and help their partners solve the puzzle. The other engaging element was the maze. They enjoyed moving into the maze and navigating their partner in the maze. They found the maze a suitable connector of the rooms. The other engaging elements they mentioned were the theme and communication with the game partner.

2. **What the players enjoyed the most in the game**

   The responses suggest that what players enjoyed the most was the collaboration with their game partners and the success they had together. One player said that
“figuring out what to do in a room with my partner was fun. We saw different things and had to describe what we see to each other and I think that was a good challenge. I enjoyed how, by helping each other, we proceed in the game.” The players also enjoyed the environment of the game and graphics. “Solving the puzzles and feeling accomplished” was another source of joy for the players. One person enjoyed that she was able to connect to a stranger and get comfortable with them so quickly through the game.

3. The puzzle the players enjoyed the most

Almost all participants reported that they enjoyed the crossword puzzle the most. The reasons they gave were that it was “fun” and that “crossword puzzle is something that I know and it was very interesting doing it in collaboration with someone else.” Another player noted that “the crossword puzzle required little moving around and was very clear. So it was not frustrating and I enjoyed going through it with my partner.” Interestingly, a player said, “I loved the crossword puzzle. The items were all related to Alice in Wonderland and although I knew the story, I didn’t remember the details. The hints on the wall and my partner were really useful and I was totally engaged in this puzzle.” Similarly, another response was about how the difficulty of the puzzle was “just about right” and it motivated the player to proceed.

4. What worked best for the players in the game

According to the responses, the maze worked best for the players. This means that the players went through the maze smoothly and felt engaged. They also believed that the maze worked well as an interval between the puzzles. Some players reported that the communication with their partners worked best for them, while others thought the ultimate goal of the puzzles, i.e., finding a code to escape the room, worked best for them.

5. The most common difficulties in the game

A common difficulty that the majority of the players referred to was their inability to solve the second puzzle, the tea party. They believed that there was a need for more hints in that puzzle, especially with ordering the teapots on the table. Another difficulty was the controllers. The controllers in this playtesting were the laptop keyboard and a mouse. It seems that the players were not comfortable with using both of these
controllers at the same time. Finally, some players noted that the fact that they could not see what their partners saw made it difficult and sometimes frustrating because the partner was not very good at describing the scene. A few players complained about the distractive visuals in the third room. It seems that the jungle environment was too complicated for easy exploration of the room.

4.3.3. The Second Prototype

The playtesting of the first prototype was followed by data analysis and a meeting between the research team and the design team to discuss the results and come up with an outline of the changes to make on the prototype. Based on the feedback from the players that were discussed in the previous section, the following refinements were made to the second prototype of the game:

• The speed of the game was reduced and the movements became slower.
• A built-in voice chat feature was added to the game to replace Skype voice chat.
• Several hints were added as “tip” pages for the puzzles (Figure 22).
• A scoring system was added to the game to give the players a score by completing each task.
• The character of Humpty Dumpty appears more often to reward the players (Figure 23).
• The visuals of the third room, Cheshire Cat, was changed to simpler visuals which are less straining visually for older adults.
• The tablet version of the game was upgraded to become fully functional.
• The controllers were changed to a set of intuitive virtual joysticks for tablets.
• For the laptop version of the game, the need to use the mouse and the keyboards concurrently was eliminated.
The design team implemented the refinements on the game using the *Unity* game engine. We had another meeting to test the game with them before organizing a usability testing session with older adults.
4.3.4. Usability Testing of the Second Prototype

The usability testing of the second prototype was the final stage in which older adults participated in the game development. Twelve older adults who had not participated in the previous stages were recruited to play the game. The game sessions were held at SFU Harbour Centre in two rooms. Android tablets were used as the game platform in all game sessions. The players completed two surveys – a background survey and a usability survey – and each pair of players participated in an interview. Moreover, two research assistants observed the players during the game sessions and took field notes. In this section, the results of this usability testing are presented.

Participants demographics

For usability testing, 12 older adults played the game. Half of these players were men and the other half were women. Table 7 below shows the demographic data of these players. Ten players (83%) were between 65 to 69 years old, which means that most of them would have used computers either personally or professionally. One player was 70-74 and one player was 80 to 84 years old. Half of the players reported having “beginner” computer skills, whereas 42% had “intermediate computer skills. About 83% of the players had played digital games before, but only 33% of the players believed they had “intermediate” ability to play digital games. The other 66% considered themselves “beginners.” Finally, 80% of the players who had reported they had experience with digital games used either phone or tablet to play games and 20% used computers.

Table 7  Participant demographics in the usability testing of the 2nd prototype

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Category</th>
<th>Frequency (n)</th>
<th>Valid Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Female</td>
<td>6</td>
<td>50.0</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>6</td>
<td>50.0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>12</td>
<td>100.0</td>
</tr>
<tr>
<td>Age</td>
<td>65-69</td>
<td>10</td>
<td>83.3</td>
</tr>
<tr>
<td></td>
<td>70-74</td>
<td>1</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>80-84</td>
<td>1</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>12</td>
<td>100.0</td>
</tr>
<tr>
<td>Marital Status</td>
<td>Single</td>
<td>8</td>
<td>66.6</td>
</tr>
<tr>
<td></td>
<td>Married/Partnered</td>
<td>4</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>12</td>
<td>100.0</td>
</tr>
<tr>
<td>Highest Education Level</td>
<td>High school</td>
<td>2</td>
<td>16.6</td>
</tr>
<tr>
<td></td>
<td>Some college</td>
<td>4</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>Bachelor’s Degree</td>
<td>4</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>Master's Degree</td>
<td>2</td>
<td>16.6</td>
</tr>
<tr>
<td>Characteristics</td>
<td>Category</td>
<td>Frequency (n)</td>
<td>Valid Percent (%)</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------</td>
<td>---------------</td>
<td>-------------------</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>12</td>
<td>100.0</td>
</tr>
<tr>
<td>Working Situation</td>
<td>Retired</td>
<td>11</td>
<td>91.6</td>
</tr>
<tr>
<td></td>
<td>Part-time employment</td>
<td>1</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>12</td>
<td>100.0</td>
</tr>
<tr>
<td>Computer Skills</td>
<td>None</td>
<td>1</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>Beginner</td>
<td>6</td>
<td>50.0</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>5</td>
<td>41.6</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>12</td>
<td>100.0</td>
</tr>
<tr>
<td>Have you played digital games?</td>
<td>Yes</td>
<td>10</td>
<td>83.3</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>2</td>
<td>16.6</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>12</td>
<td>100.0</td>
</tr>
<tr>
<td>Frequency of playing digital games</td>
<td>Once a month</td>
<td>1</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>Once a week</td>
<td>2</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>A few times a week</td>
<td>3</td>
<td>30.0</td>
</tr>
<tr>
<td></td>
<td>Once a day</td>
<td>2</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>2</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>10</td>
<td>100.0</td>
</tr>
<tr>
<td>How do you evaluate your ability to play digital games?</td>
<td>Beginner</td>
<td>8</td>
<td>66.6</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>4</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>12</td>
<td>100.0</td>
</tr>
<tr>
<td>What type of media do you use to play digital games</td>
<td>Computer</td>
<td>2</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>Phone and/or tablet</td>
<td>8</td>
<td>80.0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>10</td>
<td>100.0</td>
</tr>
</tbody>
</table>

**Results of the usability survey**

The usability survey was adapted from the Core Elements of the Gaming Experience Questionnaire (CEGEQ) (Calvillo-Gámez et al., 2010). CEGEQ has two main areas: *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. The 23 Likert-scale items of our adapted usability survey (Appendix E) are divided into three sections, namely, design of the game, control of the game, and the experience of playing the game. Moreover, the survey included four open-ended questions to allow the players to expand on their responses and provide us with richer data.

Table 8 below shows the results of the Likert-scale items of the usability survey. The results suggest that, in terms of interface design, the players were satisfied with the second prototype of the game. Concerning the visuals, 11 players (97%) liked “the way
the game looked,” and the same percentage believed the graphics were appropriate. All players believed that the game display was optimal for the screen size. However, the players’ reactions to the animations of the game were mixed. Four players (33%) disliked the animations, most probably due to eyestrain or distractions they caused, while 42% disagreed and 25% of the players were undecided about it.

Moreover, 75% reported that they could follow the instructions in the game. However, 75% of the players said that they did not understand the rules of the game. These two last findings suggest that either the instructions were not sufficient or they were not useful to the majority of the players. In Game Control category, 42% found the game easy to play, while 25% thought it was difficult and 33% were undecided. Moreover, half of the players found it difficult to navigate in the game. Almost all players found the feedback useful and only 25% of them thought it was a challenge for them to respond quickly to the game tasks.

Overall, 83% of the players enjoyed playing that game and 75% of them said they would play the game again. As for frustration, only one player (8%) said they felt frustrated while playing the game and one player was bored during the game. The responses to whether they learned something new were mixed. Thirty-three percent of the players reported that they learned something new, while the same percentage did not learn something new and the rest were undecided. Furthermore, 75% thought the game tasks were not too complicated and 83% believed that the game motivated them to keep playing.

Table 8  The Likert-scale items of the usability survey (n=12)

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

The usability survey 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 survey.

- **The players enjoyed the collaborative nature of the game.**

  The majority of the respondents reported that "collaboration" was what they liked about the game the most. They enjoyed “going through the challenges with a partner” and “navigating the wonderland together.” They liked “[discovering] what to do together
rather than competing against each other in the game.” One player wrote that “it was fun to navigate my partner in the game and help her solve the puzzles.”

- **The players were satisfied with the graphics of the game.**

  Another major theme was how they liked the visuals and the graphics of the game. Although the responses were not elaborative, a few respondents mentioned why they thought the graphics were appropriate. One of them said the elements of the rooms were familiar to her and he felt comfortable exploring the rooms. Another player said that the pictures used in the game were “good and interesting.” Another player mentioned the “realistic” maze and the “smooth” movements in the game.

