Understanding the learning and social gameplay experience of older adults playing a Bingo digital game

by

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Abstract

This study examined the social gameplay and learning experience of older adults during four weeks of gameplay using a customised educational digital Bingo game with nutrition and health content. The research design (n=50) used a sequential explanatory mixed methods approach to investigate the experience of this group of older players (60 years and above). This method split the study into two phases: the first phase consisted of four weeks of gameplay and quantitative data collection using pre- and post-tests, while the second phase consisted of post-gaming interviews of selected players to collect qualitative data.

The results showed significant improvement of players' game attitude and social connectedness scores from the pre-test to the post-test. Further support from interview data confirmed these increases. The interview data also shed light on the importance of social connectedness, co-playing, older players' preferences, and knowledge gained from playing this game. These results were consistent with earlier research studies.

New findings included the generation of a conceptual framework explaining the connections among the various themes discovered from the older adult players' game-playing experiences. This framework also explains how a digital game that offers a relevant objective to older adults (in this case, learning about nutrition and health in a good social co-playing setting) can provide them with a good social and learning experience. In addition, the positive gameplay experience provided to this group of players fostered their engagement in the game, their uninterrupted play, and contributions to digital game development based on their experiences.

Keywords: Digital games; older adults; mixed methods research; social capital; social connectedness; adult learners

Dedication

I would like to dedicate this manuscript to my Lord and Saviour, Jesus Christ; my wife, Hannah; and daughter, Rachel. I also would like to dedicate it to my academic mentor, Dr. David Kaufman, and faculty members of Educational Technology and Learning Design. Thank you for all of your precious time and efforts given to this study; without you, my studentship in this doctoral study would be like a fruitless tree.

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Special thanks to all the hardworking Research Assistants and Facilitators: Fan Zhang, Haley Rutherford, Simone Hausknecht, and Gee Lam, for working with me to run this research study together. Thanks to your effort and collaboration, we managed to reach the finish line, despite all the challenges and difficulties faced during the study.

I offer my sincere thanks to all senior centres' coordinators who have helped me tremendously, from recruitment to the very end of completing this study. May you succeed and thrive, as you serve the senior folks with your passion.

And last but not least, I want to recognize all the senior participants who took part in this study. Their support, enthusiasm, and valuable stories shared are as precious as gold. May you continue to play digital games, and live life to the fullest.

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List of Acronyms

DGBL   Digital Game-Based Learning

ESA   Entertainment Software Association

HCI   Human Computer Interaction

LTE   Long Term Evolution

qual   Qualitative

QUAN   Quantitative

SAVIE   Society for Lifelong Learning Research

SFU   Simon Fraser University

SCS-R   Social Connectedness Scale - Revised

SPSS   Statistical Package for the Social Sciences

UCLA   University of California Los Angeles

WHO   World Health Organization

Wifi   Wireless Internet for Frequent Interface

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Glossary

Digital game
: A game played on electronic devices, which might involve the capability for multiple individuals playing while connected through the Internet. Also commonly known as video game, computer game, and electronic game.

Gameplay
: The process, event, or act during which a game is being played. A modern digital game with multi-player features involving players' surrounding environment, cultural, and various background characteristics of players. Also known as co-playing when in a multiplayer game setting.

Learning
: This study uses Adult Learning Theory (Knowles, 1980), to define learning for older adults, which involved older adults' serious decisions when choosing to learn a topic, acquiring knowledge, or learn a skill that is relevant to them.

Older adults
: For this study, older adults refer to people who are at least 60 years old. Also commonly known as seniors, elderly, third- and fourth-age adults.

Social capital
: Social capital refers to the collective goods provided by the public, group or community where a person lives or participates in, and at the same time, shares the good or social benefits provided by it with others (Cannuscio, Block & Kawachi, 2003).

Introductory Image

"Technology holds great promise for enhancing the lives of elders generally."

(Whitcomb, 1990, p. 112)

"Games are the most elevated form of investigation."

Albert Einstein

Chapter 1.

Introduction

According to the World Health Organisation (WHO, 2012), the number of people sixty years old and above is forecast to reach two billion by 2020 globally, which is double the number in the 1980s. This group of older adults will form 26%, or over one quarter, of the total world population in the coming decade. This shift in demography is known as the 'silver tsunami,' or simply 'population aging,' and has started to trigger alarm about shortages of senior care manpower including medical, social, and mental care personnel for older adults (Delafuente, 2009). This concern has also led to an increase in the number of research studies investigating the potential of using assistive technology in medical, social, and communication domains to address the needs of older adults (Rogers, Stronge, & Fisk, 2005). One of the more recent technologies on which ongoing research is being conducted is the utilisation of computer or digital games to improve the well-being of this group of people (e.g. Brady, 1987; Whitcomb, 1990; Gamberini, Alcaniz, Barresi, Fabregat, Ibanez, & Prontu, 2008).

"Technology holds great promise for enhancing the lives of elders generally" (Whitcomb, 1990, p. 112). There is a never-ending, increasing interest in research on digital games for this group of elderly folks (Nap, de Kort & Ijsselsteijn, 2009; Gajadhar, Nap, de Kort & Ijsselsteijn, 2010; De Schutter & Vanden Abeele, 2010; Marston, 2013). Many adults who have reached the age of 60 have lived through and seen waves of technological change. In fact, many of these seniors have already been encountered present day innovations including computers, mobile technologies, computer games, smart television, and so forth.

As people get older, or even retire from their full-time jobs, they can further explore their use of spare time rather than withdrawing from the common society and communities

(Brady, 1987). Digital technology is a tool to afford this group of users with many new and exciting ways of using their time, as well as allowing them to keep up with new applications (Brady, 1987). These new technological tools can also help them to overcome and handle the fast pace of modern day society, and help them achieve a good quality of life (Whitcomb, 1990).

1.1. Purpose of the Research

The purpose of this research study is to reach out to older adults with a useful and relevant digital game to help them age well. This study will also extend ongoing research in the field of digital games for older players, specifically investigating their social gameplay and learning experiences through the utilisation of a customised digital Bingo game. The reason for using Bingo is that it is a commonly played board game, and enriching it with embedded learning content on nutrition and health makes it a tool for learning a subject that is important for people at this stage of their lives. The purpose was also a response to the call from the report of the Entertainment Software Association (ESA, 2011) showing a steady 2% yearly increase in older adult players since 2004. This means that approximately 29% of older adults are currently playing digital games regularly.

Since the last decade, attention has also been drawn to improve the quality of life for older adults, especially those who have reached the age of 60 years old (WHO, 2002). Computer-based information and communication technologies have been researched heavily in the last twenty years, in order to counter the negative effects of physical, cognitive and social problems experienced with advancing age (Bouwhuis, 2003). The adoption of these technologies by seniors has been low in the last 15 years (Bouwhuis, 2003); nevertheless, the last five years have seen a shift in their technology adoption, especially among those who have recently entered into their third age (60 years and above). This reflects their increased exposure to, and welcoming acceptance of, modern day technologies (Ijsselsteijn, Nap, de Kort & Poels, 2007). It is not surprising that seniors who have had previous exposure to computers and digital games have been found to show interest playing digital games (Whitcomb, 1990).

1.2. Problem Statement

There is a need to investigate the social effects of digital gameplay and the learning opportunities of multiplayer educational digital games for older adult players. These are areas that need more research to provide us with additional insight for this group of players (Nap, de Kort & Ijsselsteijn, 2009; De Schutter & Vanden Abeele, 2010; Marston, 2013). It is important to understand the social gameplay processes of older adults, in particular how they can assist in dealing with social isolation. It also has been suggested that digital games should emphasise promoting social connectedness of players, using the options of multiplayer features and communicative functions (De Schutter & Vanden Abeele, 2008). Such features can also lead to more meaningful gameplay for senior players.

The level of social isolation and the reduced level of community involvement of people in their third and fourth ages have been growing in our modern day society, as family and friends can live far away (Harley, Fitzpatrick, Axelrod, White & McAllister, 2010). This is where research on the use of technology, especially social co-playing games, can alleviate isolation and improve social connectedness with peers and family members.

Besides the fun elements of digital games, some authors have encouraged developers to include serious educational aims and content in their digital games (Griffiths, 2005). Digital games have been used for training and learning purposes to improve seniors' mental and physical health (Basak, Boot, Voss & Kramer, 2008), and their socio-emotional wellbeing (Goldstein, Cajko, Oosterbroek, Michielsen, Van Houten & Salverda, 1997). The integration of learning and educational components has also provided opportunities for players to learn while playing games they enjoy. As Marston (2013) put it in her research report, learning and knowledge gained from digital gameplay have provided a purpose for players, so that they themselves have an end goal and objectives for playing. Games' educational benefits also help them to stay focused and engaged during gameplay and build up their self-confidence and knowledge.

1.3. Research Questions

The following research questions were crafted to guide the researcher in conducting the investigation (Creswell, 2013).

The research questions for this study are:

1. Is there an increase in knowledge and social connectedness for older adults while playing a multiplayer educational digital game?

2. What is the social experience of older adult players while playing a multi-player educational digital game with other players?

3. What elements help contribute to a positive gameplay experience for older adults while playing a multiplayer educational digital game with other players?

This study also hypothesised that there would be significant improvements from before to after the digital gameplay. The hypotheses were:

1. Playing a series of digital Bingo educational games with local co-players will improve players' social connectedness.

2. Playing a series of digital Bingo educational games with serious learning content embedded will increase players' knowledge of the content.

1.4. Research Aims

This study used mixed-methods research to better understand the learning and social gameplay experience of older adults (60 years above), when playing an educational game with embedded learning content. The study employed a customised multiplayer digital Bingo game with nutrition and health learning content to conduct a four-week experiment. Using the customised Bingo game allowed us to see how a particular topic of interest to older adults, in this case nutrition and health, could be learned from a series of social game-playing sessions.

The study utilised two types of data collection: a gameplay experiment for quantitative data, and interviewing to collect qualitative data. An explanatory, sequential mixed-method design was used, whereby qualitative data was collected to explain and support the quantitative results. The experiment collected gameplay outcomes with quantitative data from a series of game-playing sessions, while the interviewing helped to gather qualitative data to support the quantitative data, and examine the social experience and the learning gained from the gameplay. The quantitative and qualitative data were intended to complement each other, providing richer details about the learning and social experiences of older adult players during the game-playing sessions.

The specific investigation focused on the social processes underlying the senior players' gameplay sessions, including on how they interacted with one another, the social connectedness that they developed throughout the gameplay, and factual knowledge that they gained from the embedded learning content. The evidence from this study was not meant to shape clinical recommendations.

The author and researcher of this study also speculated that positive social gameplay sessions, coupled with the practical benefits of playing this Bingo game (learning about nutrition and health), would lead to positive social experiences and learning outcomes for this group of older players. Furthermore, with such positive game-playing experiences, it could also lead them to better acceptance of digital game, as well as potentially leading them to become regular game players.

1.5. Research Significance

This study is important because it provides us with new understanding, extending the limited information reported in the literature on learning and social process during older adults' gameplay (Marston, 2013). It also informs future work on the benefits and difficulties faced by older adult digital game players about learning, sociability with other players, and flow of play during gameplay with other older adult players. It will especially inform researchers and designers who are exploring the use of digital games for this group of players, with the purpose of enhancing games' sociability and co-playing features.

This study should help researchers to better understand older adult players' opinions and perspectives on social gameplay experiences, including social behaviours during gameplay and how they can benefit from the learning content of an educational game. Sociability and learning benefits found in digital games have been identified as two of key contributing factors motivating older adults to play digital games (Pearce, 2008; Nap, de Kort & Ijsselsteijn, 2009; De Schutter & Vanden Abeele, 2010; Wang, Lockee & Burton, 2011; Marston, 2013).

With the advantage of a mixed methods methodology, the quantitative data coupled with qualitative data should enable a deeper understanding of older players' social gameplay experiences and learning gains from the digital Bingo gameplay. These findings may also offer valuable insights to researchers whose goal is to design tailored gameplay interventions, especially to improve gameplay's engagement and promote regular game-playing for this group of users. The qualitative data, using open ended, in-depth interviews, were collected to generate findings that explore the co-playing experiences and perceptions about the social gameplay norms and dynamics, as well as players' learning perceptions of nutrition and health topics.

In addition, this study also helps to inform the development of digital games for older adults by exploring what they expect from digital game-playing sessions and the factors that can affect their becoming regular game players. These findings, based on older players' perspectives of what they want from playing digital games, will be able to address at least some fundamental areas for future development of research-based and commercial digital games targeting this group of users. This should result in digital games that are more appealing to senior audiences, potentially including learning content and enhanced social co-playing features. This is also consistent with game researchers Bianchi-Berthouze, Kim, and Patel's (2007) conclusion that "we are providing the game designer with a huge amount of information that could allow the creation of more social and entertaining games" (p.11).

1.6. Theoretical Framework

This study is organised using Social Capital Theory (Putnam, 2001) and Adult Learning Theory (Knowles, 1980) as the theoretical frameworks for guiding the study and explaining its results. Hence, the interpretation of what the author reports is affected by these theories' epistemology and ontological perspectives. Research should be grounded with respectable theory, so that the Bingo educational game used as a social and learning tool can be supported with strong theoretical arguments and clear explanations to support its claims, thereby contributing significantly to the field (Ravenscroft, 2001). This section briefly explains the two theories; more detailed descriptions will be presented in the Literature Review (Chapter 2).

Social Capital Theory is concerned with the collective social gains provided by the public, group or community in which a person lives or participates, at the same time sharing its social benefits with others (Cannuscio, Block & Kawachi, 2003). This body of theory is particularly relevant to the present study because "social capital is an important ingredient for successful aging" (Cannuscio, Block & Kawachi, 2003, p.395).

According to Putnam (2001), social capital is significant to the successful aging of older adults because: 1) adults tend to lose social ties as they grow older, and 2) the level of social capital available in many developed countries continues to decline while the aging population continues to grow rapidly.

As with the physical and human capital that a person acquires in his or her life, social capital is of great importance. For example, a person seeking a job does not just rely on his own human capital (capability and credentials), but, also on having an established social capital of social network connections that can be equally helpful in securing a good job. Social capital has both individual and collective aspects (Putnam, 2001, p. 20). Individual aspects involve the seeking of social gains for one's own interests, while collective aspects involve benefits for others in the same community.

Gaining social capital (as opposed to being socially isolated) can also lead to successful aging for older people. Putnam (2001) states that the accumulation of social capital takes place either by choice or necessity, but either way, it reinforces a person's

identity to a group with which he or she bonds. It is necessary, especially for elderly people, to find a good social network of community and friends with which they can bond and regularly socialize.

As for the specific value of social capital to be gained, in the context of this research, it would be those gained during game-playing sessions among the older players. The researcher's aim is to identify some of the value gained during the gameplay, as a result of social connections built, including trust, cooperation and reciprocity (Cox, 2004). These three social values were used as a guide, but did not preclude consideration of other values recognised during the gameplay. Identifying these social capital values also aided in spotting them when interviewing the players about their social experiences resulting from the game-playing sessions.

As an educational specialist, the researcher has learned to view older adults as learners who have needs that differ from those of younger learners. The researcher has also learned from the adult learning principles of Knowles (1980), especially the adult andragogy model of learner-centred learning that addresses the motivations and relevant learning needs of this group of learners. It is important to know that adults learn with the intention of achieving a learning goal which, in most cases, involves skills and knowledge that are practical to their needs.

Knowles also explains that adults, especially those who are in middle age and older, have accumulated rich life experiences and knowledge that make them view learning with goal and relevance-oriented perspectives. The learning involved must also motivate them. This makes multiuser digital games a medium of choice for gaining new skills and knowledge related to aging well. It also explains why digital gameplay, rewarding them with learning opportunities and catering to their style of learning, is more likely to be adopted by them as they play and achieve learning that can be applied to their lives. Digital games must be implemented and used with strategies to assist the players in maintaining their life skills, such as recall and transference of what they have learned to similar or associated situations.

As for this study, the Knowles' Four Principles of Andragogy (1984) are used as the main framework for understanding the older adult playing the Bingo educational game.

The Four Principles of Andragogy state that: (1) adults need to be involved in the planning and evaluation of their instruction, (2) adults need learning activities based on experiences, (3) adults need learning topics that are relevant and applicable to their lives, and (4) adults' learning is problem-centred.

Although this study focused on viewing gameplay events from an educational specialist's perspective, the ludology perspective on digital games supplements the main theoretical viewpoint of this study. Ludology "…studies games in general and video games in particular" (Frasca, 2003, p. 222). The focus of these game studies can also be seen to lean more towards the playing of games. It is the play event that creates the fun and meaningful activity. De Schutter and Malliet (2014) discussed digital games' ability to provide a magical and meaningful activity, which is capable of catering to the emotional, social, and motivational needs of healthy older adults. Besides the play and eventful happenings in digital games, the content found in digital game draws and motivates potential older players to play more frequently and to continue playing games (De Schutter & Vanden Abeele, 2008).

Ludology researchers perceive ludophile players as those who have enjoyed playing throughout their lives. These types of players value the social-cultural and artistic phenomena in digital gameplay as important facets of digital games. Digital gameplay is also valued as part of their lives and is an important passion in their everyday activities (De Schutter & Malliet, 2014, p. 22).

1.7. Definition of Terms

1.7.1.   Digital game, video game, and computer game

A digital game, also widely known as a video game or computer game, is "a game which we play, thanks to an audio-visual apparatus, and which can be based on a story" (Esposito, 2005, p. 2). This short and simple definition, according to Esposito, explains the well-known thoughts about "game, play, interactivity, and narrative" (p. 2), which are important components of today's video or digital games, rooted in the integration of computers and internet technology.

In layman's terms, as explained in the Merriam-Webster Dictionary (2013), a game is an "activity engaged for diversion or amusement." Games are played by many people and for many reasons. People like to play games throughout their lifetime. Even when we get older, we are surrounded by simple game-like activities, like guessing the weather for the day with a buddy, or calculating the next bus to arrive at a bus stop. Games can be played on many types of platforms, including computers, dedicated game machines, and mobile phones.

The Bingo game used in this study is a multiplayer social game with embedded nutritional and health educational content. This game is highly suitable for older adult players and is targeted mainly at non-expert digital game players.

Bingo is a favourite game that is regularly played by older people in both traditional and digital formats. Despite the game being simple and easy to play, it still draws many people due to the excitement of collecting numbers and winning the game. This aligns with the finding of Mubin, Shahid and Al Mahmud (2008) that most older adults prefer playing digital games that are easy and uncomplicated to play, for example offering simple rules and socially entertaining content.

1.7.2. Gameplay, game co-playing, and players' interaction

"Game-play" and "game co-play" are common terms used in research studies on digital games and by commercial digital game manufacturers. Gameplay or co-playing can be explained as "…the component of the computer games that is found in no other art form: interactivity. A game's gameplay is the degree and nature of the interactivity that the game includes" (Rouse, 2004, p. xx). Smed and Hakonen (2003) describe it as "…an immersion to the game world, a sense of purpose, and a sense of achievement from mastering the game" (p. 3). More specifically, for this study it is understood as a learning activity as opposed to being an educational digital game (Scardamalia, Bereiter, McLean, Swallow & Woodruff, 1989, p. 9).

Gameplay, according to a ludology perspective, highlights the importance of fun while playing a game. Scholars in the field of ludology highlight the importance of including games with meaningful playful events, while others, especially narratology scholars, stress

the importance of having a strong narrative storyline in the game. Many modern games have both these fundamental aspects, with some games being more focused on the storyline of games and others emphasising the playful events during gameplay (Pearce, 2005).

Interaction refers to "mutual or reciprocal action or influence" (Merriam-Webster Dictionary, 2013). To interact is easier to explain, which means "to communicate with or react to each other" (Oxford Dictionary, 2013). Interaction is also best explained according to the context of how it is used. In this case, the 'interaction' used throughout this study refers to how older adult players interact with one another in terms of physical, verbal, and non-verbal communication, or collaboration. The purpose of understanding this interaction is to describe how the older adult players interact during gameplay activities, and understand what learning is involved and manifested from such interaction. Interaction here is closely linked to, but not always synonymous with, players' social behaviours, as interaction in gameplay can be linked to the emotional and cognitive facets of human experience. Hence, the best way to describe it is to look at Max Weber's (1991) theories of social interaction, in which 'social interaction' consists of action and meaning. Action refers to the behaviour of the person, while meaning is what the person perceives in relationship to other people. It is the knowledge, or getting to know the other person that makes an action or interaction social. Interaction, interacting (verb) and interactivity (noun) are used interchangeably in this study to describe the phenomenon of seniors' gameplay interactions.

1.7.3.   Older adults, seniors, third age, and fourth age

Older adults and seniors are two common terms used interchangeably in this study. These terms refer to people who have reached the age of at least 60 years. Some studies use the minimum age of 55 to qualify people as seniors, while others prefer the age of 60 and above. For this study, the older adult players were those who are 60 years old and above. The terms older adults, gamers, and players are used interchangeably, since the various fields of literature discussed in this study have varying preferences.

Like other adults, seniors or older adults learn differently as compared to younger people. According to Adult Learning Theory (Knowles, 1980), adults learn with the intention to achieve a learning goal which may include skills and learning outcomes that are practical to their current needs. In this study, the learning involved in the gameplay interaction, besides the nutrition and health knowledge, also included social benefits that could be applied to their everyday lives. Knowles explains that adults, especially those from middle age and older, have accumulated rich life experiences and knowledge that make them see learning as goal and relevance-oriented.

"Third age" and "fourth age" are other terms commonly used in the Gerontology and Adult Learning fields. "Third age" normally refers to adults who have reached the age of 65, while "fourth age" describes those 80 years old and above (Smith, 2002). As described by Weiss and Bass (2002, p. 3), "The life phase in which there is no longer employment and child-raising to commandeer time, and before morbidity enters to limit activity and mortality brings everything to a close, has been called the third age. Those in this phase of life have passed through a first age of youth, when they prepared for the activities of maturity, and a second age of maturity, when their lives were given over to those activities, and have reached their third age in which they can, within fairly wide limits, live their lives as they please, before being overtaken by a fourth age of decline."

1.7.4. Learning (Older adults' perspective)

From the perspective of Adult Learning Theory (Knowles, 1980), learning for older adults normally comes with a serious decision to learn a topic, acquire knowledge, or learn a skill that is relevant to them. Older adults learn according to what benefits them, often consisting of skills and knowledge that can be applied to their needs or at least make practical sense to them. This applies to playing an educational digital game, where they will likely use a cost-benefit analysis to weigh or gauge whether it is worth investing their time and effort (Mclaughlin, Gandy, Allaire & Whitlock, 2012). The fun and engaging features of digital games can be utilized to motivate them to learn and become competent with new skills and knowledge in the unavoidable aging journey.

1.8. Chapter Summary

Rather than shying away from the benefits of current technologies, older adults can be encouraged to use them in an exciting and personally beneficial way. Technological tools such as digital games should help them overcome and handle the fast pace of modern day society, so as to achieve a better quality of life (Whitcomb, 1990). To fulfill this endeavor, this research study aimed at providing older adults with a useful and relevant digital game to help them age well. Using a customized digital Bingo game, a common game played by older people, this study extended ongoing research in the field of digital games for older players by investigating older players' social gameplay and learning experiences.

There is a need to investigate the social effects of digital gameplay for older people, particularly on how playing multiplayer games regularly can reduce their levels of social isolation (Harley et al., 2010). The integration of relevant learning and educational components has also provided opportunities to attract older players to learn while playing games they like (Griffiths, 2005; Marston, 2013).

Using an explanatory sequential mixed-methods methodology, the combination of quantitative and qualitative data is helpful in supporting each other, as well as in providing us with richer details of the learning and social experiences of older adult players. The research questions were crafted with a mixed methods approach, so that both the quantitative and qualitative data collected were used to answer them effectively. The findings of this study are helpful for extending our current understanding of older adult game players, as there is a need to know more about this group of players, particularly their social gameplay process during gameplay.

1.9. Organization of the Thesis

The remaining sections of this thesis are organized as follows. Chapter Two presents a review of literature that is relevant and useful to this study. This includes research works that help to establish the theoretical framework for the data analysis and interpretation. In Chapter Three, the methodology used for this study, together with the

research participants, research instruments, data collection and analysis, are described. In Chapter Four, the results of the data analysis and summary of the findings are presented. In Chapter Five, the final chapter, there is a discussion of the findings, including limitations, future research recommendations, and implications for consideration by digital game researchers.