- **Navigating the game with two virtual joysticks was a challenge for the players.**

  The controllers on the tablet version of the game are two virtual joysticks on the touchscreen. One joystick is for direction and the other for movement. The players had to use both of them at the same time to move around in the game. However, many of the respondents believed that it was too challenging for them to control the movements using both joysticks. They believed the game was “difficult to navigate” and “sometimes moving in the maze was frustrating because [the movement] was not easy to control.”

- **The players asked for more hints/instructions to solve the puzzles.**

  The last major theme was a need to include more hints for the puzzles. Most players believed that they spent “too much time” figuring out the solution for the puzzles. A respondent said that he “couldn’t finish the game because the second puzzle took so long to solve.” Another respondent thought that some general instructions about the goal of each room would help them have a plan in mind. Although these comments are understandable, it should be noted that escape room gameplay involves finding clues and discovering solutions in collaboration with game partners.

**Results of the interviews**

After they were finished playing the game, each pair sat for an interview to respond to eight questions regarding their experiences in the game (see Appendix I). Most of these questions focused on the different aspects of the game rather than the player. These interviews were audio-recorded and then the recordings were transcribed for further analysis. The analysis procedures were similar to the focus group analysis in
the first phase. The responses were coded and organized in a spreadsheet and then themes emerged from the categories of codes. In this section, these themes are presented.

1. **The older adult players would be willing to play the game again if the game offered new challenges or could be played over multiple sessions.**

   Almost all respondents said that they would play the game again. Most of them believed that the game was “fun to play” and they would play it in different sessions if their game could be “saved” so that they could start from where they stopped playing. This because some players thought it is not realistic for them to imagine playing the game for an extended period of time in one session. Others reported that, if they finish the game, they would not be interested in playing the same game again. One of them said, “if everything is the same, the only motivation for me would be to play the same game with a new person – which could be fun, but that wouldn’t be a strong enough motivation for me.” Another respondent said, “I would play it again, but I’d like to see some new themes, new stories and characters.” Another respondent expanded on that comment by saying, “even the same theme and puzzles but with different contents and different clues would make the game more appealing to play again.”

2. **Collaborating with another older adult to achieve the same goal was something the players liked most about their experience.**

   The responses suggest that a highlight of the players’ experience was collaborating with a partner in the game. This is in line with the responses they offered in the usability survey. Some players believed that “looking for clues” and “figuring out how to solve the puzzles” with a partner was the most fun part of their experience. A respondent said, “our conversations throughout the game were real and we needed each other to go forward. I liked this interaction and had a lot of fun doing it.” Similarly, a player said, “I liked the cooperative nature of the game. We were not trying to beat each other; we were together with a shared goal.” Another respondent said the built-in voice chat feature had made her communication with her partner smooth and “helping each other out in different roles was enjoyable.”
3. **The objectives of some game tasks were not clear to the older adult players.**

Even though most players liked the familiarity of the crossword puzzle, they thought that they needed more guidance to understand their tasks in the other rooms. This is in line with their responses to the usability survey. 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.” A respondent said, “when we didn’t know what to do, I felt a little bit disengaged and it was even frustrating to go around the room trying things and not knowing what to do. I mean, eventually, you would figure it out if you spend enough time in the room, but it could be frustrating.” Overall, it seems that the players did not engage with the “clue finding” part of the rooms very much. Their comments suggested that they preferred to skip the discovering stage in each room and get to solving the puzzles.

4. **Using the virtual joysticks were difficult for almost all older adult players.**

Similar to what they reported in the usability survey, the players expressed how difficult it was for them to use the double joystick controllers, which in turn made it difficult to move inside the maze and the rooms. A respondent said, “moving with those controllers was a pain. I couldn’t control it the way I wanted. It was especially frustrating in the rooms because the rooms are small and to observe different things I had to make small movements. These controllers didn’t work” Another respondent believed that the virtual joystick did not respond correctly to what she wanted: “many times I just wanted to go straight forward, but it went to one side and then moving it back made it worse.” Another respondent said that he often forgot he had to use the joysticks at the same time to move around: “I tended to use one at the time. It made me slow and even when I used them both, the movement wasn’t smooth. A lot of my energy was spent trying to make small movements, and I think it was because of the controllers.” When the players were asked if they would prefer a single joystick that would be for both moving and direction, most of them thought it would be a good idea because it is “more intuitive” and “familiar, because that is how real joysticks are.”
**Results of the observation**

During the game sessions in this phase, research assistants collected field notes guided by an observation protocol that focused on several aspects of the players' interaction with the game (Appendix F). Specifically, 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. Table 9 below shows the results of the field notes.

According to the observers' notes, only one player had difficulty starting the game. However, the players looked frustrated on several occasions during the game. In eight cases, they looked frustrated when trying to use virtual joysticks. This is in line with the results of the usability survey and the interviews. Also, five of them were frustrated when they made mistakes in the second room. Four players were frustrated when they made mistakes in navigating their partners in the maze. Moreover, in three cases, the design of the third room was a source of frustration for the players. It seems that the main reason for frustration was a wall between the elements of the puzzle requiring the players to move several time to see the space on the other side of the wall.

As for difficulty moving in the game, nine players had difficulty making small, accurate movements inside the rooms. It seems that the reason was the controllers and the fast pace that made it challenging to move accurately. Once again, the observers noticed difficulty in eight cases when players wanted to move inside the maze. However, navigating the maze was easy for most players. Nine of them navigated the maze and their partner, who was inside it. However, two players had difficulty identifying the rooms on the maze, while trying to navigate their partners to the rooms. This was most probably due to the small indicators (stars and balls).

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, five 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, seven players did not know what the purpose of the puzzle is, so the 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, eight players did not know how to figure out the code based on the suits and the order of the pictures.

Table 9  The results of the observations during the usability testing

<table>
<thead>
<tr>
<th>Item</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did participants encounter any problems when starting the game?</td>
<td>• No, they started the game without any problems. (11x)*</td>
</tr>
<tr>
<td></td>
<td>• He did not know how to connect to her partner and I had to step in</td>
</tr>
<tr>
<td></td>
<td>and guide her. (1x)</td>
</tr>
<tr>
<td>Was there anything that made participants feel frustrated?</td>
<td>• The player who was inside the maze had difficulty using the</td>
</tr>
<tr>
<td></td>
<td>joysticks at they were clearly frustrated at that. (8x)</td>
</tr>
<tr>
<td></td>
<td>• In the second room, Tea Party, the player was frustrated when</td>
</tr>
<tr>
<td></td>
<td>they didn’t get the order of the colors right and had to do it</td>
</tr>
<tr>
<td></td>
<td>again. (5x)</td>
</tr>
<tr>
<td></td>
<td>• They were frustrated when they make a mistake in figuring out the</td>
</tr>
<tr>
<td></td>
<td>correct way in the maze and had to do it all over. (4x)</td>
</tr>
<tr>
<td></td>
<td>• In the third room, the player seemed frustrated with a wall</td>
</tr>
<tr>
<td></td>
<td>between the code machine and the pictures they needed to see to</td>
</tr>
<tr>
<td></td>
<td>get the code. The frustration was due to having to move back and</td>
</tr>
<tr>
<td></td>
<td>forth (3x)</td>
</tr>
<tr>
<td></td>
<td>• No, they did not look frustrated during the game. (2x)</td>
</tr>
<tr>
<td>Did they have any problems moving in the game?</td>
<td>• Yes, they had problem making small and accurate movements inside</td>
</tr>
<tr>
<td></td>
<td>the rooms, mainly due to the fast movements and the controllers.</td>
</tr>
<tr>
<td></td>
<td>(9x)</td>
</tr>
<tr>
<td></td>
<td>• Yes, they had problem moving in the maze due to the controllers.</td>
</tr>
<tr>
<td></td>
<td>(8x)</td>
</tr>
<tr>
<td></td>
<td>• No, they didn’t have problem moving in the game. (2x)</td>
</tr>
<tr>
<td>Was it easy for participants to navigate the maze?</td>
<td>• Yes, no visible difficulty was observed. It seemed that the players</td>
</tr>
<tr>
<td></td>
<td>navigated the maze with no problems. (9x)</td>
</tr>
<tr>
<td></td>
<td>• They had some difficulty identifying the correct room to go to on</td>
</tr>
<tr>
<td></td>
<td>the maze. (3x)</td>
</tr>
<tr>
<td>Was there a moment when participants didn’t know what to do?</td>
<td>• In the first room, when they solved the puzzles, they couldn’t</td>
</tr>
<tr>
<td></td>
<td>find the light switch that would show them the code. (5x)</td>
</tr>
<tr>
<td></td>
<td>• In the second room, Tea Party, they didn’t know the purpose of</td>
</tr>
<tr>
<td></td>
<td>the puzzle; i.e., tapping on the pots in the correct order. (7x)</td>
</tr>
<tr>
<td></td>
<td>• In the second room, they didn’t know they could move the clock</td>
</tr>
<tr>
<td></td>
<td>hands. (6x)</td>
</tr>
<tr>
<td></td>
<td>• In the third room, they didn’t know how to relate the pictures to</td>
</tr>
<tr>
<td></td>
<td>the card suits so they could do the ordering on the code machine.</td>
</tr>
<tr>
<td></td>
<td>(8x)</td>
</tr>
<tr>
<td>Other comments by the observer?</td>
<td>• The player looked a little disappointed when they finished the</td>
</tr>
<tr>
<td></td>
<td>game. It seems that they expected more action or rewards by</td>
</tr>
<tr>
<td></td>
<td>winning. (5x)</td>
</tr>
<tr>
<td></td>
<td>• In the third room, sometimes the second player looked</td>
</tr>
<tr>
<td></td>
<td>disengaged because there weren’t enough tasks for them to do.</td>
</tr>
<tr>
<td></td>
<td>(3x)</td>
</tr>
</tbody>
</table>

Note: The digit and the “x” after each item in the second column represent the number of times the item was observed.
4.4. Confirmability

To further substantiate the trustworthiness of the data analysis done in this project, another research assistant who was present throughout the project was consulted for data analysis, learned about the methods and procedures, and read the interview transcripts and the coding documents. Her assessment was as follows:

The collected data are suitable to address the target research questions. The questions in the playability and usability surveys were selected from published and widely-used game design surveys and covered the core design elements (e.g., graphics, navigation and feedback). Interviews were conducted at each phase. The interview questions were clear and easy to understand, and were designed to trigger participants’ responses that could guide the next cycle of game design and development.