Chapter 2.

Literature Review

This chapter discusses the existing literature from the various fields that the author has reviewed, in order to acquire the scholarly knowledge needed to conduct this research study. It reviews research studies that provided inspiration to form this study, and suggested further investigation on the social gameplay and learning experience of older adults, using an educational game of traditional origin.

It is from the review of relevant and valuable literature that the author decided to study the social gameplay experience of older adult players, based on recent studies that concluded usability and playability are not everything that this group of players wanted. A handful of researchers have shifted their focus to study the process of gameplay, which includes the sociability of players during gameplay. Other researchers have also put their focus on learning in relation to social co-playing of game, where players learn about a given topic while having fun playing the game with other players.

This literature review discusses the scope of current digital game research and development for older adults, especially research works published in the last decade. It then describes in an in-depth manner the current research on understanding the older players' needs – usability, playability and game engagement – including this study's research focus on sociability and learning in digital gameplay. The review is framed in five sections according to the ideas and concepts related to this study's focus on digital games for older adults.

The first section examines current philosophical understanding in the digital games arena for older adult players. The second section discusses some of the most recent research on improving the usability and playability of digital games to suit the needs of older adults. This section includes empirical findings related to this study, and how the author learned from them to form the present research. This section also includes discussion of some of the significant studies contributing to the customisation, game interface, game features, and form factors of modern digital gaming systems. This section

points out some studies that have started to shift their research interests from usability and playability to the study of gameplay motivation, engagement, and social gameplay activities for older players.

The third section discusses the social benefits gained as a result of playing digital games among older adult players. It also presents current literature that reveals the importance of improved social interaction, social connectedness, and related sociability activities, as a result of modern day multiplayer digital gameplay capability.

The fourth section considers the importance of studying the process of gameplay in digital games. A handful of publications that recommend more detailed study of the gameplay process, including players' perceptions and gaming experiences, are discussed. This section also highlights the shift of some of the research work from focusing on the benefits of digital games, to investigating the often-neglected process of players' co-playing during digital gameplay. Social Capital Theory is also discussed, especially with regard to understanding how social benefit gains can be offered to older adults through digital game co-playing.

The fifth section discusses current studies focused on the learning and educational benefits of digital games played by older adults. This section includes a discussion of older adult players through the lens of Adult Learning Theory perspectives, the continuing learning needs of older adults, current research on educational digital games for older players, and related studies on educational digital games for health purposes.

2.1. Literature Search Criteria

Inclusion and exclusion criteria were created to move from broad to a more specific search of the literature concerning digital games for older adults. The researcher began by searching online databases with these general keywords: social connectedness, social construction, social-emotional activities, interaction, interactivity, social interaction, skills, knowledge, and learning (all related to digital games for older adults). Also included in the search criteria were all types of digital, video, computer games, multi-user games, online

games, and inter-generation games. As for the subject of this study, the researcher included criteria for an international context and terms commonly used for seniors such as: elderly, seniors, older adults, third- and fourth- agers, and baby boomers. Articles were excluded that studied digital games for players 60 years old and below.

Based on the above selection criteria, databases (Google Scholar, AgeLine, ERIC, JSTOR, SFU Library, and so forth) were searched for literature that was published between 1997 and 2014. The search results were then narrowed down to include the literature relevant to this study. In addition, the researcher read the abstracts of about 95 peer-reviewed journal articles, conference papers, proceedings, and research reports from governmental bodies such as ElderGames in the European Union. The researcher read promising articles and decided on a selection of 62 papers that met most of the criteria, with useful theoretical concepts, findings, empirical data, and methodology of sufficient quality to critique and discuss. The articles chosen were from a mixture of fields, including Gerontology, Adult Education, and Human-Computer Interaction. Every article's citations and notes were entered into a reference management system (RefWorks) and archived in digital folders for further reference.

2.2. Understanding Current Older Adult Digital Game Players

This section discusses current scholarly understanding of older adult players in relation to this study on learning and social gameplay. It has been reported that at present, older adults, especially those who just entered into their 60th year of age, have rich experience of technology and digital games (Ijsselsteijn, Nap, De Kort, & Poels, 2007). This has motivated recent research investigating many beneficial outcomes from digital gameplay for improving older adults' well-being, such as: cognitive behaviours (Scarmeas & Stern, 2003; Miller, 2005), social interaction and communication skills (Gamberini, Alcaniz, Barresi, Fabregat, Prontu, & Seraglia, 2008; Heylen, 2010), memory power and reasoning abilities (Miller 2005; Engelhardt, Buber, Skirbekk, & Prskawetz, 2010), functional and motor skills (Drew & Waters, 1986; Segal & Dietz, 1991; Goldstein, 1995; Hebert, Beland, Dionne-Fournelle, Crete, & Lupien, 2005; Miller 2005) and learning from educational game-based media (Gee, 2003, 2005, 2007; Shaffer, 2006).

As the research on digital games for older adults develops, many researchers have shifted to study players' preferences and expectations of digital game and gameplay. These include seeking older adults' preferences with respect to game genre, gaming platform (Marston, 2012), game content (Hsu & Lu, 2004), gameplay context (Gajadhar, De Kort & Ijsselsteijn, 2008; Hwang, Hong, Hao, & Jong, 2011), game flow and playability (Nap, De Kort & Ijsselsteijn, 2009; Hwang, Hong, Hao, & Jong, 2011), as well as players and game interactivity (Cheok, Lee, Kodagoda, & Tat, 2005).

2.2.1.   Older players' game-playing preferences

Digital game researchers have recently begun studying the many facets of what actually makes older players play, and continue to play digital games. The ability to engage and immerse oneself in digital gameplay does not only appeal to younger players, but also to the older audience. Older adult players also tend to play a digital game more regularly when they find it engaging and worth spending their time on (ESA Canada, 2012; Delwiche & Henderson, 2013). These findings are congruent with Knowles' (1980) Adult Learning Theory, which suggests that older adults choose what they need to learn and will invest in learning things that benefit them.

One aspect that draws older players to engage in gameplay is the ability to interact socially with other players (De Schutter, 2010). It is this social interaction that indicates that their time is well spent playing a game; this includes investing time playing and meeting other players during the gameplay. The social interaction during gameplay with other players is capable of leading to powerful deep learning (Gee, 2003). Using Social Capital Theory to interpret this, we can identify the social benefits and gains from the source of social game-playing sessions with other players.

The social context surrounding older adult players is another area worth investigating, as it has been largely neglected by researchers (Gajadhar, De Kort & Ijsselsteijn, 2008). Very little has been reported about how various social contextual and environmental factors can affect players' performance and the results of gameplay. Modern digital gameplay can be carried out in many different social contexts, locations, and modes of play, including online co-playing with other players and virtual game agents.

Gajadhar, De Kort, Ijsselsteijn and Poels (2009) also reported senior players' acceptance of digital game co-playing in various multiplayer settings. Their study reported that older adult players still prefer to play digital games that offer more physical presence of fellow players in a local setting. The ability to play with other players virtually and online is acceptable, but it is not acceptable for them to play with an artificial game agent or without the presence of a player. The ability to play with other players, and their social presence to interact, communicate, collaborate, exchange and compare game-playing advice, are highly regarded by this group of players. Gajadhar, De Kort, Ijsselsteijn and Poels (2009) also stressed the need for more research to study senior players' social needs in a multiplayer environment, in terms of the social presence of other players with whom they could interact physically and co-playing in various social environments. The provision of social events during gameplay can also directly affect players' enjoyment in a social gameplay session (Gajadhar, De Kort & Ijsselsteijn, 2008).

2.2.2. Gameplay competition and challenges

Some researchers recommended implementing game challenges with levels of gameplay so as to make the gameplay more challenging and engaging for older adult players (Malone, 1982; Melenhorst, 2002; Ijsselsteijn, Nap, De Kort & Poels, 2007; Gajadhar, Nap, De Kort & Ijsselsteijn, 2010). According to them, such challenges are able to build up skills of game content and self-confidence of players, which ultimately leads to positive game-playing experience and encouragement to play more games. It also allows older players to realise and develop gaming goals and achievements. This finding has prompted other researchers to seek greater understanding of what older players want to achieve and what ultimately leads them to continue playing games.

Digital games, especially multiplayer games, normally come with competitive and challenging features such as game levels, players' lives, timescales, and so forth. Many studies suggest providing equivalent degrees of competition and challenging features in digital games for older players, just as in those used for younger players (Pearce, 2008; De Schutter & Vanden Abeele, 2008). However, not all researchers agree with this suggestion, as it has also been reported that competition and challenges are not the primary aim for most older adult players. Rather, it is the opportunity to develop

engagement in game-playing sessions and socially co-play with a familiar circle of players, teaching and supporting each other in the gaming circle (Pearce, 2008; Nap, de Kort & Ijsselsteijn, 2009).

In line with this suggestion, Gajadhar, De Kort and Ijsselsteijn (2008) and Gajadhar, Nap, De Kort and Ijsselsteijn (2010) stated that older adult players are less concerned about their game-playing performance, and who is winning or losing, than the engagement and flow of the game. They also noted that older adult players are very concerned about how digital games can appeal to them with good game flow, without heavy interference and challenges from other players during game-playing sessions.

2.2.3. Concerns about digital game ergonomics

The past decade has seen a lot of emphasis in digital game research on understanding a game's usability and playability for older adult players. Many game researchers have taken the opportunity to improve and customise digital games for older adults as a way of appropriately and safely implementing digital games for them (Cheok, Lee, Kodagoda, and Tat, 2005). Studies have provided significant evidence that both intervention with treatment and testing of usability with prototyping design can result in digital games that improve the well-being of older adults. For example, empirical studies from gerontology researchers have proven the tremendous benefits of digital games' capabilities in improving older adults' cognitive and social behaviours (Gamberini, Barresi, Maier & Scarpetta, 2006, 2008; Mubin, Shahid & Al Mahmud, 2008; Engelhardt, 2010).

Researchers in the field of Human-Computer Interaction (HCI) have studied the usability and playability of digital games for older adult players. HCI and design-based researchers (Khoo & Cheok, 2006; Mubin et al., 2008; McLaughlin, Gandy, Allaire, & Whitlock, 2012) are interested in exploring the interfaces of digital games for older adults, customising game design and features, as well as simplifying gaming tasks for elderly gamers.

The last decade has also seen demographic shifts, with more people living longer and over 20% of elderly needing more care and health attention (Delafuente, 2009). This promotes effective game design with special attention to the usability and playability of

customising digital games for this group of older players. One such example is provided by Zwartkruis-Pelgrim and Ruyter (2008), who developed an adaptive memory game application for older adults to improve their memory and cognitive decline. Building on an early evaluation of a game designed with participants, they redesigned and developed a customisable cognitive game that presented a higher-than-expected level of a cognition maze game as being requested by the older players. The subjects of study were 14 participants all living independently (11 males and 3 females), aged 46 to 78, with a mean age of 65. After a two-week intervention in a field experiment, the older players were indeed able to show improvement in their cognitive performance as a result of the game-playing challenges from the maze game. Besides the positive outcome expected, they also revealed that the positive experience of engagement the players had, boosted them to put in more effort to do well in the game.

While Zwartkruis-Pelgrim and Ruyter's study focused on healthy and independently-living older adults, Gerling, Schulte and Masuch (2011) used prototyping to develop a game for adults of frail health: suffering from cognitive and physical limitations. In a methodology similar to Zwartkruis-Pelgrim and Ruyter's study, they used iterative and participatory methods of improving the game design, but with a lower cognitive and physical challenge type of game known as SilverPromenade. This customisable design digital game is to be played with players doing virtual walks and performing simple roles with an off-the-shelf Nintendo Wii Remote and Wii Balance Board as input devices. Fourteen residents permanently living in full-care nursing homes with an average age of 80, participated in the evaluative design of a usability and playability testing experiment. The evaluation results proved to be successful and revealed many new ideas for further improvement. The key results confirmed that the game prototype design met the needs of the frail elderly players in many respects, including the interaction design for players and the complexity of game mechanics for their special needs.

Based on their success in having frail older gamers appreciate a customised prototype game design, Gerling et al. (2011) provided many suggestions for game design for this target audience group. One of their suggestions was to "carefully explore the abilities of your target audience to provide accessible gameplay" (p. 6). They argued that game designers should consider customising games using the participatory-design

prototyping techniques, instead of quickly jumping into designing a one-for-all design and thinking that older adults will get used to the interface and game features gradually. Besides Gerling et al., other researchers like Hwang, Hong, Hao and Jong (2011) and Cheok, Lee, Kodagoda and Tat (2005) used similar iterative design approaches by improving game usability and playability in stages, and changing the game interface to meet their target users' specific needs.

The growing exploitation of digital games as tools for older adult players continues to seek further investigation in interventions of game usability and playability design enhancement (Whitlock, McLaughlin & Allaire, 2011). Whitlock et al. launched a study with the common and easy to play Nintendo Wii Boom Blox game, to investigate older adult users' physical and cognitive limitations when playing this game. They observed video recordings of gameplay sessions and questionnaire responses from 56 participants ages 65 to 93 ($M = 79.77$, $SD = 6.64$) to better understand common problems related to older adults' physical and cognitive condition, in terms of game display and motivation. Their findings revealed that game design limitations specific to physical accessibility have been real and common issues for this group of players. Another finding was that playing at more advanced levels challenged the mental capabilities of elderly players and led to some frustration. The researchers suggested that game designers take into consideration the physical limitations and cognitive loads of elderly gamers attempting to handle challenging gaming tasks. Nevertheless, this study found that motivation in games, especially through the rewards and feedback provided by the gaming systems, can occasionally reduce frustration and push older players to achieve higher-level gaming skills.

Most research studies on the usability and playability of digital games for older adults offer advice and guidelines based on test results. For instance, Sauvé, Renaud, Kaufman and Duplàa (2015) recommended the following three core quality criteria for ergonomics and design of digital games, including those aimed at older players:

1. Design: components of the game must adapt to the characteristics of the users,
2. User-friendliness: the game interface and computer equipment must be easy to use, and,
3. Readability: the way in which the text, illustrations and videos are visually presented must facilitate reading and understanding by users (p. 2).

Using a customized Bingo game, Sauvé, Renaud, Kaufman and Duplàa addressed these three criteria with an emphasis on educational content and technology adaptation for older adult players. After testing the game with 27 seniors, they concluded that online educational games should be designed for ease of use, as this can reduce many potential problems faced by the players. Good ergonomic design must also consider users' satisfaction, and the specific needs of this audience. In addition to the customization of displays and the game interface, tutorials and explicit explanations of game rules play important parts in adapting educational games for older adult players.

Older adult game players are a target group of players who require special attention to the design's usability, playability, and their motivational needs. Indeed, their needs are more complex than many researchers have thought them to be, especially due to their multifaceted psychological background (Lindley, Harper, & Sellen, 1998). Nevertheless, despite the many areas involved in improving digital game design for them, usability and playability are crucial if digital games are to benefit this group of game players.

2.3. Digital Game Usability and Playability Are Not Everything

It is not surprising to see much of the literature on digital games for older adults focusing on improving digital game design, usability, and playability. The primary reason for many such research studies is to emphasise two fundamental aspects: gameplay performance outcomes and overall acceptance of games for this group of older players. There is an implication that if usability is properly addressed, everything else will fall into place; however, some scholars have suggested that usability and playability are not everything, nor are they the only two elements in the digital game that affect elderly players' acceptance (Ijsselsteijn, Nap, De Kort & Poels, 2007; Lindley, Harper & Sellen, 2008). Usability and playability are important, and there is no excuse to reject these fundamentals in digital games; however, as some researchers have argued, older adult players want more than just good ergonomics and game design to meet their expectations (Hwang, Hong, Hao & Jong, 2011).

Several recent research studies focusing on usability and playability together with motivation-related factors have started to identify ways to improve the overall gameplay experience for older adults. Whitlock, McLaughlin and Allaire (2011) and McLaughlin, Gandy, Allaire and Whitlock (2012) suggested that building on social enhancements, together with usability and playability are more effective in enhancing gameplay for this group of players. A study by Hwang, Hong, Hao and Jong (2011) developed a customised interactive software program using Macromedia Flash, a commercial application of Adobe for creating animations. The main goal of Hwang et al.'s study was to understand senior adults' experiences of game playing, with refinements made to suit users' abilities. One facet worth noting about the uniqueness of Hwang et al. experimental study was that they studied the different backgrounds of the participants (subject variables) of the older adults and how users' perceptions about usability of the game affected their gaming experiences. The various backgrounds of the seniors selected included those from a rural community centre, an urban community centre, and full-time nursing homes in Taiwan. The participants of the study consisted of 30 older adults (above 60 years old, 14 males and 16 females) from the three different settings. Based on a structured interview and observations of the gaming sessions, the result revealed that older adults from the nursing home had higher user satisfaction with the game, whereas those who were from the rural community centre had the lowest. Surprisingly, older players who were from the urban community centre had mid-range user satisfaction, but they were more active in trying new things and in social participation than were those from the other two settings. The authors hypothesized that this could be due to an effect on their social participation from their urban background and lifestyle. This surprising finding also prompt them to re-analyse their interview data, which led them to the seniors' gameplay experiences. While replaying the gameplay videos captured recording to analyse the expressions and gestures of the seniors when they played the games together, they tried matching data revealed to those gathered from interview sessions. Further findings revealed that female older players preferred playing with others to playing alone, and their flow experiences (playing games uninterruptedly) came from the process of sharing and interacting with others. In contrast, the male older players preferred playing alone, and their flow experiences came from indulging in their personal preference of gaming style of playing.

A study by Mubin, Shahid, and Al Mahmud (2008) highlighted that a game can motivate seniors by allowing them to engage socially with other players. With the user-centred approach in mind, Mubin and his researchers evaluated the social engagement activities of a mobile game for seniors known as Walk 2 Win, a game specifically designed to encourage players in a community centre setting to interact with each other during gameplay. Before studying this customised game, they conducted a preliminary study to identify design and environmental factors best suited for the setting.

Walk 2 Win was a mobile memory game with two gaming modes (individual or team playing) and two game levels (easy or difficult). Four players could play at the same time with their own mobile devices, connected through wireless communication. The study was conducted on eight voluntary participants (five males and three females) with an average age of 71 (from 67 to 78) in the same local community centre. All the senior participants were healthy and could walk without any assistance. Only three of them had computer experience, but all had experience in traditional card games played with procedures and rules like the digital one. The game was evaluated in two sessions (individual and team mode) with the eight voluntary participants. Each evaluation session lasted for two hours long, and with two breaks. As usual, game procedures and rules were briefly explained by the researchers to the participants. Before the actual game was played, a small introductory pilot session was carried out to ensure that the rules were fully understood, as well as to familiarise players with the mobile device. The community centre did not allow any of the sessions to be recorded, so the researchers had to make field notes on what they observed.

The procedure for this study was as follows: First, the researchers carried out an ethnographic study in the community centre on the senior members. Then, they interviewed the caregivers who took care of and supported the senior community members. Next, they conducted their study with the implementation of the game. Finally, they organised a focus group session with the senior participants. Findings from the initial ethnography study revealed that most of the senior participants carried out their activities in the community centre in groups, for the purpose of socialising and interacting with each other. These included planned socialising activities like fitness, game playing, arts sessions and short courses, but they also have unplanned sessions. The caregiver also

stressed that social communication was important among the members of the community. These findings led them to define three key design principles that were later incorporated into their final game design:

- To design a game which encouraged senior players to be more active in participation (both active and passive involvement)
- To design a game which encouraged them to interact with each other during game play
- To design a game that had simple rules yet provided fun (p. 12).

The results showed that the senior users in this non-residential community centre expressed a strong interest in building a team of players among themselves as long as the game was simple, uncomplicated to play, and socially entertaining. In their research study, observations showed some of the senior players cheering for the winning players. There were occasions when tension and competition kicked in among players, as when some players broke the rules during the gameplay by customising the game according to their liking. Further questioning with the senior players suggested that the main reason they wanted to change the game rules was due to their keenness to play simple games with uncomplicated rules. They also expressed strong preference for games that have enhancements over existing features that they usually play, and they needed time to get used to new games with new rules. Over time, the elderly players did learn to socialise with one another and eventually chose their own team members. However, in most cases there was more collaboration among the team members, as they cooperated and developed strategies to win the games. The investigation into the user-centred design of the game also revealed several design principles to be added to the game elements, such as social interaction, easy customisation of games, user control of games, and so forth. The most important of these elements, according to the authors, was that senior players should have the option of changing their gameplay activities according to their own preferences, which should eventually motivate them to play the game.

Mubin and his researchers also recommended that games designed for older adults should be unisex in nature. Both male and female senior players should be considered and equally chosen when conducting this type of study. They highlighted that many related studies have neglected gender differences, although these were also addressed by Hwang et al. (2011). Mubin's study, using a micro-ethnography approach,

with prolonged study of the participants, allowed them to implement social interaction and active engagement activities for the senior adults, using a customised digital game. They compared and redefined social interaction in gameplay among the senior players, before the study with their own interpretation, and after the study with the senior players' refined interpretation. Furthermore, they also noted that caregivers' understanding of the seniors' social interaction, behaviours, and related activities added a better understanding of these dynamics.

Usability is not everything; there are other factors that can lead to enjoyable and engaging gameplay sessions. Researchers must look beyond usability and playability of digital games to the actual needs and preferences of older adults. Many studies have concluded that usability and playability are not the only factors that bring the older adults to play digital games (Ijsselsteijn et al., 2007; Lindley et al., 2008). It is correct that when a game is easy to play, and caters to the needs of the older adults, they are more than willing to play the game (Mubin et al., 2008). This reflects Knowles' (2008) Adult Learning Theory, which argues that adults, including older adults, learn to achieve skills and knowledge that they can apply to their practical needs. Hence, digital games and gameplay sessions should be easy, fun to play, and most importantly, incorporate learning gains that can be applied in seniors' everyday life activities.

2.4. Shifting of Attention To Older Players' Sociability In Digital Games

Recent research investigating usability and playability has also widened its focus to include older adults' motivation for playing digital games. For example, studies from Cheok, Lee, Kodagoda and Tat (2005), and Mubin, Shahid and Al Mahmud (2008) have explored how the customization of the usability and playability of digital game systems can suit the needs and motivate the game-playing mood for certain groups of older adults. Other researchers have also begun to study the social processes of older adults' gaming activities (De Schutter, 2010).

De Shutter (2010) advocates for further research from both gerontology and design perspectives to study the playing experiences of experienced older adult players, rather

than to keep focusing on having older adults playing more digital games. One example of studying the gameplay process is a study by Miller, Veletsianos, and Doering (2008) who investigated how older adult players conversed during the gameplay sessions using game communication agents built into the digital game. This communication and the ability to interact with other players were both important components for older adult players during gameplay. More recently, it was once again confirmed by Shim, Baecker, Birnholtz, and Moffatt (2010) that socialising, including the ability to interact with other older adults, was one of the most important life elements for older people, and this also applied when they played digital games.

There are many studies that focus on the tremendous benefits of digital games, especially with the advancement of technology such as the Internet and mobile computing. For instance, Cheok, Lee, Kodagoda, and Tat (2005) conducted an observational study to investigate the gaming experience in a customised digital game for older adults. The targeted participants were 35 healthy males and females, averaging 60 years old, living in a full-time nursing home in Asia.

Cheok and his colleagues (2005) developed this customisable inter-generational digital game and encouraged siblings, friends, and other older players to play the game together online, as well as at the site of a nursing home. The customised game, Age Invader, was designed to mimic the traditional arcade game Space Invader. The main theme of this game was for the players to protect their territory by shooting down any invaders, but with novel and slow-paced interactive constraint. This helped them to investigate interaction among senior adults playing games together, as well as with their friends and young gamers, both online and onsite. Their key finding was to identify the technology and game's design best suitable for the senior players that allowed them to play with their younger family members. Their main challenge was to come up with game features that would not be too difficult for seniors, nor too boring for younger ones to play together. They also implemented game features that encouraged social and physical collaboration in the family gaming systems by allowing the users, both elderly and younger, to interact through the Internet while playing the game. Results from their observations, coupled with open interview transcripts, indicated that the interactive features were very well accepted, and provided social engagement that other games

lacked. Excellent results were noted for gameplay interaction as grandparents and their siblings and grandchildren enjoyed playing games together. One of the biggest challenges in this study was the design of game features and interfaces that could meet the expectations of the two separate player groups, even though the younger participants were not the targeted participants.