The researcher used different methods to code the qualitative data. For the open-ended questions in the usability surveys, the codes were categorized into themes related to game design such as interaction, navigation and challenge. The qualitative data of the focus groups were analyzed using the constant comparison analysis method. The themes generated from the codes were organized based on the interview questions, such as the most engaging elements of the game, what worked best for the players in the game, what worked least for the players in the game, and common challenges and difficulties. The themes were useful for game designers to develop in-depth understanding of various aspects of the nature of older adults' game play such as motivation, aesthetes, and the needs and challenges older adults would face during the game play.

A wide range of methods (e.g., paper sketches and prototypes) can be used to support the UCD process, but the principles, methods and the order of activities must be adapted to the particular context. In this project, the researcher used appropriate methods to collect data. The interview questions are understandable. The codes are organized into meaningful categories that help the researcher and game designers understand older adults' needs and get feedback for further improvement.
Chapter 5. Discussion and Conclusions

In this digital game creation project, we designed, developed, and evaluated an online escape game for older adults using a user-centred design (UCD) process. The game is based on the concept of real-life escape rooms. The project was guided by four questions about: (1) the needs of older adults in escape rooms, (2) the design requirements of an online escape game for older adults, (3) the usability of the online escape game’s prototype, and (4) the effectiveness of a UCD process to design an online escape game for older adults. The project followed a UCD process that started with a needs assessment in which older adults played real-life escape rooms. This phase gave us design ideas for the online escape room. In the next phase, a playable prototype of the game was developed with the participation of the target players. Finally, a usability test was carried out to investigate the extent to which the prototype game is usable, playable, and could achieve its goals. In this chapter, the results of the data analyses and the effectiveness of our design process are discussed. Moreover, design recommendations and the next steps are proposed. Finally, the conclusions, limitation, and future directions are presented.

5.1. Participants’ Demographics

The characteristics of the participants in this project were diverse. In terms of gender, although the number of men and women was roughly equal, there were slightly more women than men, which is not surprising, as women are more likely to volunteer and participate in such projects (Kaufman et al., 2016). As for their age, most participants were between 65 to 69 years old and all participants were mobile and cognitively normal. Very few of them had previous experience with escape rooms and most of them expected to have “fun” in escape rooms. In the last phase, we asked about the participants’ highest education level and most of the participants in that phase had completed either some higher education or had obtained a bachelor’s degree. Almost all participants who took part in the second and the third phases of the project had experience playing digital games with different frequencies of playing, but most of them played digital games a few times per week. However, most participants self-reported their computer skills as “beginner,” followed by “intermediate.” Almost all participants who played digital games often played them on a handheld device, such as tablets and
smartphones. This project seemed to have been an effective intervention to engage participants in learning computer skills, which, according to Delello and McWhorter (2017), are valuable for various areas of life, including health literacy and social connectedness. These findings are in line with Hagestad’s (2018) argument that, despite the typical portrayal of older adults, they are not a homogenous group and, thus, should not be perceived that way. This is salient because collaborative games should be accessible to, and playable by, a diverse range of older adults.

5.2. Older Adults’ Needs in Escape Games

As mentioned in previous chapters, most real-life escape rooms were not designed for older adults despite Nicholson’s (2015) suggestion that escape rooms should be accessible to all types of players. Due to age-related changes, games for older adults need further design considerations. The literature has provided game designers and researchers with a description of needs and design considerations for games targeted at older adult players. However, in an attempt to learn more about older adults’ needs in escape games, specifically, we, the researchers, observed their play in real-life escape rooms and interviewed them about their play experience.

Older adults who played real-life escape rooms in this project enjoyed playing them. They enjoyed finding clues and helping their team members. They also liked the fact that the puzzles followed the theme and logic of the room. The collaboration involved in completing the game tasks was a prominent part of older adults’ positive experience. They enjoyed the collaborative nature of the game (as opposed to competitive) and were satisfied that each member could have a role and contribute to completing the game tasks. They were able to form pairs and work on different parts of the puzzles. These findings are quite similar to the findings of Pan and Neustaedter (2017), as escape rooms seemed to have offered the older adults opportunities to practice collaborative problem solving and engaging in different types of group work.

Moreover, it seems that older adults' experience in escape rooms includes some aspects of problem-based learning, as described by Van Eck (2007). Completing the game tasks in a linear succession of the clues and puzzles by the players through interactions with other players, the game artifacts, the feedback from the game, and the game’s narrative provide opportunities for scaffolding. The experience of the participants
in the escape rooms also resembled aspects of experiential learning, as described by Rooney (2012), since participants were immersed in a reality that is difficult, if not impossible, in real life and they were continually going through trial and error and reflection processes in solving the puzzles.

However, the older adult players faced several challenges in the escape rooms, as well. The majority of these challenges were the direct result of the design elements of the rooms, while others rooted in the players’ inexperience or ineffective interactions. It could be argued that the design-related challenges were, in part, rooted in the age-related changes, i.e., perceptual, motor, cognitive, psychological, and social. One of the significant challenges were playing in the dim light of the escape rooms. Performing visual tasks is a key part of finding clues and solving puzzles in escape rooms. One of the escape rooms that the participants played was a haunted house with a very dim light. Visual tasks are difficult to understand and perform in dim lights (Schieber, 2006). This is mainly a challenge for older adults who have impaired vision. Also, sensitivity to colour and dynamic visual acuity is diminished in old age (Charness & Jastrzembski 2009). Not surprisingly, one of the major complaints that we received regarded the insufficient light in the rooms. The other perceptual challenge was difficulty reading small texts in the rooms that were important in solving puzzles. The older adults had also difficulty communicating with the staff over a walkie-talkie and demanded more accessible communication with the staff, which could be due to a diminished sense of hearing.

Moreover, limitations in motor movements could have made older adults slower than younger players, and, hence, they could not finish the game within the regular time limit. Our data confirmed this. In our observation, in many cases, it took the players a long time to move books from one shelf to the other or to look up a code in an artifact. Moreover, some of the players said that they needed to sit down several times during the game. Others reported that, sometimes, they figured out the solution but had difficulty performing the physical implementation of the solution.

Cognitive changes may explain some of the other challenges faced by the older players of escape rooms. Glisky (2007) stated that attention span and working memory are the most prominent cognitive abilities that decline with age. This decline affects problem-solving and decision-making. Fisk et al. (2009) also believe that spatial
cognition, which is the ability to manipulate patterns and images, diminishes with age. Since the escape room puzzles that the older adults tried to solve involved complex problem-solving, observational skills, and memorizing patterns, numbers, and other codes, it might be safe to assume that their failure in solving some puzzles, as well as their demotivation and frustration, was due to the cognitive overload. As reported in the interviews, some players complained about “too many numerical clues” and having to remember codes for “too long.” Finally, psychological and social changes, including diminished self-esteem, loss of social importance, lower sense of independence, and difficulty in maintaining meaningful interpersonal relationships (Sneed & Whitbourne, 2005), could have affected the way older adults evaluated their ability to succeed in escape rooms. Our observations suggest that, in many cases, some players preferred to be bystanders. Also, it seemed that they would become avoidant after making mistakes.

The older adult players who played real-life escape rooms in our project voiced several preferences during the focus group interviews. First of all, they asked for more diverse puzzles. Most of the puzzles in the two escape rooms they played were either numerical or word puzzles. Besides, the puzzle presentation was linear, so it was not possible to solve multiple puzzles at once to solve the ultimate puzzle that would open the door. As a result, some players reported frustration and even boredom. Others believed that the lack of diversity had made the puzzles predictable. It seems that a path-based model of puzzle presentation (Nicholson, 2015) would better suit the older adult player, as they tend to form pairs and, in this way, each pair could work on a different puzzle.

Furthermore, puzzles that draw on visual clues in conjunction with words or numbers might be easier for older adults to understand, remember, and solve. Another preference was a longer time limit or even elimination of the time limit. Due to the age-related changes discussed above, it typically takes more time for older adults to complete the game tasks in escape rooms. Therefore, longer time limits would reduce their stress and could motivate them to success. Finally, older adult players preferred guided teamwork in which there is a leader in the team and everyone has an assigned task. This is in line with Weimker et al. (2015), who suggested that a player should take the role of the leader. The leader should be good at compartmentalization and guiding the other members of the team to work on different things in the room (Weimker et al., 2015). The older adults also engaged in one-on-one interactions most of the time. This
observation gives strengths to the suggestion that the puzzles be presented in the pathway model. Table 10 below summarizes older adults’ needs in escape rooms design based on their age-related changes. Of course there are other differences, such as interest, hobbies, and previous life experiences, but these were beyond the scope of this project.

Table 10  Older adults’ needs in escape rooms and their implications for design

<table>
<thead>
<tr>
<th>Type of Need</th>
<th>Implication for Escape Room Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceptual</td>
<td>• Bright Rooms with less clutter</td>
</tr>
<tr>
<td></td>
<td>• Large fonts for any texts that are important to solving the puzzles</td>
</tr>
<tr>
<td></td>
<td>• Loud and high-quality speakers for communicating with the staff</td>
</tr>
<tr>
<td></td>
<td>• Using different colors in the room with higher contrast</td>
</tr>
<tr>
<td></td>
<td>• Playable artifacts are distinguished from the décor.</td>
</tr>
<tr>
<td>Motor/Coordination</td>
<td>• Puzzles that require less strenuous physical movements</td>
</tr>
<tr>
<td></td>
<td>• Putting chairs in the rooms for players to rest whenever they want</td>
</tr>
<tr>
<td></td>
<td>• Artifacts that should be lifted or moved are not too heavy</td>
</tr>
<tr>
<td></td>
<td>• Clear walking paths in the room with few small artifacts in the way</td>
</tr>
<tr>
<td></td>
<td>• Game tasks that requires a single controller action, rather than requiring multiple, sequential actions.</td>
</tr>
<tr>
<td>Cognitive</td>
<td>• Themes that are known and relevant to older adults</td>
</tr>
<tr>
<td></td>
<td>• Puzzles that are familiar to older adults</td>
</tr>
<tr>
<td></td>
<td>• Puzzles that do not require a lot of memorization</td>
</tr>
<tr>
<td></td>
<td>• Puzzles that do not include many numerical clues</td>
</tr>
<tr>
<td></td>
<td>• Puzzles that include visual clues</td>
</tr>
<tr>
<td></td>
<td>• Puzzles that do not require attention on multiple things at a time</td>
</tr>
<tr>
<td></td>
<td>• Puzzles that follow logic and commonsense</td>
</tr>
<tr>
<td>Psychological &amp; Social</td>
<td>• Diverse puzzles that include various types of clues</td>
</tr>
<tr>
<td></td>
<td>• Asking the team to pick a “leader”</td>
</tr>
<tr>
<td></td>
<td>• Assigning roles to the players</td>
</tr>
<tr>
<td></td>
<td>• Facilitating one-on-one interaction by presenting the clues in pathway and sequential models</td>
</tr>
<tr>
<td></td>
<td>• Extending the time limit</td>
</tr>
<tr>
<td></td>
<td>• Designing game tasks that are conductive to different levels of ability and skills</td>
</tr>
</tbody>
</table>

5.3. The Design and Development Processes

The results of the needs assessment gave the research and the design team a basis for the digital game concept and several design ideas. The design phase started with setting goals and objectives for the game and delineating the affordances of the game, which were presented in Table 3 and 4 in Chapter 4. The initial goals of the game were engaging older adults to use technology; providing a fun, social, interactive
experience; creating reusable assets for future game development; and providing an educational experience in the literary setting of the game. Moreover, affordances include social engagement, cognitive challenge, emotional benefits, and self-efficacy.

To design the game, we adopted a UCD process – based on Vanden Abeele et al.’s (2012) P-III model, which the authors used for creating serious games. The outcome of the second phase was a list of design recommendations that we discussed in Chapter 4. The recommendations were general and in line with the results of our needs assessment. Next, design documentation was written based on the data collected from older adults and Vasconcelos et al.’s (2012) design rules. Table 11 shows the design needs and their corresponding implementation in the proposed escape game concept.

Table 11  Design requirements and their implementation in the proposed escape game concept

<table>
<thead>
<tr>
<th>Design Need</th>
<th>Implementation in the escape game concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Familiar puzzles</td>
<td>Crossword puzzle, color ordering puzzle, completing a poem, using numerical, letter and visual codes.</td>
</tr>
<tr>
<td>Being active throughout the game</td>
<td>Envisioning a two-player, two-screen game for one-o-one interaction. Creating puzzles that require collaboration and cooperation to be completed.</td>
</tr>
<tr>
<td>Knowing one’s role</td>
<td>The players choose the role of either the navigator or the player who moves in the rooms.</td>
</tr>
<tr>
<td>Knowing one’s tasks</td>
<td>The puzzles are made in a way that each player’s task is clear.</td>
</tr>
<tr>
<td>Constant reward</td>
<td>Players accumulate points after finishing each room. There are characters who praise the players after each success.</td>
</tr>
<tr>
<td>Unlimited play time</td>
<td>There is no time limit in the game.</td>
</tr>
<tr>
<td>Literary themes</td>
<td>The theme of Alice in Wonderland was chosen for the game.</td>
</tr>
<tr>
<td>Puzzles that are not too dependent on the theme</td>
<td>The puzzles use elements of Alice in Wonderland’s story. However, solving the puzzles do not require detailed knowledge of Alice in Wonderlands.</td>
</tr>
<tr>
<td>Communication via voice chat</td>
<td>Skype voice chat was used to connect the players.</td>
</tr>
<tr>
<td>Using direct input devices</td>
<td>Designing for tablets and smartphones with touchscreens</td>
</tr>
<tr>
<td>Senior-adapted interface</td>
<td>The color contrasts will be high and the fonts large.</td>
</tr>
<tr>
<td>Instant feedback</td>
<td>The player can clearly see the feedback of their actions in the game.</td>
</tr>
</tbody>
</table>

The puzzles and the visual arts of the game were designed and created over several weeks and refined through collaborations between the design team and the research team. The first playable prototype of the game was created using the Unity game engine. The game consists of a maze with three different escape rooms.
in different places inside the maze. The players work together to find the rooms, enter it, and complete the game tasks to find the code that unlocks the room. All three rooms share a code machine; however, the code is a word in the first room (crossword puzzle), a series of numbers in the second room (tea party), and symbols in the third room (Cheshire cat). Following Gerling et al.’s (2012) suggestion, the puzzles follow an ascending order of difficulty. Moreover, to promote verbal communication and joint discovery, we decided to put minimal guidance in the first prototype.

5.3.1. Playtesting the First Prototype

The game was tested for playability with 12 older adults who played the game in six pairs on PC laptops. Almost all participants had experience playing digital games and half of them had played real-life escape rooms earlier in our project. The other half did not have any experience with escape games. The results of the playtesting suggested that the players enjoyed their overall experience of playing the game. In terms of gameplay, the performance of the game was satisfactory, but some areas needed improvement. The goal of the game was clear to the players, the theme was interesting, the game challenges were a positive experience, and the purpose of each puzzle was clear to most players. These are important findings because, due to the difficulty of decision-making for older adults, games that are intended for older players should have very clear goals and understandable purpose (Trefry, 2010).

Moreover, goals provide motivation and, ultimately, a sense of accomplishment that may increase the value of the game for the older adult player (Vasconcelos et al., 2012). However, the majority of the players encountered difficulty navigating the game and understanding the next action during the game. It seems that difficulty with navigating the game was due to the inefficiency of the laptop controllers for older adults. This would confirm Rogers, Fisk, Mclaughlin, and Pak’s (2005) theory of direct input versus indirect input devices that maintains that direct input devices, such as tablets, are more appropriate for older adults due to their motor skills limitations. The interview responses suggest that the difficulty understanding the next action is, to a large extent, related to the second puzzles. It seems that the players needed more guidance as to how the puzzle is solved on the mechanical level but understood the purpose of the puzzle.
In the *game story* feature of playability, the game was very effective. The players were interested in the storyline and were comfortable with the level of the theme’s involvement in the puzzles. They also understood the storyline without difficulty. However, the *mechanics* of the game had some issues. Most players found the Skype voice chat inefficient for communicating with their partners. They also had difficulty with the controllers of the laptop. Finally, the speed of the game was too fast for most players. Overall, most players found the game fun to play and they would play the game again. These findings are in line with Trefry’s (2010) characteristics of games that are suitable for older adults – what he calls “casual games.” These characteristics are: (1) clear rules and goals; (2) adaptability to the player’s life and schedule; (3) Players being able to reach proficiency quickly; and (4) game concepts borrowing familiar content and themes from life (Trefry, 2010).

The data from the focus group interviews complemented the playability survey by shedding light on more specific aspects of the game’s playability. According to the results, the most engaging elements of the game were playing in the maze and solving the crossword puzzle. It seems that the reasons are, first, familiarity and clarity of the tasks and, second, gaining a sense of control over these elements quickly (Vasconcelos et al., 2012). Furthermore, the most enjoyable element of the game for the players was collaboration with their partner and solving puzzles together, which suggests that more than succeeding in games, older adults enjoy social interaction. The players also enjoyed the graphics and the visuals of the game.

The interview responses also indicated that solving the second puzzle was a difficulty highlighted by many players. It is also the puzzle that the players were still trying to solve when the game session’s time was up. One possible reason is that this puzzle required quick, sequential use of multiple controllers and most players were not comfortable with the controllers. Another reason could be the fact that the second puzzle consists of two puzzles, and this could have made it too complicated for older adults. Finally, it could have been a lack of sufficient guidance available to the players.

5.3.2. Usability of the Second Prototype

Based on the results of the playtesting, the second iteration of the game went through a series of modifications. The main refinements included lowering the speed of
movements, replacing Skype with a built-in voice chat feature, adding a scoring system that rewards the players frequently, creating a fully functional tablet version of the game with virtual joysticks as controllers, making some visuals simpler and less distracting.

Following the recommendations in the literature (e.g., Wood, Willoughby, Rushing, Bechtel, & Gilbert, 2005; Vasconcelos et al., 2012), we decided to use direct input devices for the usability testing of the second prototype. Direct input devices, such as tablets allow older adults with mobility issues to place the tablet in a position that is comfortable for them. Furthermore, due to the touch and gesture-based method of interaction, they require reduced coordination and cognitive demands (Wood et al., 2005). Also, the background survey revealed that most older adults who played digital games played it on a direct input device.

The results of the usability testing suggested that the players were satisfied with the overall interface design of the second prototype, found the game feedback useful, and enjoyed playing the game in general. They also reported that the game kept them motivated to keep playing and that they would play the game again. An interesting finding in the usability testing was that, although most players indicated that they followed the instructions and they found the game tasks not too complicated, 75% of them reported that they did not understand the rules of the game. This contradicts the finding in the play testing in which most players understood the rules of the game, in spite of the fact that there were fewer tips and less guidance. The follow-up interviews shed some light on this finding. It turned out that players believed they spent too much time figuring out the game tasks in the rooms. Our observation confirmed this, as players seemed to have been “stuck” several times in the second room or not knowing how to operate the code machine in the first room. Therefore, it seems that the players needed even more guidance in the game. This need was voiced in the interviews where players asked for more hints to save time and be able to proceed in the game. The decision to put more hints in the game is a difficult one. On the one hand, discovery and trying out different possibilities is a core element of escape room gameplay that fosters collaboration and social interaction between the players. On the other hand, the game sessions in the usability testing were timed and we do not know whether players would complain about the time-consuming process of figuring out the game tasks in a real-life game-playing situation. The interview responses also revealed that the objectives of some game tasks were not clear to the players. This is mostly relevant to the clue finding
activities in the game and confirms Gamberini et al.’s (2008) 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, this would be different.