Cheok and his colleagues (2005) criticised current inter-generational and common game systems, including those customised for senior players, for lacking physical and gameplay interaction components and thus greatly reducing players' enjoyment. They stressed that gameplay interaction features should be an essential component in most gaming systems made for seniors, as well as in any inter-generational games. Social and physical interactions, including verbal and body signals during gaming, were reported as vital for enjoyment and engagement when playing games together. They also concluded that well designed inter-generational games narrowed the generation gap between family members. This also enhanced the senior players' mental and physical vitality, which help them to relate and connect well with younger family members through intergenerational gameplay. With Internet connectivity, the elderly residing in nursing homes could also become more active in their gaming participation and social activities with their family members. The game also enabled family members to play virtually with the nursing home's residing seniors from their own homes or offices.

Cheok and his colleagues' (2005) research study provided a new understanding of the importance of gameplay interaction components in digital games, in an Asian context of senior adults living in a nursing home. The main aims of their study were to improve the game design and components to cater to the needs of this group of users, and to investigate how it could be played with their siblings. However, the study did not delve into details on specific social interaction activities such as gamers' collaboration, negotiations, reciprocity, gaming responsibilities, role playing, and so forth, as evaluated by Lindley et al.'s (2008) review. The other area that they did not discuss or consider was the gender differences in seniors' gaming interaction, as highlighted by Mubin et al. (2008) and Hwang et al. (2011). This is an important aspect, as it would be useful to observe how the social interaction could affect different genders, or to see if certain gender players,

who interact more with their players from the opposite gender, have other motives that are non-related to gameplay.

Most of the studies discussed here used customised digital games (Cheok et al., 2005; Mubin et al., 2008; Hwang et al., 2011) to study the social gaming interactivity for senior adults, played mainly on Personal Computer peripherals. In contrast, Vasconcelos, Silva, Caseiro, Nunes and Teixeira (2012) developed low- to high-fidelity digital game prototypes built on a tablet-based gaming platform. This tablet had the screen size of a common laptop, mobile and portable; and most of all, it used a touch screen rather than the mouse or joystick control common with other gaming platforms.

In one of their most recent studies, Vasconcelos and his researchers argued that older adults, in reality, are prone to reject technology because it has not been adapted to meet their needs. However, technology that is adapted to their needs can have a powerful impact and provide them a wide range of benefits. This happened when the tablet becomes easily available and provided a physical form-factor easily accepted by senior users. Hence, Vasconcelos and his team developed low- to high-fidelity digital game prototypes built on a tablet-based gaming platform. The subjects of study were 13 older adults (10 females and 3 males, 74-88 years old) in an adult day care centre, with multiple attempts with an improved game version. The goal of the study was to investigate the enhancement of quality-of-life and psychological well-being of this group of seniors when they played a simple cognitive puzzle tablet game together. They reasoned that it was important to study the seniors' cognitive and social well-being, due to the age-related reduction in social networks of friends and relatives that can negatively affect seniors' lives psychologically and socially. By incorporating cognitive training mechanisms into customised tablet games, they aimed to promote better quality-of-life and personal well-being through better gameplay interaction and friendly competition with other seniors.

While observing and interviewing groups of senior players who played the games, Vasconcelos and his group of researchers discovered that these players favoured playing experiences that promoted gameplay interaction, competition, and developing teamwork with other players. However, the senior players also preferred not to play games that required a lot of physical and mental effort. The physical size, portability, and touch screen

on the tablet made it very comfortable to play. From informal conversations with the adult daycare centre caregivers, they learned that older adults also preferred not to play over an extended period of time, as they grew physically tired more easily than did younger adults. This confirmed the researchers' hypothesis that older adult players have an average game-playing endurance of 30 minutes to perform maximally in gaming tasks on most types of digital games. This helped the researchers to consider redesigning games to avoid prolonged playing and task repetition. A study by Derboven, Van Gils, and De Grooff (2012) promoted taking periodic breaks while playing digital games and found that this practice could affect game-playing outcomes for older players. Derboven and colleagues also explained in their research that the social content found in games was more motivating than the user interface. Both, Vasconcelos et al. (2012) and Derboven et al. (2012) realised that user interface familiarity can be improved after prolonged or multiple gameplay. They also agreed that usability can be improved with gradual exposure and familiarisation, either to a new or unfamiliar gaming system.

2.5. The Need For Communication and Connectedness in Digital Games

Some recent studies have also moved from studying games' usability and playability to focus on the game-playing communication and connectedness of older adult players. These help us to understand how older players communicate, connect, and interact with one another. The advancement of high speed Internet connection in the last decade has promoted the development of many multiuser, networked digital games, including massive online multiuser gaming platforms (Gee, 2007). Some researchers who were quick to respond to the call of trying out new technology have also jumped onto this wagon of opportunity; but the danger of not knowing the appropriate way to implement digital games for older users is a big concern. This was also highlighted by Cheok et al. (2005), Mubin et al. (2008) and Vasconcelos et al. (2012) in their studies to identify adaptive and game acceptance levels of older adult players, and of games that can cater to their needs. The sections that follow discuss research on communicative features for older players that allow them to play, communicate, connect, and interact with other players.

Shim, Baecker, Birnholtz, and Moffatt (2010) developed a game known as TableTalk Poker, an online social gaming environment designed for seniors. They worked on user interaction to suit senior players based on the weaknesses and deterrents of the game interface designs, as learned from some of their previous research studies. Some of the interface design problems they encountered were smaller than expected text size, busy screens, the need for fast response times, lack of time between games, inadequate support for beginners, and poorly designed mechanisms for social interaction.

In the study, Shim et al. implemented an online gaming platform for senior participants, ranging between 72 and 86 years old that included online browsing experiences. Player experience varied greatly, from those who were very keen to those with no online experience. The participants were enrolled in a continuing education program for individuals over 50 in Ryerson University's LIFE program in Toronto, Canada. Participants were scheduled to play against the computer and against one another (virtually or physically) once per week for one hour. As a Flash-based web application that required a commonly available Internet browser with a plug-in Flash player, TableTalk Poker is platform- and browser-independent. For simplicity in the study, a quick two-way voice conversation between a player and his or her partner was facilitated by Skype, which was installed and set up beforehand. Participants' voices were coded after each session as follows:

- Problems that users may face,
- Subtle dynamics when players worked together,
- Conversations that might occur,
- Whether functionality was used or not used (p. 100)

Informal discussions were held to gather feedback from participants, on what features they would like to have added and how these features would appear and be used. Based on the older adults' feedback, the system was modified and improved weekly by the researchers. It was observed that frequent silence between gameplay sessions was caused by players' involvement in unrelated conversations. However, it was noted that this silence was good and important to encourage relationship building. Due to this, in-between breaks between gameplay sessions were implemented. A five-minute break was awarded after every 30 minutes of gameplay. This contrasted with typical online games

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that have no breaks or rest time, and it was also discussed in Vasconcelos et al.'s (2012) study, in terms of concern about the gaming endurance of older players.

In Shim et al.'s study, an appraiser rubric was designed to evaluate whether their system needed to expand on game engagement, learning, and social interaction based on the game's partner role-play and on voice communication between the players. This was inspired by Gamberini et al.'s (2008) work on using voice and video communication to aid gaming and social interaction. To do this, Shim and his researchers divided participants into two groups. The first group was a Treatment group that used the full system, in which players had conversational partners who could assume different roles. The second group was a Control group, in which players had no partners or communication facility. To measure the system's learning effects, a poker questionnaire was implemented, covering subjects of strategy and game rules. An interview session was conducted with the players using a standard set of social engagement questionnaires to assess and measure relationship strength between partners. Another set of social community questionnaires was used to measure relationships between opponents, and how attached they were to the community. The game engagement questionnaire was designed with a User Flow Theory to evaluate the senior gamers' flow experiences and interruptions during the gameplay sessions.

Findings revealed that social interaction and the ability to connect with players in gameplay were the most important key elements for gameplay. One of the key features implemented in the TableTalk Poker game was the voice conversation function that allowed players to communicate and interact during gameplay. Players also assumed different roles in the poker game such as peer, mentor, or learner. The result showed that allowing them to take on different roles did improve the game's accessibility and aided in their learning to play the game. The project also produced good results about the game's user-centred design, in that it was suitable for these senior users and improved those deterrents discussed earlier. Shim et al.'s study also found that a large portion of the social gameplay interaction took place in the space of the gaming environment, connected across a network through the Internet, when players played together across various locations. However, their report did not put much emphasis on what actually happened in the social space when the older adult users interacted with one another during gameplay.

Shim and his researchers acknowledged that a long-term goal was to conduct further study on how to build a gaming environment that could eliminate deterrents and provide an understanding of the need for virtual construction of gaming social interaction. Lindley et al. (2008) also noted that minimum attention has been given to what actually happens in the social space when older players play together; they encouraged researchers to look further into this area of research opportunity.

In addition to the above discussed findings, Derboven, Van Gils, and De Grooff (2012) investigated whether video chat communication could influence seniors' gaming experiences while playing simple intergenerational games with younger players. Their result revealed that all their participants, both elderly and younger players, explained their preferences based on the availability of the video chat, rather than their familiarity with the game. In Derboven et al.'s study, a brain training shopping game was evaluated, with and without video chat, after it was played by couples (one senior paired with one younger player). Conversations between these players were video recorded, timed, and tagged according to the conversation contents. The results were compared with participants' "game pleasure" ratings from a post-experiment questionnaire. This was known as the TranseCare project and was funded by the European Flemish IBBT (Interdisciplinary Institute for Broadband Technology) with industrial partners including Androme, Custodix, and In-Ham. The project lasted three years from 2007-2010 with senior participants (all over 60 years old, with an average age of 68). The project's main aim was to assist elderly people who suffered from chronic and degenerative illnesses by setting up a communication network in their home, so as to enable the elderly to communicate with medical staff, caretakers, and their family and friends. In order to encourage communication and social engagement while they were at home, the shopping game with video chat function was used to allow them to communicate, as well as to socialise with other users.

Derboven et al.'s (2012) observational study lasted for a total of four months, so as to investigate the senior users' experiences, with and without the video chat functionality. Fifteen couples of one senior and one of their children or grandchildren participated in the study. The older players, six males and nine females, were paired with five male and 10 female younger players. Pairs of gaming couples were instructed on how

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to play the shopping game while in a separate locations, connected via the Internet using video chat software. They played the game twice in separate multiplayer mode sessions: with one having video chat (condition A), and another one without video chat (condition B). Seven couples started out with the video chat game (condition A), while the other eight couples first played the game without video chat (condition B). This made for a within-subjects test design with two test conditions.

During the video-recorded observation, Derboven et al. noticed that in condition A when the gaming couples played the game, they tried to remember to buy the items from the same grocery list through the video chat store. The gaming couple was able to see the content of each other's shopping carts and make use of the video chat to discuss and negotiate about the gaming tasks on what items to buy, and what not to buy. In condition B, both gaming couples also tried to remember to buy the items from the same grocery list according to the gaming task. They were also able to see the content of the shopping cart of one another. However, it was obvious from the observation through the video recording that the lack of video chat prevented discussion between the gaming couple about which items to buy.

Another significant finding by the Derboven et al.'s study was that, on average, 30% to 60% of gaming time was used in discussing the gaming tasks and game interface in condition A, with video chat. A post-test questionnaire was used to document the players' experiences after playing the game, specifically whether they liked the game they just played, and which version they preferred (with or without video chat). About 60% of the senior gamers stated clearly they preferred the game with video chat, while 40% found both games, with and without video chatting, equally fun. Even when the couple-players were relatives, it was observed that only an average of 1% of the total conversation time was used for personal topics. This showed how engaging and motivating the gaming sessions could be when the players were able to communicate well, especially for the purpose of achieving their gaming tasks.

The Derboven et al.'s study also pointed out that the senior players valued the social aspect of playing games with others, including the younger players. The ability to be helped, guided, and able to discuss the gaming tasks provided an extra social

dimension, promoting more than the usual players' interaction, collaboration, and engagement of the gameplay. This also helped to make the digital game more appealing to the players. Video chat used in an intergenerational gaming context created extra excitement, and was a useful addition to the gaming experience for both the younger and elderly players.

Derboven and researchers also explained that players' communication and social content, supported by the chatting feature of the shopping game, were more important for motivation than was the user interface. From their experiences, they realised that user interface familiarity can be improved after prolonged or multiple game play. Their stance was that usability can be aided by gradual exposure to a new or unfamiliar gaming system. This was slightly contradicted by Cheok et al.'s (2005) and Hwang et al.'s (2010) research studies that stressed the importance for older users' usability and the gaming interface, both of which can affect their adaptation; and argue for redesigning of digital game customised for this group of older players.

Nevertheless Derboven et al. reported that younger and older players enjoyed playing games together, with collaboration, negotiation, and learning from one another. The learning curve of playing games initially was lower with communication and assistance from the younger player. This indicates that playing games in a group or with another partner (the younger one in this study) can improve the learning stage of the new game. It also can remove many negative emotional effects such as frustration, fear of technology, nervousness, feelings of being lost, and so forth, found especially in initial gameplay sessions. Similar to Hwang et al.'s study, the strength of Derboven et al.'s study also stressed on defining the background of the seniors: in their case, seniors who have suffered from chronic and degenerative illnesses due to old age. As in Gamberini et al.'s (2008) ElderGames project, they studied the video facility in digital games and its potential to enhance the social activity of senior gamers playing games together. However, further improvement of their study can be done by defining more specifically the terms of social engagement and interaction used; for instance, what types of interaction (negotiation, agreement, role-playing, etc.), or the frequency of occurrence of each one of these types of interactivity.

2.6. Current Discussion on Social Connectedness in Digital Gameplay

Many studies have shown interest in digital games' cognitive and social benefits. However, for this study, the focus is on social benefits, with emphasis on the importance of older adult players' social connectedness during social gameplay activities.

A lack of socially-related activities can lead to poorer cognitive performance in the later life of elderly folks (Engelhardt, Buber, Skirbekk, & Prskawetz, 2010). Engelhardt and his colleagues were assigned to analyse the data collected by the Survey on Health, Ageing, and Retirement in Europe (SHARE) from 11 European countries and Israel, between 2004 and 2006. The analysis sample consisted of 22,949 people (10,902 men and 12,047 women, mixture of day care and full-time nursing home residents), having a mean age of 62 years for men and 63 years for women. From the analysis, they discovered that improvement in an older adult's cognitive performance (memory power and reasoning abilities) was correlated with the person's social lifestyle, social involvement, and the way the elderly socialised with other elderly people. The level of social involvement and size of social network were positively correlated with the cognitive abilities of the older adult. Cognitive abilities, according to Engelhardt and his colleagues, included crystallised abilities that comprise accumulated knowledge and skills, such as the meaning of words and size of vocabulary, learned during their younger days. Fluid abilities refer to those that involve performance in terms of speed and reasoning abilities, in relation to learning and processing new materials. For older adults, crystallised abilities tend to stay with them as they grow older, whereas fluid abilities normally decline over the adult lifespan. Engerhardt et al. recommended that technology designed for older adults should focus more on utilising crystallised abilities when dealing with usability. They argue that technology, including digital games, is a preferred medium for research on improving and maintaining the fluid abilities that decline as older adults age.

Digital games are fun to play, especially when they are being played in a group of multiple players, rather than alone. When playing with other players, one of the key elements for an engaging gameplay session is constructive interaction and involvement between players. In a recent critical review of the literature, Lindley, Harper, and Sellen

(2008) reviewed research works conducted on interactive technology including digital games for older adults. They systematically reviewed 53 significant literature studies from the fields of Gerontology, Human Computer Interaction and Human Factors published between 1990 and 2005. Their theme of inclusive review of the literature included social activities like reciprocity, autonomy and the renegotiation of roles, and gaming responsibilities of senior adults above 60 years of age during digital gameplay sessions. Articles found were then organised into groups and analysed according to the social activities (reciprocity, autonomy, renegotiation of roles, and gaming responsibilities) during digital gameplay, and according to the perspectives from the fields of Gerontology and Human Computer Interaction. They evaluated the research design of each study and recommended some of the studies that had produced valuable information for further research on the social aspects of digital games.

Lindley et al.'s evaluation discovered that many studies have been designed and implemented with too-simple assumptions about the needs of senior players, who often have more complex issues than expected. They mentioned that looking at seniors from a Gerontologist perspective, revealed that some studies had not identified the relationship roles and identities that seniors had with their friends and peer groups, when they socialised or gathered together. On the other hand, from the perspective of Human Computer Interaction, they expressed their concerns on how some studies lacked focus: applying too much context and scope, including having seniors continue their engagement with community, and at the same time, with family, with the assistance of interactive technologies. They found that most literature, especially in the field of Human Computer Interaction, focused mainly in the physical and cognitive development of this group of users with the aid of technology. They pointed out that some studies needed to be viewed with extra caution, because it's not just the physical interface or usability of the games that can meet the needs of this players, but what the senior gamers wanted from playing those games. Based on their analysis, Lindley and his research team suggested that seniors were highly motivated to engage in meaningful relationships with community and family in the last phase of their lives. Therefore, technology and games developed for seniors should emphasise more on building relationships and social connections (meaningful networks of relationships with other seniors), besides concentrating on the usability design and technical improvements in the games.

In challenging Lindley et al.'s review, Hwang, Hong, Hao, and Jong (2011) noted that it seemed to exclude some important literature that revealed significant findings from various customised games and inter-generational games for older adults. Another group of researchers, Shim, Baecker, Birnholtz, and Moffatt (2010) also criticised Lindley et al.'s review. Shim et al. pointed out that most part of the review were limited to how social activities have an effect on the gaming sessions. Shim et al. stated that Lindley et al. should have also evaluated the correlations of social activities and effective gameplay. For instance, when older adult gamers were socially and emotional stable, they tend to play digital games longer (Causality). In addition, when older adult gamers were socially and emotionally stable, they tended to agree that playing digital games was meaningful time spent with friends (Correlational). Despite that, both Hwang et al. and Shim et al. agreed with Lindley et al. that more studies should be conducted to measure or understand the social-emotional activities of older adult gamers. Other measurements they recommended could take the form of measuring seniors' technological backgrounds, previous gaming exposure, responses to gameplay, and so forth.

Despite many findings that state that older adult users play games less often than their younger counterparts, Ijsselsteijn, Nap, de Kort, and Poels (2007) discovered that the majority of older adult players were actually receptive to the use of new technologies. It is obvious that older people do not want new technology to replace their routine way of doing things, but games for social and educational enhancement are very much welcomed and accepted by them as part of their regular social activity. Ijsselsteijn and his colleagues also informed us that researchers should investigate more on how older adult players are able to engage with one another, while using this new technology, instead of just focusing on the usability issues. Their emphasis is that having good usability features in games is not enough to motivate the elderly to use gaming devices; although motivation is important, the feeling of being engaged when using the new technology is more important than just ease of use.

Ijsselsteijn and his colleagues conducted a critical review of 35 pioneering research studies done on digital games played by senior adults (60 years old and above); these studies were published during the period 1985 to 2005, and specifically focused on identifying the social connectedness (meaningful conversation and any other type of

information exchanged between players) of digital games. Like Lindley et al., they hoped to draw conclusions about the importance of sustaining socio-emotional activities during gameplay among the older adults. Their review of the literature revealed findings about digital gaming benefits on improving mental and physical well-being, as well as enhancing older adults' social connectedness with other players.

From the review of these studies, Ijsselsteijn and his colleagues also compared both non-digital games such as Trivia and Bingo, and modern digital games, especially those for the Nintendo DS. Findings from these studies revealed that when the key features of socialising, interaction, and players' connectedness were included during these gameplay, older adult players valued these features far above the usability, gaming challenges, and technological features. Along with communications technologies, they discovered that digital games seemed to have the potential of improving older adult players' social connectedness and quality time spent with other older adults and relatives. Through long distance digital communication features found in some of the modern digital games, opportunities could be developed for older adult players to socialise with one another. Ijsselsteijn and his researchers also concluded that, when older players played digital games together in both online and physically close environments, it helped them to develop social bonds among themselves. Furthermore, the enlargement of older adults' social support structures, in the long run, also helped enhance social connectedness between players. This was consistent with the Derboven et al. (2012) observational study that investigated how video chat communication can influence the gaming experience. Derboven et al. pointed out that senior players valued the social aspect in playing games with others, including younger players. When they could be helped, guided, and able to discuss the gaming tasks, there was an extra social dimension that encouraged more than the usual expected players' interaction, collaboration, and engagement. This also helped to make digital games more appealing to them, rather than another boring, single-use technology.

Ijsselsteijn and his researchers disagreed with some of the findings revealed in their literature review. They suspected that digital games used in some of the studies were not suitable for this group of gamers. They highlighted challenging gaming interfaces in some of the studies that required rapid physical movements and reactions, which could

create unenjoyable experiences and make players subsequently avoid playing the games. There were also graphical challenges with smaller-sized objects on the game interface screen. Besides the usability of games for senior gamers, Ijsselsteijn et al. concluded that there was a need to explore seniors' gaming experience, including how games could motivate them, so that they would be willing to invest their time in them. They stressed that there is a need for more well-controlled studies to ensure the unambiguous effects of different genres of digital games (online, educational, intergeneration, etc.) and various types of elderly players (age, health, living condition, residential types, etc.). There is an even greater need to explore in detail the process of how games are being played, and the problems faced by older adult players, rather than simply reporting on the benefits achieved through digital games.

Ijsselsteijn et al. also explained that social interaction and connectedness developed during gameplay, as a result of the social interactivity embedded features designed in digital games, are important for motivating older players. This was consistent with Mubin et al.'s (2008) micro-ethnography study, with findings that led them to define three key design principles which were later incorporated into their final game design, and future recommendations to related study:

- To design a game which encourages senior players to be more active in participation (both active and passive involvement),
- To design a game which encourages them to interact with each other during game play,
- To design a game which has simple rules yet provides fun (p. 12).

Ijsselsteijn and his colleagues' critical review provided many insights and opportunities for future research. Ijsselsteijn and his colleagues reported that 57% of the articles cited a theoretical or conceptual framework drawn primarily from their own field of Gerontology, Human Computer Interaction and Education. In addition, they called for more explicit attention to explore digital games from other fields, and acknowledged the importance of social connectedness and players' interaction in game play. It is interesting to note that all of the 35 pioneering research studies analysed were conducted in the European and North American settings. Moreover, they argued that most of the studies reviewed should have taken into account the context and health condition of older adults, especially their physical and social conditions. In the various studies, seniors' living

environments seemed to vary across living independently, in assisted day care centres, or in assisted-living full-time residential homes. Ijsselsteijn et al. did not consider older adults' gender differences or how these could affect the results of the gaming interventions in the studies.

Shim et al.'s (2010) study, with the online social gaming environment TableTalk Poker for older adults, reported that a large portion of social interactivity and players' connection actually took place in the space of the gaming environment. This included gaming sessions that were played and connected across a network through the Internet, when people played games together across various locations. However, their report did not put much emphasis on what actually happened in the social space when the senior users interacted with one another. Shim and his researchers also acknowledged that in the longer term, a gaming environment should be built that eliminates deterrents, and further research is needed to understand the virtual construction of gaming social interactivity. Lindley et al. (2008) also noted that minimum attention has been paid to what actually happens in the social space when older gamers play together.

Hwang et al. (2011) discovered that game playability was affected by high frequency of senior gamers' interactions. Their study discovered that older players' unfamiliarity with the interface and functionality of a digital game could lead to frustration and a reduction in the flow experience of gameplay. However, once players familiarised themselves with the interface and maintained their gameplay, they were like other groups of younger players in being able to achieve high-flow experience with less interruption and longer playing times. Their study revealed that the increasing frequency of senior gamers' interactions during gameplay was one of the factors leading to longer playing times in gaming sessions.