Half of the players found it difficult to navigate in the game, mostly due to the controllers, the pace of the game, and inefficient communication with the game partner. The controllers were two virtual joysticks, one for direction and the other for movement. The players needed to use both concurrently most of the time to proceed in the game. However, performing this act turned out to be the most significant source of frustration for players. This finding is in line with that of Aison, Davis, Milner, and Targum (2002), 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.

The results of the usability testing once again indicated that the players enjoyed the collaborative nature of the game more than succeeding in it. This finding confirms Altmeyer and Lessel (2017) statement that socializing is a core motivator for older adults. It seems that older adults play 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 (Altmeyer & Lessel, 2017). 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 condition to be motivated to do so. Most respondents stated that they would play the game again if it offers new challenges and different game tasks from what they played. They also believed that with a feature that allows them to save their game – so that they could come back to it later and start from where they stopped playing – they would be motivated to play the game over multiple sessions. This is in line with Trefry’s (2010) argument that older adults prefer games that adapt to their life and could be played at different times and situations.
Several definitions of usability were provided in the second chapter. In the context of game design, usability methods could be used when the goal is to improve the player’s satisfaction and reduce their task-based failure and error frequency (Charles et al., 2005). Based on these definitions, the usability testing in this project provided sufficient data to conclude that the game is usable in terms of interface design, the puzzles in room one and room three, 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.

Following the goals set for it, the game seemed to have provided an interactive social experience for the players. However, we did not measure the extent to which the game empowered older adults by engaging them in using digital technology. As for the other goal – creating usable assets for future game developments – the game was created in a way to be used for future game developers, as the structure of the game and the puzzles can be kept in different themes.

5.4. A Third Prototype and Future Iterations

Based on the results of the usability testing, a third iteration of the game was created. In this prototype of the game, several refinements were made to clarify the objectives of the game tasks further and to enhance the sense of control for the player. First of all, more interactive hints and guides were added to the rooms to help the player figure out “the next action” after completing each game task. For example, it was observed that several players did not know the room is open after putting the final code of a room in the code machine. Therefore, in this prototype, a text appears above the code machine that reads, “the door is open!” when the players get the code right.

Moreover, the speed of the movements in the game was reduced to better match the pace of older adult players. In the third room, a wall was removed to reduce the frequency of going back and forth behind the wall to see pictures that are relevant to solving the puzzle. Finally, the two virtual joystick controllers in the tablet version of the game were replaced by a single virtual joystick that moves to all directions. This decision was made based on two criteria: (1) the older adults’ suggestion and (2) Pham and Theng’s (2012) recommendation. The authors found that game completion by older
adults was faster when they used a mixed-input game platform that required a single button and single gesture, rather than multiple buttons and sequences of gestures (Pham & Theng, 2012).

The third prototype of the game still needs to be tested for usability and playability with a larger audience to ensure that it addresses the needs of older adult players and provides an engaging, collaborative, and fun experience for them. It should be noted that, due to several limitations, the usability testing that was performed in this project did not test the game in real-world contexts of game playing for older adults. Therefore, it is necessary to carry out field testing of the game in addition to usability testing (Rubin & Chisnell, 2008).

5.5. Reflection on the Effectiveness of the Adopted UCD Process

This project designed and evaluated an online escape game using a UCD process to involve the target user in the design and evaluation of the game. In this section, I reflected on the effectiveness of the adopted UCD process itself.

The definitions and the main principles of were discussed earlier in this thesis. One of the established UCD frameworks for game development is the P-III framework, proposed by Vanden Abeele et al. (2012). P-III was developed as a method for designing serious games and, according to Vanden Abeele et al. (2012), is a bottom-up framework that is shaped, tested, and refined in several projects. The involvement of the players in P-III could range from minimal participation in the early stages of the design to full involvement of the user in participatory design. Our adopted UCD process was based on the P-III framework. It followed the same three phases; however, the stages that we followed in each phase underwent some changes, so that they meet our needs and constraints. Our UCD process was also guided by the principles proposed by Gulliksen and Göransson (2001) that was mentioned in Chapter 2.

My reflection on the effectiveness of our adopted UCD process to create an online escape game for older adults started with the usefulness of the way the older adults were involved in the design of the game. Following DeSmet et al. (2016) conclusion that the involvement of players as informants, rather than co-designers,
would lead to more successful games, we decided to involve older adults in all three phases of the development as the end-users who provide feedback and inform the next iterations of the game.

In the first phase, observing older adults’ play in real-life escape rooms and learning about their experience provided us with a valuable set of needs and design recommendations that formed the basis of our game concept. The focus group interviews gave us rich data about the positive highlights of the players’ experience, as well as the challenges and instances of frustration. However, about one-third of the older adults in the focus groups did not provide much feedback. Some of them tended to digress from the questions or repeat the same feedback over and over. As for the observation, our video footage of the escape rooms did not come with audio. Therefore, we may have missed a great source of data that could have shed light on the verbal interactions of the older adults in the escape rooms. Nevertheless, the footage offered useful data on how older adults approached the different aspects of the room and also the way they interacted to complete the game tasks.

In the second phase, game design, the focus group that we held with older adults to discuss game ideas, the proposed puzzles, and the themes were also fruitful, although not as fruitful as the user participation in the first phase. It seems that most of the older adults in the focus group did not have confidence as to what they want. This could be explained by the fact that things were too abstract at that stage and it could have been difficult for older adults to gave more detailed feedback on something for which they do not have a clear mental model. Nevertheless, the most valuable older adult feedback at this stage regarded their preferred puzzle types and the themes. However, in line with the findings of DeSmet et al. (2016), older adults’ feedback on the aesthetics was not very helpful, as they gave mixed opinions and discussed ideas, implementation of which would have been beyond the capabilities of the design team. Therefore, it seems that it would be more useful to use “expert” end-users who are experienced with the type of game in question together with randomly-selected end users.

The participation of older adults in the playtesting and the usability testing in the third phase was perhaps the most crucial end-user involvement in this project. The feedback they provided in the playtesting of the first prototype had significant
implications for the second prototype. It would have been even more effective if we could do the testing in older adults’ natural playing environments. Two of the most important issues with our tests were, first, the timed game sessions, and, second, the presence of research assistants who provided help whenever the older adults needed it. Another limitation was frequent technical glitches that would interrupt the older adults’ game.

5.6. Ideas for the Next Steps

As discussed earlier in this chapter, a third prototype was created by refining the second prototype of the game based on the players’ feedback. This prototype is the final version of the game in this project. However, it is not the final version of the game to be published for widespread use. Several steps need to be taken to ensure that the final version of the game is fully playable, effective, and suitable for its target audience. Some of these steps will be discussed in this section. It is to be noted that these are the immediate next steps before the game could be published to a wider audience.

First of all, the third prototype of the game still needs to be tested for usability and playability with a larger number of older adults to ensure that it addresses the needs of older adult players and provides an engaging, collaborative, and fun experience for them. Second, the refined prototype should be field-tested, i.e., in the environment in which it will be used. Due to several limitations, the usability testing that was performed in this project did not test the game in real-world contexts of game playing for older adults. Therefore, it is necessary to carry out field testing of the game in addition to usability testing (Rubin & Chisnell, 2008). Third, the game should be playable and stable on all platforms, including indirect-input devices such as laptops and desktop computers. Therefore, it should be tested and improved on those devices, as well. Fourth, more interactive, real-time hints and guidance should be provided as the player proceed in the game to make sure the older adult players are aware of the next action at all times. Fifth, our final prototype does not include sound effects. However, sound effects are a main interface of digital games and a fundamental element of the game structure. Therefore, various sound effects should be added to the game and tested with older adults to find out about their preferences and the extent to which it helps with the effectiveness of the game in providing an enjoyable and engaging experience for older adults. Sixth, more themes with more diverse puzzles should be created and offered to older adult players so that they could choose and be motivated to play the game more than once. Moreover,
the game should become customizable in terms of difficulty and speed to match the
skills and the pace of players. Finally, the game should be tested with intergenerational
pairs of players. Many older adults enjoy playing digital games with younger generations,
such as their children and grandchildren. Therefore, the game should be engaging and
enjoyable to a certain extent for younger players as well.

5.7. Conclusions

This thesis reports on an online escape game development project that used a
UCD process to involve the end-users (older adults) in the design process. Seniors have
several needs that should be met in order to provide an enjoyable game experience for
them. This project showed that it is crucial to assess older adults’ needs and convert
needs into design requirements for digital games. Some of these needs are the results
of age-related changes, while others are interests and preferences of older adults.
Moreover, this project found that older adults enjoy playing escape games, both real-life
escape rooms and our online escape game. Our findings confirm Ijsselsteijn et al.’s
(2007) and Salmon, Dolan, Drake, Wilson, Klein, & Eskes’s (2017) suggestion that older
adults highly value social interaction in game-playing and prefer games that involves
interaction and collaboration with other players. The older adults in our project
highlighted their collaboration with their partners as one of the best part of their
experience.

The involvement of older adults during the early stages of the game design was
fruitful. The older adults provided us with valuable information regarding their puzzle
preference, the themes they want to see in an escape game, and the level of the
puzzles’ dependence on the theme. However, they were not as helpful in giving us
useful ideas for art design and gameplay mechanics, possibly due to their lack of
knowledge about these areas of the design. Moreover, the usability testing of the
prototypes showed that the game is playable and enjoyable for older adults. It revealed
that older adults in this project prefer familiar puzzles and would like to know the actions
they have to do in their roles in the game. They prefer games that are customizable to
match their pace and would like to be rewarded frequently for their successes during the
game. Older adults prefer games that are playable in different sessions based on their
life schedule. They also respond better to direct input devices and need controllers that
require simple actions. The usability testing also showed the flaws of the game and led
us to make several refinements. However, there are still several areas in the game that require improvement for the game to be ready for publication to a broader audience.

Moreover, proper field testing needs to be performed to ensure that the game is usable in older adults’ natural playing environment. Overall, we found the UCD process employed in this project effective. However, it could be improved by taking a few measures. For example, it seems that a combination of “expert” end-users and randomly-selected end-users should be recruited in an attempt to receive more productive and useful feedback. Furthermore, in the early idea generation stages, older adults should be provided with clear and specific information so ensure they understand the game concepts and be able to provide relevant and useful feedback.

In the end, the main contribution of this project is to the literature on digital games for older adults. More specifically, it contributes to the design of virtual escape games intended for promoting social connectedness and technology use among older adults, on which the body of research is still quite scant. Further, this project could contribute to any future endeavors by serious game developers who are interested to create online escape games for older adults. This game could provide a structure for their design and they would be able to embed their puzzles, themes and other game content on it. Finally, this project makes contribution to player-centred serious game design literature by employing one of the well-known models and exploring its effectiveness.

5.8. Limitations

There were several limitations to this project. In this section, first, the limitations of the overall project will be discussed and then the limitations of each phase will be presented.

First of all, the primary sources of data were surveys and interviews that collected self-reports. There were observations, but the protocol only focused on a few aspects of the players’ game playing. Second, the players in this project played the game for a short time and, as a result of their limited exposure to the game, they could not provide us with profound data about their experience. Third, the number of older adults who participated in this project was limited and we could not generate any
empirical findings. Fourth, the interview and the survey data were anonymous. This could have encouraged participants’ honest responses, but it made it impossible to connect the demographic information to the responses. Fifth, although we had intended to create usable assets for future game developers (and our final prototype could be used to build new themes and puzzle content), the game cannot be described as a template for novice game designers to implement their game ideas. Sixth, we experienced several instances of technical glitches that disrupted the flow of play for the participants. Sometimes this was frustrating to them and it is safe to assume that it affected their overall experience. Last but not least, we did not measure the extent to which the game achieved all the goals set for it. For example, we still do not know if the game empowered the players to use digital technologies.

In the first phase of the project, we assigned older adults to only two escape rooms, where the puzzles were predominantly word- or number-based with similar puzzle presentation. Furthermore, our observations of their play were based on the escape room facility’s camera footage that only gave us a long shot video of the room and left out the sound – an important source of data that could have shed light on the verbal interactions of the players in escape rooms. Also, the needs assessment did not assign players to a digital game with a similar concept to escape rooms, in addition to the real-life escape rooms. As a result, several design recommendations given by the players did not apply to our digital game.

In the second phase, a larger and more diverse focus group of older adults should have been held to collect richer data on all aspects of the design, including the aesthetics and specific game tasks. Moreover, we only included older adults early in the second phase for idea generation for the game. It would have been better if we could have another focus group in this phase at the end of paper prototyping to refine the prototype before starting the development of the game.

In the third phase, our playtesting of the first prototype mainly focused on the game play aspects of the playability and we did not collect enough data on other aspects of the game, such as mechanics and several aspects of the game interface. In the usability testing of the second prototype, we only tested the game on 12 players. Although this number is close to an optimal number of players for what Faulkner (2003) called “problem discovery,” it is not sufficient for an empirical usability testing. Moreover,
our game sessions during the usability testing were only one hour, even though the
game did not have any time limit and the players should have had the opportunity to play
it as long as they want. Related to this limitation is that the usability testing taking place
in an environment that was probably different from the players’ natural, or preferred,
environment for playing the game.

5.9. Future Directions

Beyond the ideas for the next steps of this project, which were discussed above,
several possible future directions could be undertaken. The game could be used over an
extended time in the real game playing contexts of older adults to measure its potential
cognitive, emotional, and social benefits. More specifically, due to human interaction and
the amount of collaboration in the game, future research could focus on the impact of the
game on online collaboration skills and the social connectedness of older adults.
Similarly, the game’s potential to empower older adults in using new technology through
a fun activity could be investigated with this game.

Moreover, collaborative online games offer great opportunities for learning and
escape games have been used for learning in educational settings (e.g., Borrego,
Fernández, Blanes, & Robles, 2017; Clarke, Peel, Arnab, Morini, Keegan, & Wood,
2017; Hou & Chou, 2012). This online escape game could be modified to include more
learning content and investigated with older adults to learn about its lifelong learning and
other educational potentials for this age group. The other direction future research could
take would be performing intergenerational tests on the game and explore the potential
of the game for the facilitation of intergenerational interaction and enhancing the
attitudes of different generations towards each other.
References


Chopik, W. J. (2016). The benefits of social technology use among older adults are mediated by reduced loneliness. Cyberpsychology, Behavior and Social Networking, 19(9), 551-556.


Appendix A. Background Survey Administered in Phase One, Game Concept

BACKGROUND QUESTIONNAIRE FOR OLDER ADULTS GROUP

1. Gender
   □ Male □ Female
2. How old are you?
   □ 60-64 □ 65-69 □ 70-74 □ 75-79 □ 80-89 □ 90+
3. Have you ever been to an escape room before?
   □ Yes □ No
   If yes, how often ____________________________
4. What are you expecting from this experience?
Appendix B. Background Survey for Play Testing of the First Prototype

Project Title: Usability Testing for Educational Games: Ensuring Proper Usability and Playability for Older Adults

BACKGROUND SURVEY

1. Gender
   Male    Female    Transgender

2. How old are you?
   65-69   70-74     75-79     80-84     85-89     90+

3. Have you played digital games?
   Yes (GO TO QUESTION 7)
   No (GO TO QUESTION 8)

4. How often do you play digital games?
   Once a month
   Once a week
   A few times a week
   Once a day
   Other ________________________________
Appendix C. Background Survey for the Usability Testing of the Second Prototype

Project Title: Usability Testing for Educational Games: Ensuring Proper Usability and Playability for Older Adults

BACKGROUND SURVEY

1. Gender
   Male    Female    Transgender
2. How old are you?
   65-69  70-74  75-79  80-84  85-89  90+
3. Your current relationship status:
   Married / Common law    Single / Widowed
4. What is the highest level of education you have completed?
   Less than high school
   High school or equivalent (such as GED)
   Some college/CEGEP/2-year degree (associate, diploma)
   University degree (e.g., 4-year Bachelor, Master, PhD)
5. What is your employment situation?
   a. Unemployed
   b. Retired
   c. Part-time employment
   d. Full-time employment
6. Your skill level in computer technology/internet?
   a. Beginner
   b. Intermediate
   c. Advanced
7. Have you played digital games?
   Yes (GO TO QUESTION 8)
   No (GO TO QUESTION 9)
8. How often do you play digital games?
   - Once a month
   - Once a week
   - A few times a week
   - Once a day
   - Other ____________________________

9. What type of media do you use to play digital games?
   a. Desktop/laptop computers
   b. Game consoles (including portable gaming devices)
   c. Tablet and/or phone
Appendix D.  The Playability Survey

TALE OF TALES: AN ESCAPE GAME

Play Testing of the First Prototype: Playability Survey

1. Did you find the Alice in Wonderland theme interesting to you? Yes ___ No ___
2. Was the goal of the game clear? Yes ___ No ___
3. Were there sufficient tutorials in the game? Yes ___ No ___
   Please, explain:

4. Did you feel rewarded for your progress during the game? Yes ___ No ___
   Please, explain:

5. Do you think the challenges in the game were a positive experience? Yes ___ No ___
   Please, explain:

6. Did you encounter any difficulties in navigating in the game? Yes ___ No ___
   Please, explain:

7. Did you encounter difficulties understanding what to do next? Yes ___ No ___
   Please, explain:
8. Did you have any difficulty understanding the puzzles? Yes____ No____
   Please, explain:

9. What do you feel about the duration of the game? Too short____ Just right____ Too long____
   Please, explain:

10. Did you understand the game storyline without difficulty? Yes____ No____
   Please, explain:

11. Were you interested in the storyline? Yes____ No____
   Please, explain:

12. Were you comfortable with the involvement of the storyline in the puzzles? Yes____ No____
   Please, explain:

13. Did you have any difficulty in communicating with your partner? Yes____ No____
   Please, explain:

14. Did you have any difficulty with the controllers? Yes____ No____
   Please, explain:
15. Did the game’s speed match your pace? Yes__ No__
   Please, explain:

16. Overall, was this game fun? Yes__ No__
   Please, explain:

17. Would you play this game again? Yes__ No__
Appendix E. The Usability Survey

## Project Title: Usability Testing for an Online Escape Game: Ensuring Proper Usability and Playability for Older Adults

1. Please rate the degree to which you agree with the following statements about the design of the game you just played.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Unsure</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I liked the way the game looked.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I did not understand the rules of the game.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The graphics were appropriate for the type of game.</td>
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</tr>
<tr>
<td>I didn’t like the animations of the game.</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>The art design was not appropriate for me.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>The game display was optimal with respect to the size of the screen.</td>
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<td></td>
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<tr>
<td>I couldn’t follow the instructions of the game.</td>
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<td></td>
</tr>
<tr>
<td>The help offered in the game was useful.</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
2. Please rate the degree to which you agree with the following statements about the control of the game you just played.