Social benefits, especially being socially connected and able to interact socially while playing games, have been an attractive study focus for many researchers. Research on sociability in digital games involves investigating the social processes of players, or what happens when older adult players play digital games together, especially in a multiuser gaming platform.

It is important to investigate the social process, besides knowing the social benefits derived from social gameplay. By knowing the social process and experiences of gameplay, we can further understand what actually goes on during the game-playing event, and what seniors want from digital games and gameplay. With a better-informed understanding of the social process of gameplay, older players can look forward to playing digital games that meet their needs.

The potential of digital games for older adults looks optimistic. A recent study by Kaufman (2013) reported that there is a large and diverse group of older adults who are still actively and regularly playing digital games (p. 6). Kaufman's study combined four years of multiple research studies investigating the effect of digital games on enhancing older adults' cognitive and social lives. In a survey of 891 adults aged 55 years and older, he used cognitive and socio-emotional measures in a questionnaire to identify older adults' ratings of socio-emotional and cognitive changes as a result of digital gameplay. Some significant findings were reported: 88% of survey respondents played at least one day or more per week, on average. Interestingly, 93% of these older adults played an average of 2-5 hours per day. Also, 83% of respondents responded that mental exercise was the greatest benefit of playing digital games, followed by 71% respondents who chose enjoyment or fun. These were followed by the social and emotional benefits of playing games: social interaction (26%) and escape from daily life (26%).

2.7. Social Connectedness of Players Leading to Social Capital Gain

Social capital is significant for the successful aging of older adults (Cannuscio, Block & Kawachi, 2003). Social Capital Theory as a framework for this research study helps us to define the types of social capital gained by the older adults when playing digital games in groups. This is essential to help us understand older adults' involvement as members of organisations or groups.

Social Capital Theory has been adopted in digital game research to investigate the effects of computer-mediated intergenerational game as entertainment and socialization aids between older and younger adults. One recent example was a pilot study conducted

by Yin, Puay, and Tan (2012) that used Nintendo Wii games to understand how intergeneration digital game was used as entertainment and socialization aid to promote positive mental and social health for older adults. The study grouped 14 pairs of elderly-teenager participants. It produced positive results in which general attitudes towards the other age group improved after a period of playing (elderly towards teenager players scored the highest). This study also concluded that intergenerational games, when designed and implemented appropriately, can facilitate the building of social capital and bonds for the elderly; in this case, there were improved attitudes toward the other age group. Before playing the game, the elderly participants had lower than expected opinion and tolerance towards the youths, due to their prolonged period of feeling isolated from this community. However, their attitude changed after a series of gameplay sessions that built trust and positive social experience among the players.

Research studies conducted using Social Capital framework has generally used proxy indicators to understand and eventually measure the social capital gained by individual persons, or by a group of seniors. In research practices, the investigation of social capital gained by a participant can be measured through formal membership in an organisation or group. Other measures include participation in a civic organisation or informal socialisation activities with other members in a community. Larger-scale formal measurement can be in the form of participation involvement in social activities, the density of membership of a civic organisation, or the level of trust between an older adult member and a community (Kawachi & Berkman, 2000, cited in Cannuscio, Block & Kawachi, 2003).

Social capital gained by digital game players can be accessed using social components and features used in the game, as well as by identifying the social activities manifested during gameplay. Digital games have been researched and reported to be an exceptional means and technology for older adults to meet and socialize with each other, especially in their leisure time (Gajadhar, Nap, de Kort & Ijsselsteijn, 2010). It is not surprising to see that many studies have reported on the increase in players' social capital (Nap, De Kort & Ijsselsteijn, 2009; Wollersheim, Merkes, Shields, Liamputtong, Wallis, Reynolds & Koh, 2010; Allaire, McLaughlin, Trujillo, Whitlock, LaPorte & Gandy, 2013). The improvement, found in psycho-social connectedness among players, is promising and

encourages further exploration on the sociability of this media, which is often considered merely as an entertainment product.

It has also been reported that more than half of digital game players who play social games online have shown an increase in the social capital of making new friends and players, which they continue by playing online and sharing social resources (Litwin & Shiovitz-Ezra, 2011). It is not a surprise to see that digital games have also been found to provide strong social engagement among players in multiuser gaming environments, which can lead to better socio-emotional wellbeing (Miller, Adair, Pearce, Said, Ozanne, & Morris, 2014). Mclaughlin, Gandy, Allaire and Whitlock (2012) reported positive players' response to gameplay, when they have the ability to connect and socialize with other players; as this was crucial to the emotional health and engagement of game-playing, when playing with other older players.

De Schutter and Vanden Abeele (2010) developed a list of social and emotional meanings for digital gameplay activities, including connectedness, cultivation, and contribution. De Schutter and Vanden Abeele explained that digital gameplay is an activity that structures a conversation with other players, facilitates meeting new players, and is valuable for coping with loneliness. Despite this, a handful of older players dislike meeting strangers or someone that is unfamiliar, especially an online game. This makes local co-playing setting a much preferred gaming environment, where older players can play face-to-face with other players, even someone they do not know, but can see their face and physical presence. This is contrary to Gajadhar, de Kort, Ijsselsteijn and Poels (2009)'s finding that older players enjoy playing online games but do not enjoy playing with a virtual, non-existent player or with a computer opponent. Still, De Schutter and Vanden Abeele's list of social and emotional meaning for digital gameplay provides a useful guideline to help us understand and probe the social meanings of digital gameplay of older adult players.

A study by Gajadhar, Nap, de Kort and Ijsselsteijn (2010) of the effects of various co-player settings on social gameplay, revealed that the presence of players in a co-playing setting had a substantial impact on older players' gameplay experience. Gajadhar et al. also found that seniors in their study preferred playing against a human co-player

rather than a non-human virtual player. Senior players reported positive gameplay experiences, especially the opportunity for social interaction with face-to-face human players. Their finding revealed that seniors experienced less enjoyment when playing over the Internet with other players was consistent with the earlier finding by Nap, De Kort and Ijsselsteijn (2009). Gajadhar, de Kort, Ijsselsteijn and Poels (2009) also reported that digital game players testified of social fun: activities that were related to social interaction, social competition, and escaping from reality. Gajadhar et al. confirmed that having a physical co-located environment where the older players can play together socially and engagingly, is the primary motivator for them to play digital game.

Because gaming's social component has been missing in many theories and models for studying players' gameplay experiences, digital gaming platforms have not been fully valued as a social medium, affecting socialisation of bringing many players together (Klimmt, 2003; Ermi & Mäyra, 2005; Sweetser & Wyeth, 2005). There are still opportunities to investigate social capital gained by older players, particularly with respect to the social connection of older players in various types of game settings and environments. For example, Gajadhar, de Kort, Ijsselsteijn and Poels (2009) reported on older players' acceptance of digital game co-playing in various multi-player settings. Their study also revealed a need for more research on older players' social needs when playing in multiplayer environments.

2.8. Understanding Older Adults' Learning Experience through an Adult Learning Perspective

According to Knowles' Andragogy (1980), older adults are most interested in learning a new topic that is both practical and useful for their needs. Digital games with learning purposes for older adults should aim at these objectives, in order to encourage this group of players to invest their time and effort in gameplay.

Andragogy consists mainly of five assumptions underlying the concept of an adult learner:

1. Has an independent self-concept and can direct their own learning,

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2. Has accumulated a reservoir of life experiences that is a rich resource for learning,

3. Has learning needs closely related to changing social roles,

4. Is problem-centered and interested in immediate application of knowledge, and,

5. Is motivated to learn by internal rather than external factors (Merriam, 2001, p. 5).

Since the 1990s, scholars studying andragogy have taken two separate directions (Merriam, 2001), some maintaining Knowles' original concept, and others finding it lacking emphasis on the external social context where learning occurs. Grace (1996) pointed out that Knowles never considered "the organizational and social impediments to adult learning; he never painted the 'big picture'. He chose the mechanistic over the meaningful" (p. 386).

From an adult theory perspective, older learners want learning outcomes to be practical and transferable to their everyday lives. This applies to playing digital games, when they are likely to gauge, through a cost-benefit analysis, whether it is worth investing their time and effort to play (Mclaughlin, Gandy, Allaire & Whitlock, 2012). Older adults are keen to use technology when they find it beneficial (Melenhorst, Rogers & Bouwhuis, 2006). This becomes important when developing game content and gameplay events, as older players may not see the usefulness of a digital game, but instead view it as an entertainment product (Hsu & Lu, 2004). Some might even have negative initial thoughts of receiving a new game with which they are not familiar. However, when well-developed games are able to provide a social and engaging flow experience, players' perceptions of the game will eventually change.

Integrating learning and educational elements in a digital game provides an opportunity for players to learn while playing games they like. A few recent studies have reported on older adults positively accepting digital games that offer learning objectives, as well as giving high regard to the learning experience, not simply playing for entertainment purposes (Pearce, 2008; Wang, Lockee & Burton, 2011; Nap, De Kort & Ijsselsteijn, 2009). Other researchers (Whitlock, McLaughlin & Allaire, 2011; McLaughlin, Gandy, Allaire & Whitlock, 2012) have suggested looking at games' social enhancements in addition to their usability and playability. Marston (2013) agreed with the suggestion that

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digital games should provide a purpose for the players, so that they themselves know what is the end goal or reason for them to play. This ultimately keeps them focused and engaged during gameplay, which eventually builds their self-confidence and knowledge of the game. Most of these recommendations are consistent with Knowles' Andragogy (1980), arguing that adults learn to achieve knowledge and skills that are beneficial or applicable to their needs.

Besides learning gained from games' embedded content, learning in digital games, which also involves gameplay interaction with other players, should include knowledge and skills that can be applied to the everyday lives of older players. Knowles explained that adults, especially those middle aged and older, have accumulated rich life experiences and knowledge which make them see learning as goal- and relevance-oriented activities. Learning should also motivate them, and this makes multiplayer digital game a choice medium for providing the motivation they need, to help them maintain and stay competent with new skills and knowledge, and to age well.

Driscoll (2000) explained that knowledge can be constructed from learners' experiences. From an andragogic point of view, knowledge can be constructed whether it is being taught or received through an activity, in this case, game-playing sessions. Griffiths (2005) highlighted that besides the fun elements of digital games, serious educational aims and content should be included. Marston (2013) also found adults to be highly interested in learning something useful and practical to their current needs; she recommends that games should provide players with a purpose, so that they themselves know the end goal and objectives of playing. Digital games are more likely to draw older players' interest if their current needs are considered.

2.8.1. Learning and continual learning for older adults

Continual learning has long been encouraged for older adults. Education and learning have been considered important for older people, as a form of participating in society and maintaining a positive quality of life (WHO, 2002, p. 16). In fact, learning a new topic or skill, or learning to master an existing skill, plays an important part for older adults in aging productively (Ardelt, 2000; Dench & Regan, 2000).

Learning seems to be a non-stop event in this modern world. With today's technology and rapid societal changes, it is recommended that older adults continue with learning, especially on using newer technologies. Ardelt (2000) suggests that older adults should continue learning to keep up with technological and scientific advancement. This, in turn, allows them to enjoy the benefits that technology can offer for them and to maintain their quality of life: improve their self-reliance, enhance life-style sufficiency, and improve their ability to cope with physical, health and social needs (p. 772).

Consistent with Ardelt's suggestion, Dench and Regan (2000) also encourage life-long learning for older people. They suggest that learning, be it formal or informal, is able to promote active minds, self-confidence, life satisfaction, life coping ability, increased social involvement, and better health and enjoyment for older people (p. 1). They emphasise that the most important of all these benefits is the ability to keep minds active and take up learning challenges. Andragogy scholars Boulton-Lewis, Buys, and Lovie-Kitchin (2006) agree that keeping the mind active and exercising the mind regularly are beneficial to older people, keeping them mentally stimulated, keen to attain goals, and constantly seeking learning opportunities (p. 279).

Withnall (2000, cited in Boulton-Lewis, 2010) argues that older adults are motivated to learn for self-fulfillment and pleasure. Self-fulfillment can also be a form of acquiring better understanding and gaining new individual insight. Withnall suggests having older adult learners involved in the development of learning instruction and design so that we can better understanding their meaning, or learning components that represent their needs and interests. This also prompted Boulton-Lewis (2010) to seek more investigation of older adult learners' attitudes to learning, especially the why, how, and what they want to learn, rather than what we think they wanted to learn.

Chang and Lin (2011) emphasise that lifelong learning should be a way of life for older people in the 21st century. They argue against the stereotyping of older adults as unfit for learning, as a result of their weakening physical, mental and sensory being. Instead, they encourage older adults to keep on learning and continue their participation in learning activities, especially learning that promotes physical and mental health. They

also recommend that older adults should spend their long days wisely, and the most ideal way of spending their day is to continue learning.

2.8.2. Digital game-based learning with older adults

There are many ongoing research efforts to investigate the tremendous benefits and potential of using digital games for learning purposes. One such area worth discussing is Digital Game-Based Learning (DGBL). Digital game-based learning aims at making learning engaging by focusing intensely on identifying the motivation of game. Digital games should be capable of providing a process of play through which players can actively experiment and learn through mistakes, feedback, experience, and discovery (Mayer, 2005).

Digital game-based learning has garnered high attention recently, after extensive research that provides evidence of how it can be effectively used. This has helped to silence critics who have been very much against using digital games for learning (Van Eck, 2006). Serious games, with relevant content and customisation, can be suitably used for learning particular topics, with learning content embedded within the game.

Game is not just play; game also has a place in learning (Van Eck, 2006). Play and learning are related. When players play games, they are personally involved with what they are seeing and doing within the game, attaining various levels of gaming tasks, and interacting with other players (Mayers, 2005). "A motivated learner can't be stopped … It therefore makes a great deal of sense to try to merge the content of learning and the motivation of games, and this is indeed what is happening" (Prensky, 2003, p. 1). Learning requires effort, and learners, especially adults, will not likely do it without a motive, which might include the gaining of a reward, attaining a goal, or pleasing someone. Digital games can offer adult players a high level of motivation in learning, and can be played for hours with other players. (Mayers, 2005).

Although the research on game-based learning is expanding, it focuses mainly on younger players. The older audience has generally been excluded from this research trend, and very little has been studied with older players (Wang, Lockee & Burton, 2011). Still, it is worth knowing what has been done in the area of game-based learning, and how

to improve in the area of using digital game for learning, especially for older players. For instance, an area of game-based learning worth investigating for older players is game flow for players (Sweetser & Wyeth, 2005). This includes the enjoyment or flow of playing in digital gameplay. The game's flow can also include the flow of players' experiences in gameplay: gameplay immersion, clarity of goal, challenges, autonomy, feedback, concentration, and players' interaction (Csikszentmihalyi, 1991). Despite that, the game flow experience can be different for young and older adult players. For instance, Nap, De Kort and Ijsselsteijn (2009) reported that older players see the ability for players to interact as more important than anything else in digital gameplay. The overuse of challenges can also make less-experienced older players shy away from playing games (Whitcomb, 1990). It will be interesting to see more research produce findings in the area of defining the game flow of older players.

The area of digital game-based learning and research on utilising digital game for learning is also sparely unified, with different terms and definitions being used to describe idea and thoughts. A systematic review of games and simulation game from 1998 to 2008 by Sauvé, Renaud and Kaufman (2010) outlined the definitions of game used in an educational context. Sauvé et al. concluded with six common essential attributes: (1) one or several players, (2) conflict, (3) rules, (4) a purpose determined by the game, (5) artificial character, and (6) the educational character (p.3). Sauvé et al. also described learning gained through gameplay as a process of acquiring knowledge, or new behaviour. A critical review of educational game literature also classified learning through games as the acquisition of new knowledge, development of intellectual skills (e.g. abstraction, problem resolution, lateral thinking), development of behaviours, and attitudes of players (p. 5).

2.9. Understanding Older Adults' Learning Experience through Social Gameplay

Since the Bingo game used in this study is a multiplayer game, the social components among players themselves could create an engaging and motivating gaming session, which ultimately can lead them to regular gameplay and social learning activities. This was reported by Gee (2007) in his discussion of massively multiplayer digital games and the learning being offered by digital games when players played collaboratively in

teams. This allows players to share knowledge, skills, and value to support each other's gaming and social identities during the gameplay sessions, eventually leading to engaging global gameplay sessions amongst players both young and old. Mubin et al. (2008) confirmed that in multiplayer games, players feel most engaged in a game when playing socially with other competitors, alliances, or team members to accomplish a task.

Learning socially with other learners and agents is associated, and concerns the social world surrounding learners. As explained by Stahl (2004), in social learning, knowledge is being socially constructed, and any meaning that a person makes for himself is constantly being negotiated socially in the external world. Stahl uses the term "social epistemology" to describe how learning actively is able to promote knowing, which is interactively constructed among learners themselves during a group discourse (p. 57). His interpretation of the social constructivist learning style is concerned about knowledge and collaborative knowing, with a more obvious interest in defining the "cycle of knowledge building" in his research (p. 62).

Collaboration, including interaction among learners with the aid of digital media like multiplayer digital games, is widely studied using social constructivist theory on how gamer-learners collaborate in a group discourse, particularly the in building knowledge and knowing (Stahl, 2004). Other tools, such as a multiuser online discussion forums, are popular supports for researchers studying the processes of learning and cognition, which often take place at the learners' group level discourse (Stahl, 2004, 2005). For massively multiplayer digital games, Gee (2007) studied how the players play collaboratively and interactively in teams, where players can share knowledge, skills, and values with each other, both within the game and when connected with other players across the globe.

Collaborative and interactive activities for learners are simply discussion and working together on tasks. However, these take place within other activities of learning and cooperation, as well as during individual meaning-making and social enculturation of concerning the surrounding culture of learners (Stahl, 2004). It is not just communication that takes place during a group's discourse, collaboration and interaction, but also the creation of a learning situation that promotes learner engagement (Jonassen, Cernusca & Ionas, 2007). Interactive activities among learners in a group discourse or interaction

also involve negotiation of meaning, argumentation, working together on tasks, and so forth, that are worth studying, specifically the cognition process and knowledge building (Stahl, 2004).

It is essential to understand adult learners' social learning environments, particularly the social constructivist learning environment. Such an environment normally includes: (1) the opportunity to socially negotiate and mediate their learning needs, learning content and relevant outcomes, (2) learning tasks within the learner's existing knowledge, (3) learning that takes place in a real world environment, and (4) adult learners' autonomy (Doolittle, 1999, p. 6). Through interaction with other players, new meanings that were discussed, negotiated, and ultimately agreed upon are developed into new knowledge, which override prior knowledge built on previous social systems (Vygotsky, 1978; Mezirow, 2000; Ore, 2003).

2.10. Current Research on Digital Game Learning Opportunities for Older Adult Players

With regard to learning by older adults through co-playing digital games, some learning activities have been classified as social skills. As identified by Ijsselsteijn et al. (2007), these include negotiation, making agreement, setting new rules, identifying of gamers' roles, helping one another during gameplay, and so forth. Most of these learning activities are social in nature, normally involving interaction among players, and are concerned about the surrounding social environment. Other types of learning that have been studied include those related to a player's ability to identify other players' gaming characteristics, being more attentive to other players' needs, and adjusting roles to suit to the surrounding gaming environment (Ijsselsteijn et al., 2007; Mubin, Shahid, & Al Mahmud, 2008; Engelhardt et al., 2010). It has also been found that the knowledge gained from analysing gaming tasks was also seen as quickly transferred to the older adult players' daily social lives, eventually leading them to make better and faster decisions in related real-life situations (Mubin et al., 2008; Vasconcelos, Silva, Caseiro, Nunes, & Teixeira, 2012).

Other studies conducted by Mubin, Shahid and Al Mahmud (2008) and Derboven, Van Gils, and De Grooff (2012) have also shown that older adult players have high regard for the knowledge gained as part of an achievement in gameplay activities, and this makes them want to play the game continually with other players. This is consistent with Nap, De Kort & Ijsselsteijn's (2009) findings that older players appreciate the educational value of digital games and their improvement in technology literacy through gameplay.

The educational and learning benefits of utilising digital games for younger players have attracted many scholars, with ongoing research opportunities exploring digital games' potential (Gee, 2003, 2007; Chuang & Chen, 2009; Barab, Gresalfi & Ingram-Goble, 2010). However, for their older adult counterparts, very little is being studied on games' learning and educational benefits. Despite that, other researchers have been turning their attention toward this group of players in recent years.

It has been understood that most younger players (below 60 years old) aim for achievement in playing games, chasing after rewards based on accomplishing higher levels of gaming tasks, game scores, or fame in gaming communities. For older adult players, however, the learning and enjoyment of playing with other players are two of the top motives that lead them to play digital games regularly (Ijsselsteijn et al., 2007). This was confirmed by Vasconcelos et al. (2012), who found that it was not the rewards or achievement of gaming tasks that were most important to older gamers; rather, the fun of playing with one another, along with the social and gaming skills gained from the multiplayer social games, were most important. Besides the improved user interface and physical form factor of the tablet digital game system used by Vasconcelos et al., it was learning that made the gameplay engaging and enjoyable. Vasconcelos et al. also found learning new skills as a result of the accumulated gameplay that led older adults to play the game again. Their study found that when senior players kept playing a simple cognitive puzzle tablet game, they developed better concentration, which eventually transferred to their everyday lives of handling daily activities faster and with better attention.

Digital games have also been found to improve computer literacy among older players (Wang, Lockee & Burton, 2011). Wang et al., reporting on a survey of 40 older Chinese players, found that after a series of gameplay sessions, players had an increased

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understanding and interest in technology. This included interest in how the Internet functions, so as to improve their understanding of online gameplay and related activities.

A study conducted by Marston (2013) used a mixed method study with an ethnography focus, including prolonged staying at the participants' site. Marston's study used mainly game design workshops and observations, with two separate groups of participants: Group 1 (n = 24, M = 64 years old, SD = 6.21, 10 males & 14 females) and Group 2 (n = 68, M = 57.4 years old, SD = 10.75, 40 males & 28 females). The game systems chosen were Nintendo Wii and Sony PlayStation, as both game systems allowed players to demonstrate various types of interaction with simple gaming content. The results of this study produced design guidelines that emphasised identifying gaming interaction, and content suitable for older adults to achieve effective gameplay and engaging experiences. Their findings also revealed that older adults took into account benefits of digital games that included social enjoyment, competitiveness, feeling connected, and education for oneself and other players (p. 116). Marston also recommended integrating player interaction and learning content in digital game design. Marston made a good point about providing players' ability to learn as a goal and objective for playing games. She suggested providing various levels of game tasks and difficulties to aid the learning process, knowledge gained, and self-confidence improvement for the older players. Further suggestions included games to provide positive feedback on the progression of play, in order to enhance players' awareness of their gaming performance and identity. Marston's study shed some new light on the need to encourage game design to meet older adult players' needs for interaction, learning, and self-confidence.

Similarly, in an earlier study by De Schutter and Vanden Abeele (2010), a combination of contextual inquiries and participatory design sessions was used to develop digital games that reflect game concepts of elderly life. Participants of this study included ten 68- to 80-years-old Flemish senior citizens (seven men and three women). Their game design theme consisted of Activity, Connect, Cultivate, and Contribute. Activity was the gaming activity the players needed to accomplish. Connect was how players could interact with other players. Cultivate was learning and knowledge gained from gameplay. Contribute was about contributing to society from learning through gameplay. The participatory design with the elderly participants shed new insight, in which the game's

Activity component, was surprising not the priority chosen by the elderly participants. The other three components (Connecting, Cultivating, and Contributing) were found to be equal in priority. It was also interesting to see how the elderly players heavily emphasised the importance of cultivating knowledge and learning gained from playing digital games, often neglected by other researchers.

Other researchers have also emphasised cultivating learning in digital gameplay for older adults, but not to the detail and emphasis of Marston, De Schutter, and Vanden Abeele. Nevertheless, the recent study by Derboven, Van Gils and De Grooff (2012) noted the importance of identifying players who were learning socially from one another, with collaboration and negotiation skills learned in intergenerational games. Derboven et al. realised the importance of embedding learning topics in digital games, as well as learning to play a game with the assistance of other players. They also found that playing games in a group, or with another partner, could improve the learning stage of a new game, as well as removing negative emotional effects like frustration, fear of technology, nervousness, and feelings of being lost during initial gameplay sessions.