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Unsure</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The game was easy to play.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I did not have a strategy to win the game.</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>It was easy to navigate the interface of the game.</td>
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</tr>
<tr>
<td>The learning content is too difficult for me.</td>
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<tr>
<td>The feedback was useful to me.</td>
<td></td>
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<tr>
<td>The game required quick response, which was a challenge for me.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. Please rate the degree to which you agree with the following statements about the experience of playing the game.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Unsure</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I enjoyed playing the game.</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>I would like this game to be more competitive.</td>
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<td></td>
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<tr>
<td>The learning content was interesting to me.</td>
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<td></td>
<td></td>
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<tr>
<td>I got bored playing this game.</td>
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<tr>
<td>I would play this game again</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>I was frustrated while playing the game.</td>
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<tr>
<td>I learned something new while playing the game.</td>
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<tr>
<td>The game tasks were complicated for me.</td>
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<tr>
<td>The game motivated me to keep playing.</td>
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</tbody>
</table>

4. What did you like best about this game?

5. What did you like least about this game?
6. Was the game appropriate for people aged 65+? Why/why not?

7. Do you have any comments on the game?
Appendix F. Observation Protocol for the Usability Testing

Project Title: Usability Testing for an Online Escape Game: Ensuring Proper Usability and Playability for Older Adults

<table>
<thead>
<tr>
<th>Name of Observer</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questions</td>
<td>Description</td>
</tr>
<tr>
<td>Did participants encounter any problems when starting the game?</td>
<td></td>
</tr>
<tr>
<td>Was there anything that made participants feel frustrated?</td>
<td></td>
</tr>
<tr>
<td>Did they have any problems to move cards using the touch screen?</td>
<td></td>
</tr>
<tr>
<td>Was it easy for participants to navigate the maze?</td>
<td></td>
</tr>
<tr>
<td>Was there any problems with the learning content?</td>
<td></td>
</tr>
<tr>
<td>Was there a moment when participants didn't know what to do?</td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participants' comment (positive or negative) on the game</th>
</tr>
</thead>
</table>
Appendix G.  Interview Protocol Used in Phase One, Game Concept

FOCUS-GROUP INTERVIEW PROTOCOL

1. Describe your experience in the escape room.
2. How did you find the interaction with the other older adults?
3. Has winning/failing the first game affected how you played the second game? If yes, how? If no, why not?
4. What are your thoughts on the puzzles in the room?
5. What did you think of the assistance given by the staff?
6. What did you think of the design of the room? Was there anything you would change in the room to make it more fun/engaging?
7. What encouraged or prevented you from engaging in the game or interacting with other players?
8. Would you play an escape game again? Why/why not?
The Playability Interview Protocol for the Older Adults Testing the First Prototype of the Online Escape Game

- Which elements of the game did you find the most engaging?

- What did you enjoy most about the game? Why?
  - Which puzzle did you enjoy most? Why?

- Describe what worked well for you in the game?

- Was there anything in the game that was difficult for you?
Appendix I. Interview Protocol Used in the Usability Testing of the Second Prototype

Project Title: Usability Testing for Educational Games: Ensuring Proper Usability and Playability for Older Adults

INTERVIEW PROTOCOL FOR OLDER ADULTS

Respondent No:
Name of Interviewer ___________ Date and time: ___________

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 in the game?
5. Describe what didn’t work well for you in the game?
6. Which aspects of the games didn’t you like?
7. What could have been improved in the game?
8. Do you have any other comments?
Appendix J. An Excerpt from the Design Documentation of the Online Escape Game, *A Tale of Tales*
2. Game Overview

“A Tale of Tales” is a cooperative puzzle game developed between the Department of Education at SFU and Team Labyrinth of the Centre for Digital Media. Our mission is to create, design and develop an online escape room that fits the needs and engages older adults. Older Adults are rapidly adopting new technologies and also play puzzle and card video games—same to those played before the advent of digital. Research suggests there are cognitive and social benefits for the older adult in playing video games and engaging with new technologies.

The objective is to engage older adults through elements of real life and online escape room games and puzzles, interactive storytelling, and virtual reality. The chosen subject theme for the first chapter of the game borrows elements from the story of Alice in Wonderland and Through the Looking-Glass by Lewis Carroll. A unique storyline involving the story thief—the Ink Monster—will lead the players to explore other works of literature through virtual worlds, puzzles and interactions with characters from other notable works of literature as Sherlock Holmes, Journey to the Moon, and many more.

2.1 Agile Statement

For older adults who want to be engaged, “A Tale of Tales” is a cooperative multi-platform game that immerses older adults in a virtual escape room experience unlike real world escape rooms and other video games, it is designed with their needs in mind, provides literary educational content, and gets players to interact socially in a virtual space.

2.2 Core Statement

“A Tale of Tales” is a cooperative puzzle game designed with the older adult in mind that provides a virtual social experience different from mainstream video games, by engaging them through literary themes and the use of new technologies.

2.3 Essence Statement

The sound of trouble awakes you at night. There is someone in the book study! As you open the door you see a monster made of ink, drinking the words out of the pages of your favourite stories. It sees you and jumps into a portal inside a book. It is your duty to recover the stories the Ink Monster has stolen, so you follow him right into Alice in Wonderland, Sherlock Holmes, and many other novels! First, dive into the wacky world of Alice in Wonderland where the Ink Monster has wreaked havoc on poor Humpty Dumpty. There will be many rooms and characters awaiting you; with riddles and puzzles to solve, you will need their help to make it through all the rooms, and recover all the stories from the Ink Monster.
2.4 Key features

- A multiplatform game over PC, iOS, and Gear VR.
- Communicate with your partner to pass every puzzle.
- Walk and explore fantastical works of literature in a 3D virtual world, or assist your partner through a 2D tablet experience.
- Tap to interact with objects or elements that glow.

2.5 Genre

"A Tale of Tales" is a cooperative puzzle game with elements of real time 3D adventures, casual and logic games. The game also draws heavily from fantasy literature.

The game is designed to be played between two players, one acting as an explorer and another acting as a guide. The user’s experience is different depending on what role they play. The explorer sees the world as a real time 3D experience, while the guide plays the game in a 2D environment reminiscent of casual and logic games.

2.6 Target Audience

The target audience of this game are older adults interested in technology, looking for social interaction and/or engagement in games. The game provides a great opportunity for the older adult to socially interact with other older adults, or intergenerationally with other demographics. Users that have been tested tend to be mostly female and highly educated older adults (although our sample was too small to be representative of the whole older adult population).

Based on initial assumptions we created the following Personas as guides of who the game may be targeted to:

<table>
<thead>
<tr>
<th>Profile—Henry</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>He can speak simple English and he would like to learn more.</td>
</tr>
<tr>
<td>68 yrs old</td>
<td>His physical condition doesn’t allow him to travel for too long.</td>
</tr>
<tr>
<td>Immigration (from China to Canada)</td>
<td>His wife passed away three years ago, he has lived alone since.</td>
</tr>
<tr>
<td>Used to be a university professor in China</td>
<td>He likes reading, although his eyesight is not very good.</td>
</tr>
<tr>
<td>Widower</td>
<td>He has a smart phone and a laptop because he is open and curious to new things.</td>
</tr>
<tr>
<td>Has a daughter and a son</td>
<td></td>
</tr>
<tr>
<td>Three grandkids</td>
<td></td>
</tr>
<tr>
<td>Goals/Pain Points</td>
<td>Needs</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>• Can’t engage much with friends far away</td>
<td>• Wants to socially engage with friends far away</td>
</tr>
<tr>
<td>• Gets bored at home often due to lack of company</td>
<td>• Get entertained at home</td>
</tr>
<tr>
<td>• Talking to friends online and browsing the internet all the time gets boring</td>
<td>• Engage in fun experiences online</td>
</tr>
<tr>
<td>• Can’t find a lot of new technology catered to her</td>
<td>• Have technology catered to her</td>
</tr>
<tr>
<td>• Doesn’t like traveling</td>
<td></td>
</tr>
</tbody>
</table>

2.7 Look and feel

Please, consult the Visual Design Document.

3. Gameplay and Mechanics

3.1 Gameplay

3.1.1 Game Progression

The game progresses with the two players communicating with each other and solving puzzles collaboratively. Each player has access to partial information and needs the other’s player information to solve each puzzle together. The current version is a vertical slice of a bigger game that would encompass more books. This slice is restricted to the book ‘Alice in Wonderland’ and is a complete experience in itself.

The game progresses through two primary routes:

Maze: Player 2 has a top-down view of the maze while Player 1 has a first-person view. Player 1 starts at the centre of the maze. There are three portals, only one of which would be active and accessible at a given time. Player 2 must guide Player 1 across to the activated portal. Once all the puzzles in a particular portal are solved, the players land back in the maze and the maze changes to activate and provide access to the next portal.

Portals: Portals are essentially rooms that the players transition to, where they have to puzzles. These puzzles are interconnected such that the solution of one may be the first step to the second. There are 3 portals in the current game, each of increasing difficulty.
The game progresses for the two players together by transitioning between the maze and subsequent portals.

3.1.2 Mission

The game is designed to be a virtual escape room which can only be escaped by players working collaboratively. The full game would have multiple books to choose from, each with different smaller escape rooms. The mission of the current vertical slice i.e. ‘Alice in Wonderland’ is to find the pieces of humpty dumpty and put him back together. Each portal (puzzle room) that you escape, you find a piece of humpty dumpty. After escaping all three, you find all the pieces of humpty dumpty and you can put him back together.

3.1.3. Flow

The overall game flow:

1. Cinematic
2. Study (Choose from books: Alice in Wonderland)
3. Maze (Hub)
The user flow for Portal 1:

**Player 1**

[Diagram of user flow with decision points and actions for Player 1.]
The user flow for Portal 2:

**Player 1**

1. Communicate
2. Portal 2
3. A 5-digit number lock puzzle (with arrow device) and follow each letter to 
   scroll and an arrow button appears in 
   front of P1; 
   Green/behind elements are hanging in an 
   order
4. P1 can walk around and 
   look at the objects.
5. Did P1 trigger in sequence?
6. Is the external 
   portal?
7. P1 needs the final 
   piece of Hanging 
   Element
8. P1 pauses changing to a dark view 
   with interlock hands.
9. Removing solution from both peace.
Portal 3

The user flow for Portal 3:

Player 1
Player 2

Penta 1

Player 2

Communicate

Player 1

A poem with 4 blank words appears on P2's screen. It is followed by a hint.

P2 enters letters in the blanks to create words. (P2 can fill in the blanks in any order.)

P2 can erase/change any word entered by clicking on that word or hitting backspace.

Is the answer correct?

No

The word outline will turn red with a visual effect and audio feedback and a card suit appears next to it.

Yes

The poem completes?

No

The four words with the different suits stay lit until P1 arranges the cards in the correct order.

Yes

P2 lands back at the center of the maze on P1's completion.
3.2 Mechanics

1) **Communication (P1 and P2):** The players must communicate with each other at all times to solve any puzzle. Either player cannot progress through the game alone. Player 1 has a 3D environment while Player 2 has a 2D screen.

2) **Walking (P1):** Player 1 is in a 3D space throughout where they can move around and explore.