The critical review of the literature on digital games for older adults by Ijsselsteijn et al. (2007) also identified some of the common learning skills in games, including negotiation, making agreements, setting new rules, identifying gamers' roles, and assisting others in gameplay. Most of the learning was social in nature as it involved interaction among other players, and was concerned about the surrounding social environment. Other types of learning cultivated from gameplay included learning to identify other players' gaming characteristics, being more attentive to other players' needs, and adjusting oneself to suit the surrounding gaming environment (Mubin, Shahid, & Al Mahmud, 2008; Engelhardt, Buber, Skirbekk, & Prskawetz, 2010).

Gee's (2007) research on learning in massively multiplayer digital games concluded that playing collaboratively in teams allow players to share knowledge, skills, value, and social identities during the gameplay sessions. Mubin et al. (2008) confirmed that in multiplayer games, what made most players feel engaged during gameplay was the ability to play socially with other competitors, alliance, and team members, so as to accomplish a gaming task.

It is important to appreciate the tremendous benefits that digital games have brought to the well-being of older adult players, but there is also a need to explain in more depth the social gameplay process and related knowledge gained from the gaming content, for this group of players. There is also a need to conduct more qualitative inquiry to learn from more experienced older adult players (De Schutter, 2010), especially on what they want to gain from digital games, and what is important to them when playing digital games. A closer look at the digital gameplay processes, rather than simply focusing on the outcomes of the games, is also needed. Since current researchers tend to focus more on the benefits of games, rather than paying close attention during the gameplay session, further research with qualitative data will contribute to the literature on the social gameplay and learning experiences for this group of players.

2.11. Learning Nutrition and Health for Successful Ageing

Nutrition and health was chosen as the learning topic for this study, as it is vital knowledge for older adults. Good nutrition and healthy habits can directly impact their quality of life at this stage, allowing them to live well, stay independent, and decrease chances of developing common chronic diseases (Sylvie, Jiang & Cohen, 2013).

Digital games for learning about nutrition and health have been used in many research studies, but the subjects were mostly young players. One study, using a game very similar to this study's Bingo-based nutrition and health educational game, investigated the impact of playing digital game on nutrition and health objectives (Majumdar, Koch, Lee, Contento, Islas-Ramos, & Fu, 2013). The subjects of this study were middle school adolescents, but it produced many valuable guidelines related to both the game and the research design. The study reported significant findings on the intervention of using a serious game - Creature-101, where players played, completed brief questionnaires, and set goals to improve frequency and time to achieve good diet and physical behaviours. The intervention reported significant decreases in negative behaviours, especially consumption of sweetened beverages and processed snacks, after a series of gameplay sessions. As reported by the researchers, such improved behaviours, when consistently maintained, can eventually lead to many health benefits,

awareness and knowledge in nutrition, motivation in the gameplay, and future implementation of related games.

Another group of researchers, Baranowski, Buday, Thompson and Baranowski (2008) conducted a critical review of articles published on digital games used to promote health related behaviours. Altogether, they analysed 27 articles published until 2006 about games used to improve diet, physical activity, and other health-related behaviours. The review concluded that most of these studies showed positive health-related changes in their subjects after playing digital games. Interestingly, most of the studies reported about how stories modelled in digital games, especially players' ability to learn and model a story from a game, were key elements to promote health behavioural changes. Key components found to be useful to the players included technological capabilities in games, especially players' interactivity, goal settings, and calculation of behaviour changes.

Wattanasoontorn, Hernández and Sbert (2014) surveyed more than 100 serious games used for health-related studies. This included commercial, online and mobile platform-based serious educational games. The main aim of this survey was to identify the users of these games, and the games' effects on their health. The study identified 15 relevant characteristics of serious games used for health purposes, and reported that almost one-half of the serious games surveyed were meant for learning purposes. They pointed this out to the increasing trend of using serious games for learning objectives to various variants of players. For instance, in some studies serious games were used for individuals with Alzheimer's, using a customised Puzzle game to maintain and improve their brain functions; other studies used sports games to educate players about sports, physical exercises, and stay healthy. Wattanasoontorn et al. also investigated the potential of a multi-platform large scale serious game with 3D and real-time interaction between players, and even health professionals, in response to the increasing health educational needs for older people.

Another critical review (Papastergiou, 2009) studied scientific literature published on digital games used in health and physical education. The aims of this review were to identify digital games used as educational tools: to contribute to health and physical education, synthesise results on the educational effectiveness of digital games, and

identify future research perspectives used in health and physical education, as reported in the empirical studies. The review revealed that using digital games as educational tools for health and physical education provided many potential benefits, for instance, improved knowledge, attitudes, and behaviours in health and physical exercises. The author also highlighted the advancement of new physical interactive digital games, which were able to boost motivation for physical exercises and fitness. The findings also reported about the positive future implications of digital game research, which will be relevant and useful to current educators and practitioners, as a useful guide in using digital games for learning health topics.

Living an active lifestyle with regular physical exercise, good nutritional habits, and staying connected to a social community have been found to improve quality of life for older adults (Pernambuco, Rodrigues, Bezerra, Carrielo, de Oliveira Fernandes, de Souza Vale & Dantas, 2012). Digital games that promote quality of life, including the learning of nutrition and health, and related studies, have also shown many positive outcomes. Other studies have also revealed that digital games that provide social interaction and connectivity capabilities have been widely accepted by older players (Khoo & Cheok, 2006; De Schutter & Vanden Abeele, 2010).

An early study by Rowe and Kahn (1998) also reported of seniors' quality of life improved through players' social interaction and gameplay engagement offered by digital games. A newer study by Allaire, McLaughlin, Trujillo, Whitlock, LaPorte and Gandy (2013) reported significant results for older adult players who moderately and regularly play digital games, specifically in improved performance on tests measuring quality of life, mood, and depression. Another study by Wollersheim, Merkes, Shields, Liamputtong, Wallis, Reynolds, and Koh (2010) also reported that digital games have the ability to reduce social isolation and feelings of loneliness of older people.

2.12. Chapter Summary and Discussion

More studies are needed to investigate the social gameplay process and learning opportunities offered by multiplayer educational digital games for older adult players (Nap, de Kort, & Ijsselsteijn, 2009; De Schutter & Vanden Abeele, 2010; Marston, 2013). It is

important to understand what happens during gameplay for this group of players. Digital game design should emphasise the connectedness of older players by including options for multiplayer and communicative features (De Schutter & Vanden Abeele, 2008).

This literature review has provided insight and understanding on the importance of providing positive social gameplay and learning, both of which are vital to older adults. One aspect of this understanding is to know how these studies are informed by the diverse background characteristics of older adults: health status, social stability, cognitive ability, and living status (independent, day-care, or nursing home). It seems that most studies conducted to date, except for Asian studies by Cheok et al. (2005) and Hwang et al. (2011), have been for older adults in the Western culture. It would be useful to see more studies from other continents, which could help us to compare older adults from different regions playing digital games. Reading some of the empirical studies has also been helpful in learning how other researchers select participants for their studies. For instance, the study of Mubin et al. (2008) recommended conducting a preliminary or pilot study, before implementing an actual full-scale research project. This is helpful for gauging the players' acceptance level, and their social and cognitive abilities for playing the digital game in question. Other considerations include players' game exposure and experiences, as well as games' usability and playability.

It has been interesting to learn how different researchers from various fields have discussed game-playing by older adult players. As the literature in this review was derived from different fields, it also reveals differing schools of thought and theoretical assumptions underpinning the studies. For instance, Gamberini et al. (2008) who are cognitivist-based researchers, expected gameplay interaction to result mainly in cognitive benefits and cognition model manifestation of older adults. Despite that, their result revealed exceptional findings about older adult players who were greatly influenced by the social activities during the gameplay sessions. Lindley et al. (2008), who specifically studied the social well-being of seniors and games, used virtual models to describe the social space of older players' gameplay interaction constructed during gameplay sessions.

The present literature is concentrated mainly in the fields of Gerontology, Education, and Human Computer Interaction. So, when reviewing and learning from this

literature, it is important to know their purpose for conducting research. For instance, the researchers from the field of Human Computer Interaction, as seen in Derboven et al. (2012) and Cheok et al. (2005), tend to emphasise the usability and design of digital games to promote players' interaction and connectedness, These researchers agree on recommending video chat and communication features in digital games to assist older adults to communicate and interact with one another during gameplay. Researchers from Gerontology tend to focus more on the cognitive and social needs of the senior players.

Reading and reviewing the literature has also helped to discover the strengths of each of the studies, as well as recommendations from the various researchers to further explore the social process and learning opportunities of game-playing for older adults. It was after reading the works of Shim et al. (2010) and Lindley et al. (2008), that the researcher of this study understood there is a need for more in-depth study of the social and learning gameplay of senior players. The reading on the works of Lindley et al.'s (2008) also cautioned about the simple assumption many researchers have made on the complex background of the older adults. The conflicting perspectives and evidences of the usability (gaming features and ease of use), health status, and residential status (nursing, assisted-living, or independent) were some of the areas to be carefully studied when selecting participants for a research study. Cheok et al. (2005), Ijsselsteijn et al. (2007), Hwang et al. (2011) and Derboven et al. (2012) noticed that both male and female senior players should be considered and equally chosen when conducting digital games research. They criticised that many related studies have neglected the gender differences of this group of players. Moreover, concerning the physical design and form factor of digital games, Vasconcelos et al. (2012) revealed that game system's form factor had an effect on older adult players' preferences. Their customised tablet-based gaming platform was well accepted by the senior players.

As each literature has its own strengths and weaknesses, it is informative to pick up the strengths from some of the studies, and at the same time learn from their weaknesses. For instance, Vasconcelos et al. (2012) and Derboven et al. (2012) highlighted older players' gaming endurance, or the length of playing digital games. They encouraged gaming sessions to be short, as well as avoid being too lengthy and difficult to achieve. Despite that, they recommended promoting social activities during gameplay

to prolong the playing duration with positive results. Social activities developed when playing modern multiplayer digital games were important for older players. This information has also helped the author of this research study to decide on investigating the social connectedness and sociability of older players during gameplay.

Serious educational aims and content have been encouraged for digital games (Griffiths, 2005). Learning goals are useful for keeping older players focused and engaged during gameplay, as well as for building their self-confidence and knowledge (Marston, 2013). By studying the social and learning experiences of older adults, we can better understand how they learn about a given topic in a social multiplayer setting. This allows us to enhance the features of digital games, especially educational games developed for older adults, with engaging social and learning experiences.

When it comes to understanding how older adults learn from an Adult Learning Theory perspective, the literature has helped us to realise how older learners see learning to be something practical and transferable to their everyday life. Older adults are also more practical in their acceptance of digital games, and are more likely to weigh the costs and benefits of investing their time playing such games (Mclaughlin, Gandy, Allaire & Whitlock, 2012). Marston (2013) also argued that older adults take into account the benefits of digital games, which include social enjoyment, competitiveness, feeling connected, and education for oneself and for other players (p. 116). Marston also recommended integrating player interaction and learning content into digital game design.

Using a Social Capital Theory perspective, we are able to understand the source, social components, and social network of players, and how to enhance their social gains. Social capital theory has been adopted in digital game research to investigate how players socialise during gameplay (Yin, Puay & Tan, 2012). Digital games have also been studied and reported to be an exceptional technology for older adults to meet and socialize with each other; hence, it was not surprising to see many studies reporting on the increase of social capital for older players (Nap, de Kort, & Ijsselsteijn, 2009; Gajadhar, Nap, De Kort, & Ijsselsteijn, 2010; Wollersheim, Merkes, Shields, Liamputtong, Wallis, Reynolds, & Koh, 2010; Allaire, McLaughlin, Trujillo, Whitlock, LaPorte, & Gandy, 2013).

Social Capital Theory also guides us to understand how players learn socially (Stahl, 2004) while playing multiplayer digital games. It helps us understand how knowledge is being socially constructed and constantly being negotiated socially in a game-playing environment. Learning socially by older adults when playing digital games also takes place when identifying other players' gaming characteristics, being more attentive to other players' needs, and adjusting oneself to suit the surrounding gaming environment (Ijsselsteijn et al., 2007; Mubin et al., 2008; Engelhardt et al., 2010). The knowledge gained from analysing gaming tasks can be quickly transferred to older adult players' daily social lives, which eventually leads to players making better and faster decisions in related real-life situations (Mubin et al., 2008; Vasconcelos, Silva, Caseiro, Nunes, & Teixeira, 2012). This reminded us of phenomenon in massive multiplayer online digital games, where knowledge, skills, and values are developed and shared among a multitude of players as they play collaboratively and interactively in teams (Gee, 2007). Mubin et al. (2008) confirm that in multiplayer games, the feature leading most players to feel engaged in the gameplay is the ability to play and learn socially with other competitors, alliances, and team members.

Mubin et al. (2008) and Derboven, Van Gils, and De Grooff (2012) also informed us that older adult players are concerned about the learning gained as an achievement from gameplay activities. This is one of the factors that makes them eager to play the game again, and to play regularly with other players. Derboven et al. (2012) also reported on the importance of identifying players who were learning socially from one another, including collaboration and negotiation skills, when playing intergenerational games. Derboven et al. realised the importance of embedding a learning topic in digital game, as well as learning to play a game with the assistance of other players. This also indicates that playing games in a group, or with another partner, can improve the learning stage of a new game, as well as minimize negative emotional effects such as frustration, fear of technology, nervousness, and feelings of being lost.

Nutrition and health was chosen as the learning topic for this study, as it was one of the vital areas of knowledge that older adults need to know. Good nutrition and healthy habits can directly impact their quality of life at this age, and thus, allow them to live well, independently and reducing the danger of developing common chronic diseases (Sylvie,

Jiang, & Cohen, 2013). Living an active lifestyle of constantly staying connected to a good social community of people, together with regular physical exercises and good nutritional habits, has been found to improve the quality of life for older adults (Pernambuco, Rodrigues, Bezerra, Carrielo, de Oliveira Fernandes, de Souza Vale & Dantas, 2012). Digital games for promoting and enhancing quality of life, including through learning about nutrition and health, have reported many positive outcomes.

This review also brought the author to another level of scholarly learning for his doctoral study. More effort is still needed to keep track of the latest published works, in order to keep up with new findings. This review has provided a useful guide for the learning, planning, and development of this study on investigating the social gameplay and learning experience of playing digital game for the older adults. The following chapter discusses the methodology of this research study, based on what has been learned from this literature review.

Chapter 3.

Methods

This chapter discusses the research methods that the researcher used throughout the process of designing the study, as well as gathering and analyzing the data. This chapter has been framed with sections that consist of:

1. A discussion of the mixed methods research method, with an argument about the need to use both quantitative and qualitative data to achieve the study's aim.
2. The data collection instruments and procedures for carrying out the data collecting process, with a discussion of the participants and context of the study.
3. The data analysis process and the strategies used for analysing the data collected, with a discussion on reliability, trustworthiness, and ethical concerns, in order to ensure this research study was carried out according to current research standards.

3.1. Mixed Methods Research Methodology

A mixed-methods research approach has been used to conduct this study. Mixed methods research is a popular research approach of inquiry that combines both qualitative and quantitative research methods. The ultimate motive of using this combination was to strengthen the study, as this would make the study stronger than simply focusing on either a qualitative or quantitative research approach (Creswell & Plano Clark, 2007).

"Mixed methods research provides more evidence for studying a research problem than either quantitative or qualitative research alone" (Creswell, 2011, p. 12). Using a mixed methods research methodology also reduces the constraint of using certain types of data collecting tools, which are often considered to be appropriate in either a qualitative or quantitative research study. It also encourages flexibility to capture data that are

exceptionally rare or unique, and provides the ability to enlighten us to investigate a research problem in greater detail.

3.1.1. Rationale for choosing a mixed methods approach

A mixed methods approach can help better explain the results from data collected solely through quantitative methods. Quantitative data can thus prompt us to gather further relevant information using qualitative methods, to explain quantitative results, eventually leading to a more complete understanding of the research questions. In this way, mixed methods research further explains the meaning of data collected.

The other reason for adopting a mixed methods methodology is to deal with the complex research problem of understanding the needs of older adult game players with their abundant variety of life experiences. As Lindley et al. (2008) stressed, the needs of senior players are more complex than what researchers may commonly think. Moreover, older adults carry with them loads of life encounters, both good and bad. In addition, they also have to face challenges at this stage of their life to counter physical, mental and cognitive decline. Due to the complexity of studying older adults, this study attempted on understanding the social gameplay and learning experiences of this group of older players, when they play a digital game socially with other players.

The type of mixed methods adopted for this study uses the sequential explanatory design (Creswell, 2013). This strategic design starts by collecting and analyzing the quantitative data. It then moves on to collect and analyze the qualitative data. The researchers then produce an interpretation of the entire body of findings.

Creswell (2009) illustrates four aspects of planning a mixed methods design: Timing, Mixing, Weighting, and Theorizing. In a sequential explanatory design, the timing describes the type of procedure that will be used in this study. For this study, it uses a two-phased approach: first, collecting quantitative data (using pre- and post-tests), and then, collecting qualitative data (by conducting individual interviews with selected participants). Mixing refers to which part of the study mixes the two types of data to produce findings. For this study, it was in the final part of the study where the researcher interpreted the two separate forms of data together to produce findings.

Weighting shows that more emphasis is given to a particular type of data; for this study, it is the quantitative data. The reason the quantitative data have slightly more weight than the qualitative data is due to the standardized procedure of adopting a sequential phasing procedure. However, more weight or emphasis does not refer to more analysis, or generating more results from the quantitative data, but refers to the priority of the quantitative data. This is where it becomes important to ensure that the first phase of quantitative data collection is done correctly, or demonstrates significant results, so that the second phase of qualitative data collection can proceed according to what was found in the first phase.

Theorizing describes the theoretical lens and framework used in a study, as well as explaining the results of a study. In this study, the theoretical lens of the researcher was explained in the first chapter of the study: using Social Capital Theory and Adult Learning Theory to frame the study, and interpret the results. This also helps to inform the readers about the theoretical viewpoint of the researcher, and how it influences his interpretation of the mixed data collected in the study.

3.1.2. Challenges faced in using a mixed methods research methodology

Conducting a mixed methods study can be time consuming and frustrating. It can also require greater time, effort, and resources to collect and analyze the two different types of data, compared to a single-method research study. A researcher needs to acquire skills in using both quantitative and qualitative approaches, and learn how to use them appropriately. It requires that the researcher be familiar with the nature of rigor, reliability, validity, generalizability, trustworthiness and persuasiveness of both quantitative and qualitative approaches.

A mixed-methods researcher needs to know what they want to achieve from the research study, and how to carefully plan in collecting and analyzing the separate forms of data. It is also worthwhile to note that a mixed methods study does not make a study superior to a purely quantitative or qualitative research study: "It does not diminish the value of conducting a study that is exclusively either quantitative or qualitative" (Creswell, 2011, p. 13).

Next, there is the challenge of a researcher's multiple worldviews in mixed methods research, which can present a challenge to convince the readers of his perspective and stance. Creswell (2011) recommended informing our stance, and how we frame our mixed methods design. For example, in this study, the mixed methods design used a sequential explanatory approach, with more weight on quantitative data, and priority of timing on the quantitative phase, that later shaped the qualitative data collection phase. Nevertheless, the researcher also agreed with Creswell (2011) that the argument of having just one worldview is not relevant in the modern day complexity of understanding the world around us (p. 43). Hence, there should be more work and action, rather than continual arguing about which approach is better.

Table 3.1 summarizes, with additional details about this study research design using the sequential explanatory mixed methodology, including its characteristics, and sequence of procedures in analysing data collected.

Table 3.1.   Summary of mixed methods research design

Rationale	To identify and reaffirm that social gameplay and learning in digital games are two important variables (dependent), not widely researched with older adult players. These two variables are important to older adult players for producing engaging gameplay, and to keep them continually playing. Such continual and regular playing can reduce social isolation, and promote active cognition and successful ageing (Wollersheim et al., 2010; Allaire et al., 2013). This mixed methods study also aims to provide us with findings to move on to a future full-scale qualitative study.
Design Sequence	QUAN (Quantitative) data & results - qual (Qualitative) data & results - Interpretation

Characteristic	-Two phases of data collection
	-Types of research question
	 Q1 – QUAN
	     Q2 – qual
	         Q3 – QUAN + qual
	-One final mixed methods interpretation report (QUAN & qual,
	 for the purpose of supporting one another)
	-Emphasis is placed on the quantitative data in this study

Procedure	-Schedule the study as a two phase project, -Collect QUAN-titative data followed by qual-itative data:

First, by obtaining quantitative results with statistical evidence; answer research question 1, identify significant increase of both game content's knowledge and social connectedness (dependent variables), for older adults playing a series of multiplayer educational digital game sessions (independent variables). Next, the researchers carefully select subjects, based on the result of the statistical evidence, by interviewing them to probe for more in depth results (answer research question 2). This also helps to explain what was reported early in the quantitative results. After this, interpretation of findings from both quantitative and qualitative data are presented, including the central phenomenon and themes, that contribute to the significant results which are used to answer research question 3.

3.2. Ethical Considerations

Ethics approval for this study was obtained in May 2015 from Simon Fraser University's Office of Research Ethics. A copy of the ethics approval letter from SFU can be found in Appendix A. The concern of the research ethics office was to protect every human subject, and to emphasise the need to seek approval from the researcher's university, organisation of study, and the participants being involved. The application for approval was carried out with the researcher applying for ethical approval from his university's review board for permission to carry out this study, as it involved contact with human subjects. This application included filling out the forms that were needed for ethics approval, together with a description of this study. Other required documents included the data collection procedures with instrument description, the letter to the organisation in which fieldwork was to be conducted, and a consent form to be issued to the participants.

After this, the researcher sought the approval from the individual centres, which included residential homes and community centres: for permission to enter the site, recruit participants, and conduct this research study. A letter of explanation was also issued to the managers or coordinators of the centres, with the reasons and purposes of conducting research at their centres. The researcher and research assistants also acknowledged, and agreed to comply with, the centres' conditions before entering the sites.

The researcher prepared a consent agreement form for the participants to allow him and his team of research assistants to interact and exchange information with them during the period of this study. The participants read through the form and were

encouraged to seek the help of the research team to explain the contents or raise any questions about the study. The participants had to agree and sign this form before the study could take place. Most of the content in the form were intended to protect the participants from any physical or mental harm, especially if they felt threatened or uncomfortable during any part of the research activities. For example, the participants were permitted to withdraw from participating in any parts of the study, including gameplay, interview, or while completing the pre- and post-test questionnaires. This allowed them the right to stay away from such activities if they felt any uneasiness. Together, they were also notified before each interview that the sessions would be recorded and transcribed into text. They were also allowed to check the accuracy of the interview transcripts, and any data that was recorded about them during the study. They were assured that their interview transcript would be kept confidential, and if some of it were to be published, their name and identity would remain anonymous.

The identity of the participants that was recorded on the pre- and post-tests, and cash rewards issued for participant game winners, have also been kept confidential. Coded numbers were assigned to replace participants' names in the database. All survey data, as well as interview transcripts (digital format) that were collected, were kept securely in a password locked flash drive, locked in a secured cabinet, and will be destroyed four years from the date of collection. Interviews recorded using a digital recorder were destroyed immediately after being transcribed into digital text, in addition, participant identities were replaced with coded numbers.

3.3. Research Participants

The participants for this study were older adults who have had reached 60 years of age and above. They were males and females of various ethnicities, and deemed healthy enough to participate in the study. Participants included active and non-active digital game players. Also, due to the nature of this Bingo game (all-can-play), it is suitable for participants who are either expert or non-expert, as well as casual or persistent game players.

The participants were mainly recruited from a mix of residential homes and community centres in greater Vancouver, Canada. Eventually eight centres, representing a mix of six residential homes and two community centres, took part in this study. The total number of final eligible participants was 50. The participants played the Bingo game for four weeks, plus one extra first week of practice using a separate Canada Bingo game to get familiarised with the game's interface and rules.

Before conducting the study, a few preliminary visits to the residential homes and community centres were made to conduct information sessions to recruit participants, as well as letting the centres' administrators and the older adult participants become familiar with the research team. One other reason for doing this was to learn about the environment of the centres, and how gaming sessions could be conducted seamlessly in each individual centre. The other reason was to let the older adult participants get used to the research assistants, so that subsequently, when they participated in the gameplay experiments, they would feel comfortable and free from disturbance during their gameplay sessions.

For the exclusion criteria, the researcher excluded seniors who were younger than 60 years old. Those who were new to the residential homes or community centres less than 3 months were also not eligible to participate, as they normally took time to settle down in the new environment. Older adults who had serious health or mental disabilities, including those who couldn't handle the gaming equipment were also excluded to avoid any potential frustration or injuries to them.

The participants were required to have settled well into their residential homes, or feel comfortable in the community centres, normally after three months of being there. They needed to be healthy enough to use basic computer hardware, and have the ability to communicate well with other older adult players. It was expected that some of the older adults would have had some computer or gaming experiences prior to participating in this study.

3.3.1.   Recruitment procedures

The researcher sought the assistance of each centre's manager or coordinator to assist in recruiting and recommending potential participants. Most of the participating centres had been involved in a previous research study, and each centre was sent a recruitment memorandum. Liaising with the centres was done by writing via emails or letters. Next, with permission from the centres, the researcher and research assistants were appointed to do a few preliminary visits to the residential homes and community centres to pin up printed posters with information about this study. The researcher and research assistants also conducted information sessions to introduce the study to potential participants, answer questions from interested participants, and assist centres' coordinators in the recruitment process. Potential participants were also briefed about their involvement in the gameplay, the pre-test, post-test, and selective interviewing sessions.

Consent forms for the participants were explained and signed on the first day of this study. This was to ensure that the required number of participants would show up for the actual study. Each participant who agreed to participate was briefed by the researcher and research assistants. Each participant was given a consent form to read; however, they had a choice to either agree or not agree to participate, before proceeding to sign the consent form. If a participant signed the consent form, he or she was given a copy for his or her own record. The researcher and research assistants were present when administering the instruments, as well as answering any questions asked by the participants. This also ensured that the administration of the instruments was conducted in a professional manner.

3.4. Data Collection Instruments

Multiple data collection instruments were used in this study to complement one another. This complementarity was particularly important when emerging findings surfaced and required another instrument to confirm or further examine findings. Also, the use of various data collection tools also allowed us to have more methods to describe the personal and in-depth portrait of the informants and their community (Creswell, 2008).

3.4.1.   Sociability pre- and post-test

A set of Sociability pre- and post-tests was used to assess the results of the gameplay experiment (Full version can be found in Appendix D). Data from the pre- and post-tests allowed the researcher to investigate the social components that are important to the older adult players. The pre- and post-test results also enabled the researcher to collect additional qualitative text-based data, for further probing of the pre and post-test quantitative results. The Sociability pre- and post-test was used in an earlier research study that focused on studying the socio-emotional benefits of playing a Nintendo Wii Bowling digital game. It was slightly modified to suit this study on participants' game attitudes, sociability, and social connectedness from the game-playing sessions. The instrument used a five-point Likert scale in which participants selected one answer for each item. The post-test included additional questionnaires to seek more information about participants' social experience of gameplay.

The set of pre- and post-tests was a revision of those used in several other research projects, designed to cater to the sociability needs of mainly adult participants. The social connectedness components were originally developed and revised from the Social Connectedness Scale - Revised (SCS-R) by Lee and Robbins (1995). It was initially designed and further improved to assess each respondent's perspectives about being connected or disconnected from the social world surrounding them. The game attitude components were developed from the Friendship Scale, first published in 2006, which was originally developed with a short 6-item, user-friendly measurement to understand the social isolation of adults in Australia (Hawthorne, 2006). The sociability components were developed from The UCLA (University of California Los Angeles) Loneliness Scale (Russell, 1996), which has been revised several times and is mainly used to identify social desirability, depression and low self-esteem among adults.

The pre- and post-test was pilot tested with non-participating older adults before it was used in this study. Attempts were made to ensure that the questions used were appropriate and relevant for answering the research questions. Feedback received from the pilot test with non-participants were responded in order to improve the readability, font size, word choice, structure, and formatting of tables to hold the items. Samples of the test questions can be found below:

Table 3.2.   A sample of digital game attitudes questions

	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
Playing digital games is a good way to spend more time with friends.					
Playing digital games is a waste of time.					
Playing digital games is a good way to improve existing friendships.					

Table 3.3.   A sample of sociability questions

	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
I find it easy to relate to others.					
I feel isolated from people.					
I have someone to share my feelings with.					

Table 3.4.   A sample of social connectedness questions

	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
I would like to have a larger circle of friends.					
I feel a lack of company.					
I would like to have a close relationship with more people.					

3.4.2. Knowledge pre- and post-test

A pre- and post-test of knowledge was used to test participants' nutrition and health knowledge. The knowledge test questions were chosen from the content of the Bingo game. It is a modification from an earlier version written in French, used in a previous study by the Society for Lifelong Learning Research (SAVIE), and then translated into the English language version used for this study. Most of the nutrition and health learning content were derived from the Canadian Food Guide, Public Health Agency of Canada, and HealthLink British Columbia. The questions consisted of easy, medium and difficult levels, in both true-false and multiple-choice formats. The questions were also categorized into Nutrition, Physical Exercise, Socialization, and Prevention. For the pre- and post-test, a set of 15 questions was standardized as multiple choice questions and selected from various categories of the game's content. Some sample questions from the Nutrition and Health Knowledge pre and post-test are as follows. The full version of this pre and post-test can be found in Appendix E.

1. According to the Canadian Food Guide how many servings of fruits and vegetables does a person over the age of 55 have to consume per day?

   ☐ 5
   ☐ 6
   ☐ 7
   ☐ 8-10

2. What is the best way to stay hydrated?

   ☐ Drinking fruit juice
   ☐ Drinking sports drink
   ☐ Drinking water
   ☐ Drinking tea

3. In which of the following foods do you find the most Vitamin D?

   ☐ Broccoli
   ☐ Milk
   ☐ Turnips
   ☐ Salmon

3.4.3.   Interview

The main qualitative method of data collection for this study involved interviewing sessions with older adult players, and conducted by the researcher. An open-ended, semi-structured, face-to-face interview was conducted after the gameplay sessions. The interview sessions were used to gather information about participants' perception of their game-playing experiences, and their learning and social experiences with other players. A few participants, selected using a purposive sampling approach, were chosen to probe for an in-depth explanation of the gameplay experience and learning phenomenon.

The open-ended, semi-structured interview is an essential tool used to collect qualitative data for a mixed methods research methodology. Interviews can provide researchers with exceptional information and feedback from the subjects of study. Interviews also allow us to compare the data being gathered with those collected from other instruments; in our case, the pre- and post-test results. It can also reveal any important contextual information that could surface during the interviewing conversation. Patton (1990) explained nicely that the interview is an instrument to go along with other instruments, stating that "We interview people to find out from them those things we cannot directly observe" (p. 196). Interviews are important in collecting qualitative data, as they provide a way to specifically help us to better understand the participants, their voices, and the authentic feedback from the actual users of the digital game.

The interview questions used were meant to establish the detailed meaning of participants' responses, rather than simply generalise the results and standardise the responses from the participants in the study. The interview questions were developed iteratively and reviewed by the researcher team until they met the requirements, including the usage of relevant questions to be used during the interview. During the interview, neutral and exploratory conversations were practiced, so as to refrain from conveying a well-prepared direction, which would lead to the forcing of data and forfeiting of discovery (Glaser, 1992; Charmaz, 2006). During the research study, the researcher himself was also aware that when conducting a qualitative interview, the interviewing sessions and the interviewing procedures could change. Hence, he was prepared for any unexpected changes and allowed each emerging finding to guide the interviewing procedures, until the completion of data collection.

The following were the interview questions used to guide the researcher:

Social gameplay experience

1. What did you think about playing this digital game together in a group rather than playing alone?

2. Do you think the Bingo game made you more aware of your social skills in interacting with others? Why or why not?

3. Can you describe which part of the gaming sessions you liked the most?

4. How motivated were you to win when playing the game with other players?

5. Would you like to continue to play digital games? Why or why not?

6. Do you think digital games will be an important part of your life? (Prompt if needed: keep you active, socialising, pastime, other)

7. What do you think about spending time in digital gameplay as a pastime or hobby or regular activity?

Game content knowledge

1. What did you think about learning about nutrition and health in a Bingo game?

2. Do you think you learned much about nutrition and health from the Bingo game? Please explain.

3. Did playing the Bingo game motivate you to learn more about nutrition and health? Please explain.

4. Will you make any nutrition and health changes after playing the game?

5. What other things, if any, did you learn through the gameplay sessions?

6. Did this digital game change your perspective about what a digital game can do for learning? Please explain.

3.5.   Game and Equipment

3.5.1.   Bingo game software

The Bingo Nutrition and Health game was chosen for this study. It is a replica of a traditional Bingo; but digitized to be a multiplayer (maximum of 12 players) Flash game available on a hosting server in Montreal, Quebec. Players need to log in and connect to the server to play the game. Like traditional Bingo, each player will have a Bingo card or board of 5 columns X 5 rows of numbers, and a score panel displaying all players' score. The game was also modified with educational content questionnaires that pop-up in a Windows panel, after a player clicks on a matching number on their Bingo board. More graphics of the game can be found in Appendix B.

Figure 3.1.   A screenshot of Bingo gameplay interface with Bingo board and score panel.

3.5.2. Rationale for choosing the Bingo game

The Bingo game type and genre used in this study belongs to a quiz-cum-card game, with Nutrition and Health educational content. Bingo is a common and well-known traditional game, and can be played by older adults with any level of gaming experience. It is also a popular social multiplayer game. Despite the game being simple, uncomplicated, and easy to play, it still draws people to play due to the excitement of collecting numbers to fill their card and winning the game. Coupled with educational content embedded in it, we were able to support players to learn the topic embedded in the game, and at the same time have fun playing it socially with other players. Studies have demonstrated that a player won't learn as much from a single-player educational digital game, as compared to a multiplayer version; there are more benefits playing co-play face-to-face with other players (Nap, De Kort & Ijsselsteijn, 2009; Gajadhar, Nap, De Kort & Ijsselsteijn, 2010; De Schutter & Vanden Abeele, 2010).

3.5.3. Rationale for choosing Nutrition and Health learning content

Nutrition and Health are important learning topics that older adults need to know at this stage of their lives. These are also topics that can highly affect their ability to age well. By learning about Nutrition and Health, older adults are able to see the benefit of what a digital game can offer to them, and at the same time socialise with other senior players. This allows them to form knowledge learned from the game's content, through social participation in a locale co-playing, as well as in an online co-playing environment, where meaning making can occur (Woo & Reeves, 2007). It has also been found that older adults are more likely to use technology, including digital game, if they feel there is a benefit of using them (Melenhorst, Rogers & Bouwhuis, 2006).

3.5.4. Game content and questions

The game content focused on four themes that were related to the promotion of healthy lifestyles for older adults: physical activity, nutrition, social relations and prevention (sickness, falls, injury, and so forth). Each of these themes was presented with a series of questions (easy, medium and difficult levels; multiple choice, or true/ false) that players must answer to be awarded a Bingo number and a number of points.

Each question used was presented with relevant images and animation, displayed together with the question. Immediate feedback with answers were also displayed once the players selected their responses. The feedback presented additional information for the players, according to what he or she just answered (either right or wrong), so that the players can learn from what they answered (Ogomori, Nagamachi, Ishihara, Ishihara & Kohchi, 2011; Wu, Miao, Tao & Helander, 2012). For instance, if a player answered incorrectly, the feedback displayed the correct answer and with additional information related to the question to further educate the players.

The Bingo game and its contents were tested rigorously at the Society for Lifelong Learning Research Centre (SAVIE) for readability, understandability and user-friendliness of the design, particularly for older adult players. The design also included the following components to improve the user experience of using the Bingo game:

- immediate feedback on the answers chosen;
- navigation instructions in the game;
- tutorial assistance to facilitate understanding of the game;
- a tool to adjust the display size of the screen;
- three-level difficulty of play: Easy, Medium and Hard;
- a tool for listening to questions (SSHRC Ageing Well Project, 2014, p. 10)

3.5.5. Game learning objective

The educational purpose of the learning content in this Bingo game is to educate the players about good habits and awareness of nutrition and health, including the importance of having a good social lifestyle, which ultimately assists in successful ageing for this part of their life.

The responses to the game's questions, which consist of nutrition and health facts, were followed by feedback that explains the correct answer. The various levels of gameplay are used as an experiential learning sequence to achieve learning of the content in steps.

The overall learning objectives were to:

- recognize the contribution to one's well-being of adopting healthy eating habits and consumption of alcoholic beverages.
- recognize the effects of physical activity on quality of life.
- recognize the importance of developing relationships with friends and family to improve quality of life.
- determine the risks (prevention) to health, including poor nutritional habits and lack of physical activity (SSHRC Ageing Well Project, 2014, p. 10).

3.5.6.　　Gameplay procedures

Participants in this study played for four weeks in gameplay sessions. Before the actual gameplay, the participants also played a trial session of Bingo Canada (separate game) before the actual study, so as to get familiarised with the Bingo game interface.

The four weeks of gameplay sessions started after the trial practice session in which the game content focussed on facts about Canada. Each gameplay session consisted of two games, with each game lasting between 30 and 45 minutes. During the first week, each group played two games at the easy game level. This was followed by the second week of one easy and one medium level game. In the third and fourth weeks, they played one medium and one difficult level game.

Game-playing instruction and rules were also developed with the research team and explained to the participants before playing the game; a sample of game instructions can be found in Appendices F and H. Though the research team for this study could not make many changes to the graphical interface (Game interface was developed by SAVIE), they were able to improve the wording used in the game questionnaires, feedback, and health content.

The following is a screenshot to illustrate the gameplay question being displayed, with feedback given to players after selecting the answer.

Figure 3.2. **A screenshot of Bingo gameplay interface with a sample question**
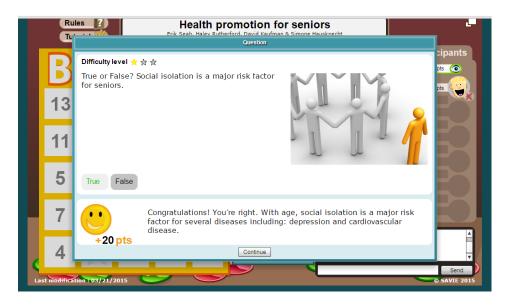
Figure 3.3. **A screenshot of Bingo gameplay interface displaying the feedback after a player selected their answer**

3.5.7. Hardware and network

After pilot testing with non-participating older adults, the research team decided to use Dell touch screen laptops with 15.6 inches displays for this study. Mouse peripherals were also purchased as an alternative input device to be used by the older adult players. Pilot testing with seven non-participating older adults provided valuable feedback so that

the research team could decide on the appropriate display and input hardware to be used for this study. The research team also let the non-participating seniors test a few different Windows-based laptops, and none of them appeared to have issues with the screen size or text display size in the Bingo game. The running speed of the Bingo game on the laptops was also acceptable. Overall, the research team also noticed that seniors who are 60 to 79 years old could handle mouse clicks, while those above 80 years old preferred using the touchscreen. So, eventually it was decided to have a touchscreen laptop to cater to both users: those who prefer mouse-clicks, and those who prefer touch-screen or have difficulty using mouse-clicks. A table summarizing the pilot test results can be found in Appendix B.

To ensure a smooth connection for playing the multiplayer Bingo game held on the Game Server in Montreal, Quebec, Canada, and not just rely on each centre's Wifi (Wireless Internet for Frequent Interface) network, the research team decided to purchase two additional LTE (Long Term Evolution) Wifi Hotspot smart-hubs to connect the laptops to the Game Server via Internet connectivity. Two sets of Huawei LTE Smart-hubs were purchased for connecting the laptops and the smart-hub to and from the Game Server in Montreal, Canada, pinging through a Telus LTE Internet network.

The two Wifi Hubs were extremely useful when the Wifi connection in some of the centres were not able to connect the game to the server smoothly. The two Wifi hotspot devices were also pilot tested multiple times with the laptops to ensure that the game could be played successfully. The two Wifi Hubs came to the rescue for connecting the laptops to the game server, particularly when several technical and connection glitches occurred during this study, in order to resume the gameplay back to normal.

3.6. Data Collection Strategy

As this study used a mixed methods approach, it also leaned towards a grounded theory approach to generate a theory or conceptual framework for explaining the gameplay and learning experiences of older players, as well as supporting the quantitative data collected earlier. The framework generated must be able to describe with rich details how it is being derived from the social gameplay and learning experiences of

the older adult gaming sessions. To generate this framework, data collected from the pre- and post-test, as well as interview came in handy to confirm, or further explain the framework.

3.6.1.   Data collection procedures

A set of knowledge and sociability pre-tests were administered before the first session of gameplay in each centre. Following this, a practice gaming session of 30 minutes, using a separate Bingo game with questions about Canadian content, was conducted for participants to learn and become familiar with the Bingo game. Next, one session of actual Bingo (consisted of two gameplays, 30 to 45 minutes each, average one hour and 15 minutes in total) was conducted each week in all the eight centres. Two research assistants were assigned to each centre during the research study to facilitate the Bingo games, support participants in playing, and administer the instruments. After the four weeks of gameplay sessions, the same set of knowledge and sociability post-tests was administered.

At a later date, interview sessions were conducted with 10 selected participants, in order to gather qualitative data. The interviewees were carefully selected among the eight centres, as they were able to represent their centres and provide valuable feedback for the gameplay sessions. One or two participants who could represent each centre were purposely selected. The reason for choosing these participants from the centres is that the researcher wanted to ensure that he captured any exceptional experiences that may have occurred in a particular centre. This was also explained by Richie and Lewis (2003) that "Members of a sample are chosen with a 'purpose' to represent a location or type in relation to a key criterion. The key constituencies of relevance are covered and within each of the key criteria some diversity is included" (p. 79).

Due to the social dynamics of social game playing, which can be a complex phenomenon often overlooked or sparely known, it is best to carefully select the right participants, in order to help us discover and explain such phenomena. It is also from the carefully selected group of participants that we can learn more in-depth about the gameplay events, as they can provide us with rich information, that would eventually

uncover the actuality of phenomenon studied, central to our research purpose (Patton, 1990).

The interview was open-ended, semi-structured, and guided by the set of interview questions. Each of the interviewing sessions lasted from 15 minutes to 55 minutes, according to the flow of discussion with the participants, and how much they were willing to share about their gaming experiences. The interview recordings were transcribed by the principal researcher. Transcripts were reviewed and checked for accuracy by another research assistant. The transcripts were also member-checked by the participants, through face-to-face and email communication, to ensure an accurate representation of what they had said. The principal researcher and research assistant also met regularly to review the transcriptions, and draw out a plan to code them. Coding of the transcripts was also conducted regularly to discuss and review the coding process, until the final emergent themes were established and agreed upon.

3.7. Data Analysis Techniques

The quantitative data collected were analysed using the Statistical Package for the Social Sciences (SPSS), version 23, from International Business Machines; while the qualitative data was being analysed using NVivo from QSR International.

For the quantitative data, both descriptive and inferential statistics were reported. The descriptive statistics reported consist of frequencies and percentages on some of the tested items, as well as means and standard deviations. The inferential statistical tests reported consist of paired samples t-tests results to compare participants on the two sets of Knowledge and Sociability pre- and post-tests.

The open-ended interview responses were coded into categories, which were later formed into relevant themes. The researcher chose to use Saldaña's (2009) two cycle approach to coding: The first cycle used an initial coding and recoding of data; followed by the second cycle of classification, integrating, synthesising, prioritizing, abstracting, and eventually theory building. The reason for using Saldaña's two cycle approach (2009), also known later as 'second order coding' strategies (2013), was that it provided

straightforward coding steps, from an initial coding to category, then themes and building up the concepts to theory or framework.

Initial coding is one of the first cycle methods recommended for beginner researchers (Saldaña, 2013). This method of coding also acts as a good starting point for providing direction to the coders, as a first step with clearer understanding of what data have been gathered, so as to explore further what needs to be analysed, for the next step (Glaser, 1978). Initial coding is also known as open coding and is suitable for analysing interview transcripts (Charmaz, 2006). Charmaz recommended reading line-by-line, detailed walking through of each individual transcript and then recording or noting it, if possible, with In Vivo codes of original words spoken by the subjects of study. According to Saldaña's (2013) suggestion, data are not coded, but recorded in the first cycle. It should be the second cycle where the large amount of recorded data are condensed and tightened into a manageable set of codes and categories, compact enough for realistic analysis (p. 206).

The procedures of the coding were as follows: During the first cycle of initial coding, the coders, who consisted of the Principal Researcher and a research assistant, sat together to scan through the transcript of each participant, one at a time. They then analysed the content of the transcript and picked up words or phrases, including In Vivo word(s), the exact words used by the participant that represented the actual scenario or phenomenon during the game-playing sessions. For the second cycle, the researchers worked together to code the data again and organised them into categories, with formation of classifications, integrating, synthesising, abstracting, and eventually building a conceptual framework. According to Saldaña (2009, p. 3), "A code in qualitative inquiry is most often a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and or evocative attribute for a portion of language-based or visual data."

3.7.1. Role of the researcher

In a mixed methods research study that comprises of qualitative research inquiry, the researcher must inform the readers about the particular roles they have taken when

conducting the research study, so as to eliminate any misinterpretation of information of the readers. Glaser (1978) stressed the importance of informing readers of the researcher's stance, especially in the beginning of a qualitative inquiry study, by describing any previous experiences and understandings that have shaped their lenses to see and interpret things. With this, the reader can better understand where the researcher stands, and take his position in the research, judge the way the researcher conducts the study, and decide if the final results are trustworthy.

In this study, the researcher and author of this report took on the role of an observer and data collector who did not participate in any of the gameplay sessions. The purpose of getting closer to the participants was to understand the social gameplay and learning phenomenon that takes place surrounding the natural setting of the participants, but keeping a safe distance and boundary from the participants (Charmaz, 2006; Creswell, 2012). The researcher also reminded himself regularly to keep a distance when observing the participants, to avoid disturbing or interrupting them when they were playing games together in their regular settings.

During the interview sessions, the researcher tried to ensure that the participants felt comfortable with the discussion and interaction. As interviewer, the researcher also ensured that the participants being interviewed felt free to express their thoughts on what they experienced during the social gameplay sessions, and what they learned from them.

3.8. Validity, Reliability, and Trustworthiness

To address the need for validity in a study, the first thing to do is to identify the internal and external validity threats, including other forms of threats that will affect the overall result of a study (Tuckman 1999; Creswell, 2008). Potential types of threats, both internal and external, were identified and addressed before the start of this study. Some of the internal validity threats identified and dealt with, before the study included pilot testing the research instruments, game's interface, and identifying the appropriate duration of gameplay. External threats included identifying ways to reduce the drop-out rate of participants, conducting the research instruments appropriately, and monitoring players' attendance.

For reliability and trustworthiness during and after data collection, transparency of data collection and interpretation were made as clear as possible. One of the methods adopted in this study was for the researcher to practise being reflexive in the report. According to Guba (1961) and Creswell (2012), to achieve this practice of being reflexive, the researcher would need to ensure that his role and involvement in the study were clearly informed throughout the reports, especially in the section on data collection and analysis. This ensured the trustworthiness (i.e., truth, value and applicability) of the data collected, analysed, and interpreted, eventually acceptable to the readers (Guba, 1961). The author also presented in the report, the fragment of participants' interview verbatim about their gaming experiences, and what they do during the gameplay, especially those they thought were important. The participants' interview verbatim were also coupled with an explanation of how it matched to the quantitative findings, and together with the researcher's interpretation of the meaning, how it contributed to certain portions of the findings.

To ensure the consistency and neutrality concerning trustworthiness (Lincoln & Guba, 1985), multiple methods of data collection were used, which included the pre-test, post-test and interview used in the data collection process. It was expected that subsequent adjustment to the instruments used, especially interview questions, with an open-ended options to ask further questions, would be useful to collect data as new findings emerged.

Member checking was also practised in analyzing the data. This type of checking is commonly practised in qualitative research, as it promotes accuracy in transcription and interpretation involving the actual participants (Lincoln & Guba, 1985; Strauss & Corbin, 1990). It was helpful in this study to allow the interviewed participants to examine the interviewing transcripts, which ensured that the findings generated would match their perceptions and meaning of gameplay, as well as their learning experiences.