3) **Interacting:** Both players can interact with elements in the game in different ways:
   a) **Player 1:** The player can move around and interact with elements that can be triggered by using mouse click or gaze and tap for PC and Gear VR respectively.
   b) **Player 2:** The player can interact with the screen using touch or mouse for the ipad and PC respectively. The player can also input characters using the keyboard (virtual or physical) and swipe and drag using the mouse or touch.

3.3 Cheats and Easter Eggs

Player 1 can walk through walls in the inner part of the maze. This allows the player to get through the maze faster to get to the portals.

3.4 Visual Feedback

The following page contains storyboards used to provide information about visual feedback to players.
Fig. 1. Visual feedback storyboards
4. Story, Setting and Character

4.1. Story and Narrative

A Tale of Tales will be a game based around worlds and characters found in popular, public domain literature from fantasy, detective, and science-fiction. As a team we found these stories to be universally appealing across multiple demographics.

Through the use of Alice in Wonderland, as well as Sherlock Holmes and others, A Tale of Tales seeks to engage and educate by connecting these beloved stories into an interactive narrative—bringing them to new light. We particularly focused on the narrative elements, plots, and characters around Alice in Wonderland and Through the Looking Glass because of the farcical and inventive storytelling of Lewis Carroll. His story truly allowed the team to think outside the box and inspired the creation of puzzles and rooms.

The idea of being able to weave different classical stories together, necessitated the creation of an overcharging story wherein the players are sent on a mission to recover the literal ink of the stories from the mischievous Ink Monster (a character of the team’s creation). The Ink Monster has drunk all the narratives from a library of books belonging to the player. When he escapes through a portal into the books it is up to the player to follow it into multiple fantasy worlds to retrieve the stories. In each new book the player finds itself trapped in a series of rooms and challenges due to the chaos caused by the Ink Monster.

The following is a storyboard of the introductory cinematic the players will see when first opening the game:
When the cinematic ends it is the beginning of the game portion, here the player will be able to select which books to travel into. Players will choose and be transported into the first book: *Alice in Wonderland.*

4.2. Game World

4.2.1. General look and feel of world

Players will find themselves first in a 2D environment within the Book Study. These place consists of a library holding many books. It is the middle of the night so an ornamented lamp is on and sits on a large desk, where a pile of books is also found. These are books that the Ink Monster has stolen the stories from. Books are also thrown about the room from when the Ink Monster was here. The player selects a book and is transported into that specific story.

Inside the world of Alice, the players find themselves inside the Queen of Heart’s Maze. The Ink Monster has broken Humpty Dumpty into pieces and spread them all over the Wonderland. The White Rabbit sends you on a mission to put Humpty back together, this will restore the story of Alice back in place.

Players will find themselves right at the centre of the Maze in front of Humpty’s Wall. The Maze leads to different areas and its central axis moves, allowing the player to travel to different rooms in the Wonderland. The Maze is modeled on the look and feel of European style hedge mazes, where the walls of the labyrinth are made of vertical hedges.

4.2.2. Areas

**Maze:** This is the central area where players will return to in order to reach other rooms (areas) inside the Wonderland. As the player collects the missing pieces of Humpty Dumpty, the player will be able to escape each room and see the full character of Humpty Dumpty be put together. Success in Alice happens when Humpty Dumpty returns to life and sits on his wall.

Three rooms await the player inside the Maze:

1. **The Room down the Rabbit Hole:** This is the victorian-style room where Alice first arrives into after falling down the rabbit hole.

2. **The Tea Party:** Set in a beautiful countryside garden, a large table with teapots awaits the player. It was here that Alice shared in the Mad Hatter’s tea party.
3. The Cheshire’s Cat Forest: On a gloomy and fantastical forest, Alice found herself confronting the mysterious Cheshire Cat. Here the player will meet the Cheshire Cat.

4.3. Characters

Ink Monster: The Ink Monster is a creature of fantasy. He is made out of entirety of ink and has a liquid-like body—this allows him to move in ways similar to different consistencies of liquids—like goo or more like water at times. He isn’t a scary character—rather he can be really cute, but he is a hungry fellow and will indiscriminately eat the ink off of books causing havoc on the fantasy worlds of these stones. He can use his powers to also travel within these worlds.

Humpty Dumpty: He is a character that Alice bumps into Through the Looking Glass, who in turn is famous for the nursery rhyme that carries his name. In our version, Humpty is broken apart by the actions of the Ink Monster and it is up to the players to retrieve his pieces and put him back together. Humpty will then thank them for helping him, and with that the player returns the story of Alice back in place.

Cheshire Cat: The player will stumble into the Cheshire Cat at the forest. He is a tricky and mysterious cat with a mischievous grin. When the player one meets the Cheshire Cat provide him with a riddle to escape this room. His body is incorporeal, so players can only see his grin on the forest.

The White Rabbit: The White Rabbit is the character in Alice that takes her through the journey into the Wonderland. In our version, the Rabbit helps the players understand what to do at each point in the game through the hints. He would also explain that the main objective is to retrieve all the pieces of Humpty together.
5. Tutorials

5.1 Tutorial Storyboard

This storyboard was used to create the tutorial at the beginning of the game to help players get acquainted with how to play the game and what all is entailed in it.
5.2 Training Room Storyboard

This is an ideation for a prospective training room to help people get acquainted with the controls and interactions involved in the game.

Player 1

TRAINING ROOM - PLAYER 1

Instructions:
- Push the up button to move up.
- Use the right and left button to move in different directions.
- Press the N button to start the game.

Awesome! You know how to do that.
Player 2

Training Room - Player 2

Choose your response:

- good
- repay

"Chat! Tap on the title to build the word array!"

Awesome! You know how to do this.

Next Playing!
Appendix K. The Visual Design Documentation of the Online Escape Game, A Tale of Tales

Design Documentation
Visual Design Document

1. Mood Board

The theme we chose is *Alice in Wonderland*, and we conducted research on *Alice* films, animations and fan art to explore the potential art style. The style of *Alice in Wonderland* is magical, mysterious and creative.
2. Research on Art Style

Based on the story setting, the player enters the game world by transporting through books. Therefore, the art style is set to be like a vintage book. The cover of a vintage book is usually hard cover with golden pattern and typography on it. And the inside pages are old yellow papers and the texts are faded out.
3. User Interface

3.1 Book covers
After the art style is solidified, the UI of several main screens were made in consistent with the style of a hard cover of a vintage book. The elements include leather material cover, golden texts and patterns, lighting effect.
3.2 Book inside pages

Besides main screens, the other UIs are made to be like inside book pages. And there is also a texture applied to texts and images to simulate the effect of faded printing.
How doth the little _____
Improve his shining _____
And pour the _____ of the Nile
On every golden _____
Font: Caslon Antique

4. 2D Arts

4.1 Background Story Cinematic
The background story started from you are sitting in your study and reading a book. You feel tired and fall asleep, after a while, you wake up and see there is a strange creature. It is a ink monster and he is drinking the ink from your precious book! He freaks out when he finds you see him, then he jumps into the book and disappear.

4.2 Game Logo
The game logo is made of a style of the title of a vintage book. The elements include three-dimensional fonts, classical ornaments.
4.3 Cheshier cat
The cheshier cat appears in puzzle 3 and it will be a 2D animation on the wall of puzzle 3. The cheshier cat is famous of his iconic smile so the smile is emphasized in the design.
4.4 Hint cards
The hint cards are served as posters on the wall of the puzzle one room. They are consistent with the same art style as old papers with faded printed pictures.
4.5 Card soldiers

The card soldiers are textures to be pasted on 3D models, so they are made to be as simple as possible to make the 3D modeling easier. And the art style is the old paper so that the art is consistent.
3D Art Style Guide

1. Moodboard

2. Art Style

We are trying to approach realistic style for the 3D environment and assets. We're aiming to create a wonderland filled with bizarre creatures, plants and puzzles. After some research from the movie and animation based on the *Alice in wonderland*, we prioritised the scene and picked the ones are iconic and fit the storyline. Because of the low polygon constraint, all the props and assets are better to maintain under 30000 polygons for each puzzle room. We analyzed several key objects and based on the game mechanics and flow prioritized the assets, and prioritized which assets should be more defined with higher polygon.
3. 3D environments

There are one maze and 3 puzzle rooms in this game. The player starts within the maze and enter the portal to each of the puzzle rooms.

This is the design of the maze in 2D. Each time the player complete one puzzle, the portal will send the player back to the center of the maze. The blue part of the maze will rotate after the player get back to the center, and each rotation can only lead to one puzzle portal.

Chapter 1: Down to the rabbit hole

This room is themed with the room after alice went down to the rabbit hole. The style of this room is traditional Victorian style. The floral wallpaper and vintage style furniture is the key element in this room to highlight the style.
Chapter 2: The Tea Party

The second puzzle room is based on the famous scene from the story- The Tea Party. This room is a garden with vivid and cheerful color scheme. The tea pots is the major game object in this puzzle room. We select 9 patterns that matches with the victorian tea pot style which brings continuity in the game art style.
Chapter 3: Cheshire Cat's Forest

The Last puzzle room is the Cheshire Cat's Forest. This is another famous scene from the book and the movie. Originally, we designed the room with trees and bizarre plants to show the mysteriousness and the darkness of this scene; however, because of the constraints of the polycount, we had to replace the tree models with better forest textures on the wall.

The layout of this room is divided into 3 chambers. The placement of each hint and puzzle is based on the order of the UX flow.
4. 3D characters and assets

4.1 Humpty Dumpty

After discussion with the team, we picked the character Humpty Dumpty as our only character that will be created in 3D. He serves as an important clue and reward at the end of the game. The design of this character is simple and adorable. Humpty is an egg wearing vintage style suits and a bowler hat. We picked the vintage victorian style texture for his outfit.
4.2 WordLock

The wordlock is one of the important game object. We combined two designs of victorian style desk calendar together to create this user friendly wordlock.
4.3 Mushroom (Portal Entrance)
At the end of each part of the maze, there is a giant mushroom transport the player to each of the puzzle rooms. There are stars on top of each mushroom. Once the player completes the corresponding puzzle room, the star will disappear.