3.9. Chapter Summary

This chapter discussed the methodology and research blueprint used by the author to conduct this research study. A sequential explanatory mixed-methods research methodology was used to conduct the study. Mixed methods research combines or

integrates qualitative and quantitative research methods into one complete research study. The rationale for combining these two forms of data is to strengthen a study, rather than simply focusing on either a qualitative or quantitative research approach (Creswell & Plano Clark, 2007). With a mixed methods approach, more insight of both quantitative and qualitative data can be gained to provide a more expanded understanding of the research problem. This approach also allows us to have a more complete understanding of the sociability and learning of gameplay, especially qualitative data collected, with the support of stronger evidence from the quantitative data.

Participants recruited for the study were 50 older adults, 60 years old and above, both male and female, of various ethnicities, and deemed healthy enough to take part in this study. The participants were mainly recruited from a mix of residential homes and community centres in Greater Vancouver, Canada. A total of eight centres, representing a mix of six residential homes and two community centres, took part in this study.

Instruments for data collection used in this study included a set of knowledge and sociability pre- and post-tests to collect quantitative data. Interview sessions were conducted with 10 selected participants after four weeks of gameplay sessions. For the digital game, a customised Bingo game with Nutrition and Health educational content was used. Bingo is a common quiz-cum-card genre game, commonly played socially by many older adults. With nutrition and health educational content embedded in the game, it should interest these older adults to learn, and at the same time have fun playing it socially with other players. The main hardware used for this study consisted of Dell touch screen laptops with 15.6 inches display and mouse input device, which were pilot tested by non-participating older adults before the study. To ensure smooth connection for playing the multiplayer Bingo game held in a Game Server in Montreal, Quebec, Canada, two LTE (Long Term Evolution) Wifi hotspot smart-hubs were used to connect the laptops to the Game Server.

The procedures of data collection and gameplay sessions were as follows: A set of knowledge and sociability pre-tests was given to the participants before the first gameplay session in each centre. Following this, a practice gaming session of 30 minutes, using a separate Bingo game with questions about Canadian content was conducted for

participants to learn and be familiarise with the Bingo game. Next, one session of actual Bingo gameplays (consisted of two gameplays, 30 to 45 minutes each, average 1 hour and 15 minutes in total) was conducted each week in all the eight centres.

After four weeks of actual game playing sessions, a new set of knowledge and sociability post-tests were administered. Two research assistants were assigned to each centre during the research study to facilitate the Bingo games, support participants in playing, and administer the instruments. At a later date, interview sessions were conducted with 10 selected participants, in order to gather qualitative data.

For analysing the data, Statistical Package for the Social Sciences (SPSS) software was used to analyze the quantitative data. T-tests were used to analyse the mean of the two sets of Knowledge and Sociability pre- and post-test. For analysing qualitative data from the Interview transcripts, NVivo qualitative analysis software was used to assist the researcher in organising and analysing the data. For the qualitative analysing techniques, the researcher chose Saldaña (2009) two cycle approach of coding. The first cycle used an initial coding and recoding of data; followed by the second cycle of classification of integrating, synthesising, abstracting, and eventually building a framework.

To ensure reliability, validity and trustworthiness during the data collection and analysis, plans to address threats for the Bingo game experiment were being addressed earlier in the study to minimise any potential threats that would affect the reliability, validity and trustworthiness of the result. Internal and external validity threats were identified before the beginning of study, including other form of threats that will affect the overall result of a study (Tuckman 1999; Creswell, 2008). Potential type of threats to validity were being addressed early before the start of the treatment study. For reliability and trustworthiness, transparency of data collection and interpretation were made as clear as possible. Multiple methods of data collection were being used, which included the pre-test, post-test and interview. Member checking of interview data with participants was also practised in analyzing the data.

Ethics approval was obtained in May 2015 from Simon Fraser University Office of Research Ethics. To follow the practice agreed on the ethics approval, the identity of the

participants in this study would be kept confidential. Reports on participants were coded with numbers instead of their names. Interviews recorded using digital recorders were destroyed immediately once transcribed into digital text with coded numbers of participants. All test data, including interview transcripts that have been collected, were being kept securely in a password locked flash drive; these data will be kept in a secured cabinet for four years before being destroyed.

Chapter 4.   Results

4.1. Chapter Introduction

This chapter consists of three sections, framed according to the sequential explanatory mixed methods design and characteristics. The first section presents the results of the analysis conducted on the quantitative data derived from the pre- and post-tests. These results address the first research question. The second section presents the results of the qualitative data analysis collected on the interview transcripts, which address the second research question. The third section presents a joint analysis of the quantitative and qualitative data. This section addresses the third research question.

4.2. Quantitative Data Results

In order to address research questions 1 and 3, t-tests were performed. A t-test is a statistical examination to determine the difference between the means of two normally-distributed sets of scores, or two population groups (Healey, 2011). The t-test were used in analysing the quantitative data (Knowledge and Sociability) pre- and post-test.

4.2.1.   Demographic breakdown of participants

Fifty-four participants initially signed up to participate; however 4 participants did not complete all the gameplay sessions, and therefore were excluded from the analyses presented here. A total of 50 participants finished the gameplay sessions, and completed two sets of Pre and Post-test (Sociability and Knowledge). Of these 50 participants, 13 (26%) were male, and 37 (74%) were female. With regard to the types of residents, they were from three community centres and five independent/assisted living homes. Table 4.1 provides greater detail about the participants including age group, game player level, previous digital game experience, and so forth.

Table 4.1.   Demographic Information of Participants

Demographic Information of Participants (N=50)		
Variables	**Frequency**	**Percent**
Centre		
Independent/Assisted living home	33	66.0
Community centre	17	34.0
Gender		
Male	13	26.0
Female	37	74.0
Age Group		
60 - 69	20	40.0
70 - 79	13	26.0
80 - 89	12	24.0
90 Above	5	10.0
Game Player Level		
Non-player	22	44.0
Beginner	11	22.0
Intermediate	17	34.0
Expert	0	0
Play digital games with		
On my own	14	28.0
Family members	2	4.0
Friends	5	10.0
Members of a club or association	5	10.0
Others	2	4.0
Non-player (don't play at all)	22	44.0
Played digital games in the past 5 years		
Yes	28	44.0
No	22	56.0

4.2.2.   Item-reliability analysis

To ensure item-reliability of the Sociability Pre and post-test used, Cronbach's Alpha was calculated on each factor using SPSS. The alpha values for the factors ranged from 0.65 to 0.90. Table 4.2 summarizes the Cronbach's Alpha coefficient of the social gameplay factors on the pre and post-tests. Both the pre- and post-test were able to obtain

scores at, or above 0.65 on the alpha coefficient reliability test; as according to Meyers, Gamst and Guarino (2013), anything below 0.6 is unacceptable, and can affect the internal consistency. Hence, anything from 0.65 and above is acceptable on the items used for the internal reliability of the scales used. As presented in the table, the pre-test presents three questionnaires with Alpha slightly above 0.65, whereas, the Post-test has three scales all above 0.75.

Table 4.2.   Analysis results of item-reliability of the Sociality Pre and post-test

Sociability Pre-test			
	Item's Scale	**No. of Items**	**Cronbach's Alpha**
Pre-test	Game attitude	6	0.69
	How sociable am I?	6	0.65
	Social connectedness	11	0.67
Post-test	Game attitude	10	0.91
	How sociable am I?	10	0.81
	Social connectedness	12	0.77

4.3. Answering Research Question 1

Is there an increase in knowledge and social connectedness for older adults while playing a multiplayer educational digital game?

4.3.1. Paired-samples T-test analysis of sociability pre- and post-test

As expected, statistical evidence on the outcome of the Bingo gameplay sessions was found in this study. For the sociability pre- and post-test, a Paired-Samples T-test analysis found significant differences on the questionnaire total scores that asked about participants' game attitudes and social connectedness. However, the score differences for the 'How sociable am I?' section was not found to be statistically significant ($t = 0.48$, $p=0.636$).

Participants experienced a statistically significant improvement in game attitudes (t = 2.96, p = 0.005) over the period of playing the game. Before they played game socially with other players, the result was (mean = 3.65, SD = 0.59), and after playing the game (mean = 3.98, SD = 0.63). The 95% confidence interval for the difference was (0.103, 0.542). Further, Cohen's effect size value (d = 0.42) suggested a moderate practical significance.

Further analysis revealed that there was statistically significant improvement in social connectedness of participants (t = 0.636, p = 0.032), after gameplay with other players. For the pre-test, the result was mean = 3.535, SD = 0.431, and after playing the game, the result was mean = 3.727, SD = 0.484. The 95% confidence interval for the difference was (0.018, 0.367). Further, Cohen's effect size value (d = 0.32) suggested a small to moderate practical significance.

Table 4.3.   Analysis results of Sociability Pre and Post-tests' Paired-Samples t-test

Sociability Pre and Post-test						
	Pre-Test		Post-Test		t-Value	p-Value
	Mean	SD	Mean	SD		
Game Attitude	3.65	0.59	3.98	0.63	2.96	0.005
How sociable am I?	3.95	0.49	3.92	0.52	0.48	0.636
Social Connectedness	3.53	0.43	3.73	0.48	2.21	0.032

4.3.2.   Change in social connectedness scores

A comparison of the 11 items used in the social connectedness scale showed significant results, t(10)= 5.62, p= .000, with a paired mean difference of M=0.20, SD=0.116, on the social connectedness scale between the pre- and post-test. The mean differences on the Social connectedness scale items fall between -0.02 to 0.34; with one item scoring a mean difference of -0.02, while the other 10 items scored above a mean difference of 0.10. There were 6 out of 10 items that scored above a mean difference of

0.20, which signified improvements in these players' social connectedness items after the game-playing sessions.

Table 4.4. **Summary of mean score of social connectedness scale items of pre-and post-test**

	Pre-test Mean	Post-test Mean	Mean Difference
I would like to have a larger circle of friends.	3.38	3.48	0.10
I feel a lack of company.	3.60	3.94	0.34
I would like to have a close relationship with more people.	3.30	3.48	0.18
I feel a lack of contact with people in my social network.	3.50	3.72	0.22
I am satisfied with the number of people with whom I have social contact.	3.76	3.86	0.10
I am satisfied with the amount of contact I have with the people in my social network.	3.70	3.86	0.16
My relationships with people in my social network feel superficial.	3.40	3.72	0.32
I derive little satisfaction from my social contacts.	3.58	3.80	0.22
I feel that people in my social network often think of me.	3.68	3.64	-0.02
I often think of people in my social network.	3.46	3.80	0.34
I don't feel I have a lot in common with people in my social network.	3.52	3.74	0.22

4.3.3. Paired-samples T-test analysis of knowledge pre- and post-test

As expected, significant differences were observed between the pre- and post-tests with regard to participants' knowledge about nutrition and health. A paired samples t-test found significant differences between pre- and post-test knowledge scores.

The evidence pointed out that participants experienced a statistically significant increase in knowledge (t = 5.93, p = 0.001), from before they played the Bingo game (mean = 10.14, SD = 2.204) to after playing the game with other players (mean = 12.22, SD = 2.063). The 95% confidence interval for the difference was (1.375, 2.785). Further, Cohen's effect size value (d = 0.85) suggested a high practical significance.

Table 4.5.   **Analysis results of knowledge pre- and post-tests paired-samples T-test**

Knowledge Pre and Post-tests' Paired-Samples T-test						
	Pre-Test		Post-Test		t-Value	p-Value
	Mean	SD	Mean	SD		
Knowledge	10.14	2.20	12.22	2.06	5.93	0.001

4.3.4.   Comparing frequency of scores of knowledge questionnaire on pre- and post-tests

A comparison of the 15 items used in the knowledge questionnaire, in Table 4.6 below, also revealed significant differences of percentages correct for each question attempted by the participants. The positive percentage differences range from 2.0 to 46.0, except for question Q14 that had a -8.0 difference. The biggest gains in the knowledge test after the gameplay can be found in items 1, 3, 14 and 15 (Nutrition), 10 (Physical Activity), and 14 (Social activity).

Table 4.6.   **Summary of frequency of score of knowledge test items on pre- and post-test (n=50)**

Questions	Question Level & Category	Pre-test Valid Percent	Post-test Valid Percent	Percentage Differences
Q1	Easy - Nutrition	24.0	48.0	24.0
Q2	Easy- Nutrition.	94.0	98.0	4.0
Q3	Medium- Nutrition	44.0	68.0	24.0
Q4	Medium -Nutrition	88.0	98.0	10.0
Q5	Hard -Nutrition	64.0	76.0	12.0
Q6	Hard - Nutrition	72.0	86.0	14.0
Q7	Easy -Physical activity	70.0	76.0	6.0
Q8	Medium -Physical activity	84.0	94.0	10.0
Q9	Medium -Physical activity	88.0	90.0	2.0
Q10	Hard - Physical activity	78.0	96.0	18.0
Q11	Hard - Physical activity	82.0	90.0	8.0
Q12	Medium - Prevention	80.0	82.0	2.0
Q13	Hard - Prevention	92.0	84.0	-8.0
Q14	Medium - Social activity	42.0	80.0	38.0

| Q15 | Medium - Nutrition | 8.0 | 54.0 | 46.0 |

From the quantitative data, we were able to obtain significant differences in social connectedness, game attitude, and knowledge gained from the gameplay. In the next section, the qualitative results from the interviews will further explain these findings from the quantitative data results.

4.4. Qualitative Data Results

The qualitative data analysis started with an initial coding phase. During this phase, the author and another research assistant manually read line-by-line each of the participants' interview transcripts. Next, they used spreadsheet software to tag each statement of the transcript with a representative phrase or sentence, including In Vivo phrases of the actual words used by the participants. They also tried to cut down the numbers of phrases used, by using repeating and similar phrases that represented the common meanings that the participants were trying to express. This went on until the entire interview transcript was analysed, and then reviewed again if anything were missing. They then moved on to analyze the second participant's transcript and then the rest of the transcripts. In total, 65 phrases or codes were generated, which represented the first overall pre-categorised set of codes or phrases, from the initial coding. Table 4.7 illustrates an initial coding sample of some interview excerpts, and how these were initially coded into their representative phrases or sentences.

Table 4.7.   Initial coding sample of Interview's transcript

Interview Excerpts	Initial coding attempts
PLAYER 20: I find that when you have Bingo game, I just like that it brings people together. When you bring in a competitive nature we all want to succeed, so we want to be better than the next person but at the end of this game also, there is reward at the end, so that encourages people to work together harder, this is not just a video game, it's social, it's competition which is great.	18 BRING PEOPLE TOGETHER 19 GAME CHARACTERISTIC: COMPETITIVE NATURE 20 GAMEPLAY: SUCCEED 21 PLAYER: COMPETITION 22 GAME: REWARD 23 PLAYER: WORK TOGETHER 24 SOCIAL: GAME-PLAYING 25 GAMEPLAY: COMPETITION

PLAYER 37: Bingo game is great because it really reinforce that what I didn't get it right the first time, I would get it right the next time. The learning aspect increases my knowledge and it's a fun game. I'm doing several things together and my brain is getting work out.	35 LEARNING: REINFORCE LEARNING 36 TRYING TO GET RIGHT ANSWER 37 INCREASE KNOWLEDGE 38 FUN GAME 39 DOING SEVERAL THING TOGETHER 40 KEEP MIND ACTIVE

Table 4.8.   Initial coding compilation of codes developed and renamed

Changed Perspective of Digital Game	Importance Of Digital Game
Comparing With Other Games	Improved Mood of Playing
Concerns For Other seniors	Improving of Social Skill
Connect With Players	Social benefits
Reinforce Learning	Good Social games
Trying To Get The Right Answer	Interaction With Other Players
Increasing Of Knowledge	Excited About Bingo Game
Fun Game	Coordination With Other Players
Doing Several Things Together	Interested In Learning Nutrition And Health
Bring People Together	Keep Brain Active
Competitive Game	Learned About Technology
Succeeding In Gameplay	Learned New Knowledge
Game Reward	Learning With Other players
Player Working Together	Make New Friends
Gameplay Competition	Making Nutrition And Health Changes
Continue Playing Digital Game	Motivated To Learn About Nutrition And Health
Deep Playing	New Learning Methods
Paying Attention in Gameplay	Not About Winning
Enthusiastic Playing Bingo Game	Cheering For Other Players
Waiting For Other Players	Feel Excited When winning
Feeling Comfortable	Positive Co-playing Experience
Feeling of Accomplishment	Sharing Of stories
Good Company Of Players	Talking To Other Players
Importance To Know Other Players	Useful Game Content
Fun To Play	Worth Spending Time Playing
Future Investment in Digital Games	Recommendation Of Game Improvement
Game As Regular Activity	Following Bingo Numbers
Game As Pastime	Need To Change Nutrition & Health Habits
Game As Hobby	Avoiding Social Isolation
Game Content Challenges	Need To Do Something Frequently
Game Flow	Game Challenges
Game Interface challenges	
Gameplay Rewards	
Good Game Questions	

The researchers then moved on to conduct their second cycle of coding. For this phase, the coders chose a focused coding method to further analyse data recorded from the first cycle. Focused coding helped to organise and crystallise data further, eventually, coding of data analytically into categories and themes (Saldaña, 2013). According to Saldaña, focused coding method is suitable as the second cycle strategy, with the main goal to develop the coded data into respective major categories or themes. The characteristics of this coding method were to search for and analyse the most frequent, salient or significant initial codes, and form them into their respective categories or themes (2013, p. 213). Focused coding is also a common method of coding used in many grounded theory studies, and widely used after initial, in vivo, or process coding (Charmaz, 2006). The NVivo software, with its useful features of displaying the nodes and coding results, made discussing and reviewing of the focused coding easier and productive, especially when renaming and making corrections to the codes being generated.

In total, 45 categories or classifications were created after analysing the entire interview transcripts. Categories were created by renaming and integrating the phrases or codes generated from the initial coding process. After the first step of coding the transcript into its represented categories, the coders reviewed the categories, and read through the transcripts again. Eventually, some of the nodes were renamed or refined to better represent a series of statements, as a whole. For example, 'not about winning' was renamed to become 'game winning', as the coders found that even though the participants spoke about winning Bingo, it was not their main objective. Instead, the participants mentioned game winning more as a bonus and reward, which they liked to achieve, but it was not their main priority. The coders also broke up the nodes or categories: Interaction With Other Players, into two separate nodes – Player Interactivity and Player Collaboration – as they noticed that these nodes or categories both represented different things, after reviewing the transcript again. This also finalised the numbers of nodes or categories to a total of 45. The table 4.8 below illustrates the first attempt of second coding cycle, where 45 categories were generated.
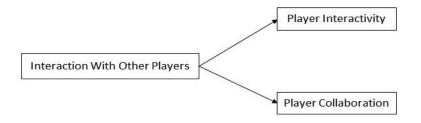
Figure 4.1. **Breaking up of coded category: Interaction with other players into two separate categories**

Table 4.9. **Category of codes being renamed and arranged according to their types**

Reanalyzing & Renaming	Reanalyzing & Renaming
Question Analyzing	Digital Game Future Expectation
Question Answering Correctly	Digital Game Importance
Application To Daily Life	Game-playing Mood (Mood, In Vivo)
Relationships Building	Game-playing Social Skill
Learning with Perspective Changed in Nutrition And Health	Player Interactivity
	Player Collaboration
Digital Game Perspective Changed	Learning Increased Interest In Nutrition and Health
Digital Game Comparison	Game-playing Keep Mind Active
Care For Other Seniors	Learning About Technology
Player Connection (Connected, In Vivo)	Learning New Knowledge
Post Bingo Study Continual Playing	Learning With Other Players
Game-playing Immersion	Make New Friends (Make New Friend, In Vivo)
Feeling of Enthusiastic	Make Nutrition and Health changes
Feeling of Excitement (Excited, In Vivo)	Post Bingo Game Motivation to Learn more about Nutrition and Health
Feeling Comfortable (Comfortable, In Vivo)	
Feeling Of Accomplishment (Accomplished, In Vivo)	Learning Game as New Learning Methods
Feeling Fun (Fun, In Vivo)	Game Winning (Winning, In Vivo)
Digital Games Potential Investment	Player Positive Co-playing Experience
Post Bingo Study Playing Game As Regular Activity	Player Sharing Of stories
Game Content Challenges	Player Talking To Other Players
Game Flow	Learning Useful Game Content
Game Interface Challenges	Worth Spending Time Playing (Worth Spending Time Playing, In Vivo)
Game Rewards	
Game Questions (In Vivo)	Game As Helpful Technology

The categories were further regrouped and integrated according to their types and representation; this was also for the purpose of making the tasks of tracing them easier, and preparing for the next step of synthesising them.

Table 4.10. **Category of codes being regrouped and integrated according to types**

Integration (Re-grouping)	Integration (Re-grouping)
Question Analyzing	Helpful Technology
Question Answering Correctly	High Positive Expectation for Future Digital Game
Good Game Questions (Vivo)	Game Content Challenges
Digital Game Perspective Changed	Game Flow
Digital Game Comparison	Game Interface Challenges
Digital Game Potential Investment	Game Rewards
Digital Game Future Expectation	Game As Helpful Technology
Digital Game Importance	Game Winning (Winning, In Vivo)
Player Connection (Connected, In Vivo)	Learning with Perspective Changed in Nutrition And Health
Player Interactivity	Learning Increased Interest In Nutrition and Health
Player Collaboration	Learning About Technology
Player Positive Co-playing Experience	Learning New Knowledge
Player Sharing Of stories	Learning With Other Players
Player Talking To Other Players	Learning Useful Game Content
Feeling of Enthusiastic	Learning Game as New Learning Methods
Feeling of Excitement (Excited, In Vivo)	Post Bingo Study Continual Playing
Feeling Comfortable (Comfortable, In Vivo)	Post Bingo Study Playing Game As Regular Activity
Feeling Of Accomplishment (Accomplished, In Vivo)	Post Bingo Game Motivation to Learn more about Nutrition and Health
Feeling Fun (Fun, In Vivo)	Application To Daily Life
Game-playing Immersion	Relationships Building
Game-playing Mood (Mood, In Vivo)	Care For Other Seniors
Game-playing Social Skill	Make New Friends (Make New Friend, In Vivo)
Game-playing Keep Mind Active	

As the categories were further regrouped and synthesised according to their types and representation, the numbers of categories were reduced from 45 to 38. Synthesising, similar to Regrouping or Clustering, was also a strategy used in one of Richards' (2009) concepts of re-categorising early codes and coding into structures or schemes. This included combining the categories of Question Analysing and Question Answering Correctly, into one single category: Question Analysing. The reason for doing this was that,

after reading through the transcripts that represented both categories, the coders noticed that when the participants mentioned answering questions correctly during the gameplay, it involved also analysing the game's questions and making decisions to select the right answer. This eventually led the coders to synthesise the categories of Question Answering Correctly, and combine them to the node: Question Analysing.

The other synthesising worth mentioning is that the researchers also synthesised the categories of Digital Game Future Expectation, Digital Game Comparison, Digital Game Potential Investment, and Digital Game Importance into one single node or category: Digital Game Future Expectation. The reason behind this decision is that, after reviewing these few categories and their respective links to the transcript data, they found that Digital Game Future Expectation was sufficient to represent what the senior players wanted or expected to have in the future. This is also one of the key reasons to encourage them to continue playing digital game, with further research that provides stronger and more relevant features that cater to their needs. In fact, this could have been done during the Integration process earlier, but the Integration process focused more on regrouping them according to their types and similarity in classification. The synthesising process also consists of two parts, where the nodes were further being combined into respective categories that best represented them.
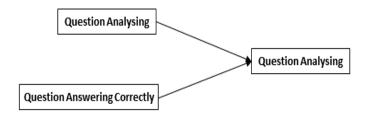
Figure 4.2   Combining the coded categories of Question Analysing and Question Answering Correctly into one single category: Question Analysing
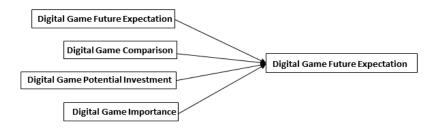
Figure 4.3. **Synthesizing several related coded categories into one single category: Digital Game Future Expectation**

Table 4.11. **Category of codes being regrouped and synthesised according to their types or representation**

Synthesizing 1	Synthesizing 1
Question Analyzing	Game Content Challenges
Good Game Questions (In Vivo)	Game Flow
Digital Game Perspective Changed	Game Interface Challenges
Digital Game Future Expectation	Game Rewards
Player Connectedness (Connected, In Vivo)	Game As Helpful Technology
Player Interactivity	Game Winning (Winning, In Vivo)
Player Collaboration	Learning with Perspective Changed in Nutrition And Health
Player Positive Co-playing Experience	Learning About Technology
Player Talking To Other Players	Learning New Knowledge
Feeling of Enthusiastic	Learning With Other Players
Feeling of Excitement (Excited, In Vivo)	Learning Game as New Learning Methods
Feeling Comfortable (Comfortable, In Vivo)	Post Bingo Study Continual Playing
Feeling Of Accomplishment (Accomplished, In Vivo)	Post Bingo Study Playing Game As Regular Activity
Feeling Fun (Fun, In Vivo)	Post Bingo Game Motivation to Learn more about Nutrition and Health
Game-playing Immersion	Application To Daily Life
Game-playing Mood (Mood, In Vivo)	Relationship Building
Game-playing Social Skill	Care For Other Seniors
Game-playing Keep Mind Active	Make New Friends (In Vivo)
	Make Nutrition and Health changes
	Worth Spending Time Playing (In Vivo)
	Future Digital Game

The second stage of the Synthesising process further groups various nodes together to form a set or group. In the previous first stage of synthesising, the coders combined the categories of Question Analysing and Question Answering Correctly into one node: Question Analysing. So, for the second stage, they synthesised Questions Analysing and another category of Good Game Questions as a set, and gave it an abstractive name

in the Abstract process later on. Take note also that in Table 4.11, Digital Game Future Expectation were synthesised to form as a set of categories with Digital Game Perspective Changed, Digital Game Future Expectation, Care For Other Seniors, and Game As Helpful Technology. The reason for synthesising them together is that, after reviewing the relevant statements on the transcripts that linked to these categories, the coders noticed that most of the older players were concerned with future aspects of digital games. The older players were not just concerned about their personal expectations of what future game should be like, but, also their authentic opinions to contribute to potential game development. Hence, the abstract name Game's Future Contribution was later used in the Abstracting process to represent these sets of nodes.

Table 4.12. **Second stage of synthesising category of codes for regrouping and synthesising according to types or representations**

Synthesizing 2		
Question Analyzing Good Game Questions (In Vivo)	Game-playing Immersion Game-playing Mood (Mood, In Vivo)	Application To Daily Life Make Nutrition and Health changes
Digital Game Perspective Changed Digital Game Future Expectation Care For Other Seniors Game As Helpful Technology	Game Content Challenges Game Flow Game Interface Challenges Game Rewards Game Winning (Winning, In Vivo)	Post Bingo Study Continual Playing Post Bingo Study Playing Game As Regular Activity Post Bingo Game Motivation to Learn more about Nutrition and Health
Player Connectedness (Connected, In Vivo) Player Interactivity Player Collaboration Player Positive Co-playing Experience Player Talking To Other Players Game-playing Social Relationship Building Skill	Feeling of Excitement (Excited, In Vivo) Feeling Comfortable (Comfortable, In Vivo) Feeling Of Accomplishment (Accomplished, In Vivo) Feeling Fun (Fun, In Vivo) Feeling of Enthusiastic	Learning with Perspective Changed in Nutrition And Health Learning About Technology Learning New Knowledge Learning With Other Players Learning Game as New Learning Methods
Make New Friends (In Vivo)	Worth Spending Time Playing (In Vivo)	Game-playing Keep Mind Active

The coding process ended at the Abstraction stage, where relevant abstract names or phrases were given to each of the synthesised group of categories. The following

Table 4.14 represents the 12 themes for the respective group of categories the coders have coded so far. According to Saldaña (2013, p. 14), "A theme is an outcome of coding, categorization, and analytic reflection, not something that is, in itself, coded". The coders agreed that these should be the finalised stage for this analysis, ready to use for answering Research Questions 2 and 3. The abstraction can still be further improved; but for this study, the coders stopped at this stage and deemed it relevantly coded to address the research questions.

Table 4.13.   An abstraction of category of codes according to their types or representations as a result of synthesising and cluttering

Abstraction		
Game Questions	Game-playing Mood	Application To Daily Life
Question Analyzing	Game-playing Immersion	Application To Daily Life
Good Game Questions (In Vivo)	Game-playing Mood (Mood, In Vivo)	Make Nutrition and Health changes
Game Future Contribution	Game Content	Life after Bingo Study
Digital Games Perspective Changed	Game Content Challenges	Post Bingo Study Continual Playing
Digital Game Future Expectation	Game Flow	Post Bingo Study Playing Game As Regular Activity
Care For Other Seniors	Game Interface Challenges	Post Bingo Game Motivation to Learn more about Nutrition and Health
Game As Helpful Technology	Game Rewards	
	Game Winning (Winning, In Vivo)	
Social Co-playing	Gameplay Excitements	Knowledge acquired
Player Connectedness (Connected, In Vivo)	Feeling of Excitement (Excited, In Vivo)	Learning with Perspective Changed in Nutrition And Health
Player Interactivity	Feeling Comfortable (Comfortable, In Vivo)	Learning About Technology
Player Collaboration	Feeling Of Accomplishment (Accomplished, In Vivo)	Learning New Knowledge
Player Positive Co-playing Experience	Feeling Fun (Fun, In Vivo)	Learning With Other Players
Player Talking To Other Player	Feeling of Enthusiastic	Learning Game as New Learning Methods
Game-playing Social		
Relationship Building Skill		
Make New Friends (In Vivo)	Worth Spending Time Playing	Keep Mind Active

Worth Spending Time Playing (In Vivo)	Game-playing Keep Mind Active	

Table 4.14.   The result of 12 themes being finalised from the two cycle coding analysis

Themes		
Useful Game Content	Game-playing Enjoyment	Application To Daily Life
Game Future Contribution	Game-playing Mood	Continual Digital Game-playing
Social Co-play	Game-playing Excitement	Knowledge
New Friends	Worth Spending Time Playing	Keep Mind Active

4.5.   Answering Research Question 2

What is the social experience of older adult players while playing a multi-player educational digital game with other players?

To address this question, the researcher uses three of the themes found in coding the interview transcripts: Social Co-play, Game-playing Excitement, and New Friends, together with their respective sub-categories to provide a description of what the older adult players experienced while playing socially during the Bingo digital game. For each sub-category, the researcher also used some relevant fragment examples of participants' voices that spoke about their social experiences.

4.5.1.   New friends

The abstraction process provided us opportunities to answer Research Question 2. The theme from the abstraction of data coding that stands out the most from

participants' social experience is New Friends. The ability to develop new friendships, including playing with someone with whom you can partner or often interact with in a game, was highly sought after by this group of older adult players. This was also one of the reasons that most of this group of players experienced positively during the social game-playing sessions. Making new friends was frequently mentioned in the interviews, with 6 out of the 10 participants mentioning it as an important event encountered, especially at the starting part of the gaming sessions. Making friends and having friendships or partnerships is so important that it can affect gameplay events dramatically. This important social capital gain, according to social capital theory (Putnam, 2001), can be achieved by participating in the game-playing sessions, and being part of a game playing group. In the code base, New Friends occurred 11 times in the transcripts of 6 participants. The following are some sample interview excerpts occurring under this code:

Player 02: "… you're meeting new people. And if you don't know them in person, perhaps there's a connection where you form it."

Player 21: "I can see how other elderly are playing, and get to know others they don't meet before. They can share their life stories, too".

Player 31: "I'm a social person. I like being with people. That's why I come down. While playing game I get to know others."

Player 37: "I really enjoy it in a group; being alone is quite isolating. Playing in a group is more ideal because you are interacting with people, you are meeting new people and you are having conversation …"

Player 37: "One of the ladies we meet, we go for lunch now. We made new friends. That was very positive, social connection …"

The social experience of making new friends is highly regarded by the older players in the gaming environment. From the conversation fragments, we can see that getting to know new players and playing together can provide a very welcoming social experience. This aligned to the findings from De Schutter and Vanden Abeele (2010), and

Mclaughlin, Gandy, Allaire and Whitlock (2012), that digital games should emphasise developing the connectedness of players, through multiplayer and communicative features. Such features can also, in turn, lead to more meaningful game play for this group of senior players.

4.5.2. Social co-play

Social Co-playing, the ability to play with other players, both familiar and new, was highly regarded by the older players. Under the social co-playing code were various sub categories which included: Player Connectedness, Player Interactivity, Player Collaboration, Player Positive Co-playing Experience, and Player Talking To Other Players. Samples of interview text coded under each category are provided below.

Player Connectedness

Player 17: "Yes, I learn a lot from the game and have an opportunity to link with others."

Player 31: "I would like to continue playing the game. The same group and we become very close doing it. Good to come out of the room to socialise and do other things, be connected with others …"

Player 37: "The players we all connect really well and got along; we were happy for each other when somebody got the answer."

Player Interactivity

Player 17: "I am more interested to play with others much better than playing alone. It's better because I could communicate with others and interact with them."

Player 24: "The interactions I enjoy, you hear them trying to figure out the questions."

Player Collaboration

Player 17: "Yes, teamwork is emphasised and I've learn to co-operate with others in the game."

Player 31: "It's a game you are playing together, working together …. It's teamwork."

Player Positive Co-playing Experience

Player 02: "Playing in a group have more fun, and can hear the sounds of other players. It also improves your mood of playing …"

Player 10: "It's very good for every people, who like to think, and talking to lot of people about this thing, about Bingo, about playing something, about talking something. It's very very good for us. For me, I like to [use] my time doing something."

Player Talking To Other Players

Player 32: "Yes, I like playing with the group, you are talking to them, playing and sitting with them, you feel comfortable."

Player 10: "Playing, I talk to people who play with me, and we talk about playing, about the food and something like that."

Without doubt, Social Co-play, with Players' Interaction, Collaboration, Connectedness, and Talking to Each Other during game-playing are important components that frequently surfaced and experienced by older players. This also aligned to Social Capital Theory (Putnam, 2001) on the importance of identifying the source of social capital, which in this case is the social co-playing events. These findings were also consistent to Gajadhar, de Kort, Ijsselsteijn and Poels (2009) who reported that older adult players enjoyed playing together with other players as the primary motivation to engage in social game play.

4.5.3. Game-playing enjoyment

Gameplay enjoyment is another important facet of an engaging social experience of game-playing. Under the theme of Gameplay Enjoyment lies the following sub categories: Feeling of Excitement, Feeling Comfortable, Feeling Of Accomplishment, Feeling Fun, and

Feeling of Enthusiasm. Samples of interview text coded under each category are provided below.

Feeling of Excitement

Player 20: "I learn one other thing in the game play – a lot of people were excited! They love the game, some of them won the bingo, even myself; the points! They were happier, we cheer one another on …"

Player 21: "Very happy when I win and learn to answer the right questions."

Feeling Comfortable

Player 32: "Yes, I like playing with the group, you are talking to them, playing and sitting with them, you feel comfortable."

Player 31: "I would like to continue playing the game. The same group and we become very close doing it and comfortable with one another. Good to come out of the room to socialise and do other things, be connected with others."

Feeling Of Accomplishment

Player 32: "It's an encouragement for my life. Now I'm not afraid in playing the game. I've learned a lot. I feel I've accomplished something. I learned something new."

Player 37: "Bingo game is great because it really reinforce that what I didn't get it right the first time, I would get it right the next time. And I did it."

Feeling Fun

Player 02: "Playing in a group [I] have more fun, and can hear the sounds of other players."

Player 17: "Because there are people playing together with me, it was more fun playing the digital game."

Feeling of Enthusiasm

Player 20: "I am just enthusiastic. My answer is I never stop playing and learning."

Player 24: "… yes, extremely interesting especially the questions, and I like to be with people and to see how they behave and how they are thinking."

The importance of feeling good and being comfortable playing with other players was shared by the older players. The emotional needs for this group of seniors were important when it came to participating in social activities, including digital game playing sessions. Some of this enjoyment encountered and felt during gameplay, as seen in the conversation fragments, were the driving force and motivation for older players to continue playing game. The ability to communicate and interact with other players were also some of the key facets for such enjoyable experiences. This was also consistent to Gajadhar, De Kort and Ijsselsteijn (2008), that players experienced more playing enjoyment as a result of increasing affordances in communication among the players. Despite that, game enjoyment and its amount of pleasure are only a generic definition; game enjoyment requires more in-depth study on game competence, challenge, frustration, and aggression, which are related to many facets of game-playing enjoyment (Gajadhar, De Kort & Ijsselsteijn, 2008). Also, for older adult players, the learning and enjoyment of playing with other players were two of the main motives that made them play the game continually and become regular players (Ijsselsteijn et al., 2007; Vasconcelos et al. (2012). This also leads us to connect with Adult Learning Theory (Knowles, 1980) that older adults learn with motives, and these motives are important for them, to attract them to learn and help them learn effectively.

4.6. Answering Research Question 3

What elements help contribute to a positive gameplay experience for older adults while playing a multiplayer educational digital game with other players?

For this section, the researcher explained the quantitative results together with the support of data and results gathered from the qualitative analysis. The quantitative results showed significant shifts in players' game attitude towards game, positive social connectedness, and knowledge gained from playing the educational Bingo digital game over the four weeks of game play. To understand how these changes may have come about in the participants' experiences, the researcher examined the qualitative results,

using the relevant themes developed from the interview transcripts.

4.6.1. Player game attitude

The quantitative results showed significant improvement in players' game attitude in the Sociability Pre and Post-test (t = 2.956, p = 0.005), before they play game socially with other players (mean = 3.65 units, SD = 0.59), and after playing game (mean = 3.98 units, SD = 0.63). The 95% confidence interval for the difference is (0.103, 0.542). Referring this data to the qualitative results, the following themes and its sub-categories were used to further explain and support this significance.

Game-playing Mood

The Bingo gameplay sessions provided a reasonable game playing sequence and flow to the older adult players, and at the same time also promoted a positive game-playing mood to these players. This theme of enhanced mood while playing was mentioned 12 times by 6 of the interviewees (Total of 10 interviewees). This was aligned with Allaire, McLaughlin, Trujillo, Whitlock, LaPorte and Gandy (2013), who also reported significant results of older adult players who moderately and regularly played digital games, performed better in tests on quality of life, mood and depression. The positive emotion of playing and the reaction to interaction – reassurance, confidence, encouragement – from the game-playing outcome and through interaction with other players can highly affect the flow of gameplay and social participation (Hwang, Hong, Hao, and Jong (2011). From the findings, we also noticed that Game-Playing Mood is closely related to Game Rewards, Game Enjoyment, and Make New Friends.

Worth Spending Time Playing

The feeling of time spent playing the game being worthwhile was one of the themes generated from the qualitative analysis. This theme and its sub-categories were mentioned 11 times by five of the interviewed players. When older adults found it worth spending time playing, especially with other players, or learned something from the gameplay, they were likely to spend more time playing. This finding was consistent with the Adult Learning Theory perspective, in which older adults see learning outcomes to be worthwhile spending time on. As it turned out, what the participants learned and played was something practical that could be transferred to their everyday life. They would likely

weigh or gauge whether it was worth investing their time and effort playing such game through a cost-benefit analysis (Mclaughlin, Gandy, Allaire & Whitlock, 2012). This was also consistent with what was reported by Melenhorst, Rogers and Bouwhuis (2006), that older adults were keener to use technology when they found it beneficial to help them in this phase of their life.

Game Future Contribution

This theme highlighted players' experiences from the gameplay, which lead them to suggest improvements to the digital game. From the interview transcripts, this theme and its sub-categories were mentioned 19 times by 7 of the interviewees, in their suggestions of what to improve and remove from the Bingo game. This also included their ideal game, suggestions, and expectations for future games that could suit the needs of older adult players. Such ideas were also suggested in the studies by De Schutter and Vanden Abeele (2010) that senior players should be included in the design and development of games to be created for them. They should be part of the game design to contribute, and also contribute to society from learning through gameplay. De Schutter and Vanden Abeele conducted a participatory design with ten elderly participants (68 to 80 year old, Flemish senior citizens, seven men and three women), which eventually shed new insight in the game's activity components. The three components included Connecting people, Cultivating personal growth, and Contributing to society; all three were equally important components of game design according to the perspectives of the elderly participants.

Keeping Mind Active

The ability to keep the mind active was, to the surprise of the researcher, mentioned 22 times by 9 interviewed players in this study. Some of them mentioned using a lot of brain power to answer the game's questions, and waiting anxiously for the next Bingo number to appear. These were exciting activities which kept them focused and attentive. This finding was consistent with a recent study by Kaufman (2013) that consists of four years of multiple separate research studies to investigate the effect of digital games' enhancement on older adults' cognitive and social lives. In one survey of 891 Older Adults (55 years and older), Kaufman used cognition and socio-emotional measures questionnaires to identify older adults' ratings of psychosocial and cognitive changes

through game play. Kaufman reported that 83% of respondents indicated that 'mental exercise' (p. 6) was the greatest benefit of playing digital games, followed by 71% respondents who chose 'enjoyment/ fun' (p. 8). Such use of their brain power was also mentioned in recent related research studies about older players' interest in their cognitive abilities, especially keeping their minds active and working when playing digital game (Scarmeas & Stern, 2003; Miller, 2005, Engelhardt, Buber, Skirbekk, & Prskawetz, 2010).

Continual Digital Game-playing

This theme and its sub-categories on continuing playing digital game after this Bingo study, were mentioned 10 times by 9 of the interviewees. Besides continuing to play digital games, some players also suggested introducing their friends to play this Bingo game. Others also mentioned their willingness to invest their time to continue playing digital games, and choosing the type of game they would like to play. This is also aligned to the work of McLaughlin, Gandy, Allaire and Whitlock (2012) who suggested that older adults do a cost and benefit analysis to gauge whether it is worth investing their time and effort in playing a digital game.

Digital gameplay should be encouraged for long-term continual and maintenance playing. The continuing and regular gameplay has been researched and reported to reduce social isolation and the feeling of loneliness (Wollersheim, Merkes, Shields, Liamputtong, Wallis, Reynolds, & Koh, 2010). Many older adults have also been found to play digital games more frequently. Kaufman (2013) reported optimistic results, that there is a large and diverse group of older adults who are still actively and regularly playing digital game (p. 6). Kaufman's survey results reported that 88% of older adults' respondents from the survey, played at least one day or more per week, on average. Surprisingly, 93% of these older adult players played between 2-5 hours per day on average.

4.6.2.   Social connectedness

The quantitative results showed significant improvement in Social Connectedness (t = 0.636, p = 0.032), between the start of the study (mean = 3.535 units, SD = 0.431), and the end of the gameplay sessions (mean = 3.727 units, SD = 0.484). Further support and explanation of this finding are explained through the following themes and its sub-

categories derived from the interview data.

New Friends

The ability to meet new friends is a very strong social aspect for this group of senior players. This theme and its sub-categories were mentioned 11 times by 6 of the interviewees. Having the ability to develop new friendships and grow in the friendships motivate them to come together to play digital game. This finding was consistent with De Schutter & Vanden Abeele's (2010) report on outlining the activities as to why older adults play games: Connectedness, a way to connect and meet people. As seniors age, they tend to lose friends for many reasons, such as the passing away of friends or relatives as a result of old age. So, it can be natural for them to seek to fill this gap in their social networks, with more friends or someone who can share their companionship (De Schutter & Vanden Abeele, 2010).

Social Co-play

The ability to play with other players, rather than playing alone is highly regarded by older players. This theme and its sub-categories were mentioned 23 times by 10 of the interviewed players. The ability to allow these older players to interact and socialise with other players are among some of the key reasons to draw them to play games, and decide their time was worth spending on a game (De Schutter, 2011)

The ability to provide social co-playing activities in the game-playing sessions has been a popular research area (Nap, de Kort & Ijsselsteijn, 2009; Gajadhar, Nap, De Kort & Ijsselsteijn, 2010; De Schutter & Vanden Abeele, 2010). Ijsselsteijn, Nap, De Kort, and Poels (2007) also agreed that social features and opportunity to socialise and play with others are key elements for this group of players to play games.

Game-playing Excitement

The feeling of excitement derived from the gameplay sessions is also one of the key elements of what a game, especially a multiplayer game should offer. This theme and its sub-categories were mentioned 12 times by 8 of the interviewed players. With excitement and players' engagement, it would no doubt draw players, including older players to play the game, and they would continue coming back to play the game again. A recent study conducted by Gajadhar, de Kort, Ijsselsteijn and Poels (2009), also

reported that digital games promote social fun for even older players. Such social fun relates to escaping from reality, being involved in social interaction and social competition while playing with others, especially in a co-located playing environment where players can be engaged in playing together.

4.6.3. Knowledge gained

The quantitative results showed significantly improvement in Knowledge (t = 5.928, p = 0.001), before they play the Bingo game (mean = 10.14 units, SD = 2.204), and after playing with other players (mean = 12.22, SD = 2.063). The 95% confidence interval for the difference is (1.375, 2.785). Referring this data to the qualitative results, we were able to find out the following themes, and its sub-categories to explain this significance with better details.

Knowledge Acquired

The knowledge acquired refers mainly to the learning about nutrition and health topics from the game's content, questions, feedback, and co-playing with other players. This theme and its sub-categories were mentioned 22 times by 10 of the interviewed players. Besides sitting together, socialising and playing the game, the older players also gained knowledge about nutrition and health from the gameplay. The knowledge gained was aligned to Knowles' Adult Learning Theory (1980), where he described adults, including older adults, seeking practical gains from learning a topic being introduced. Studies from Griffiths (2005) also highlighted that, besides the fun elements of a digital game, serious educational aims and content are encouraged to be included. Marston (2013) also found adults to be highly interested to learn something useful and practical to their current needs, including providing a purpose for playing, so that they themselves know what are the end goal and objectives for them to play those games. Hence, digital game offered for their current needs should be considered, as it would more likely draw out their interests.

Useful Game Content

Good and relevant game content were highly regarded by the group of players in this study. This theme and its sub-categories were mentioned 9 times by 9 of the interviewed players. The nutrition and health content were well received, and there was

very little disappointment mentioned by the participants. Some argued about the content, which occasionally contradicted to what they previously knew or taught; but, eventually the feedbacks and explanations provided by the game were well accepted. The opportunity for players to interact and discuss about the game's content, also convinced them of the reliability of the content. This was somewhat similar to findings reported by Hsu and Lu (2004), that older adults might have negative initial thoughts upon receiving a new game and its content, which they are not familiar with; but when a well-developed game was able to provide sociality and an engaging flow experience, their perception of the game will change.

Good Game Questions

Many participants mentioned the game's questions and feedback provided. Most commented that the game's questions and feedback were well designed. Eight players mentioned 13 times to praise the good game questions they encountered during the gameplay. Though they mentioned that the game can be improved further, the comments provided by the interviewed players, and overheard during gameplay were mostly positive. The game's questions and feedback were part of the game where the players mainly learnt about the Nutrition and Health topics.

The way the questions, answers, and feedback were presented are aligned to what was highlighted by Ogomori, Nagamachi, Ishihara, Ishihara and Kohchi (2011) and Wu, Miao, Tao & Helander (2012), noting that it could affect the learning outcome of the players. The importance of providing relevant and valuable feedback, as additional information for the players can further educate them, whether the questions were answered correctly or incorrectly. Good feedback can reinforce the learning of a topic.

Application To Daily Life

The practical application of what was learned and which could be used in everyday life to meet their needs was highly regarded by older adults. This theme and its sub-categories were mentioned 14 times by 8 of the interviewed players. As mentioned earlier, this is one of the key components of Adult Learning Theory (Knowles, 1980); it also promoted further interest for the players to seek and learn more about the nutrition and health topics, which to some, were not so important previously. Hence, the ability to apply

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what was learned is important to these older adults, as they esteemed highly the practicality of what they learned.

4.7. Chapter Summary

This chapter was framed into three sections according to the sequential explanatory mixed methods design and characteristics, as well as answering the three research questions. Besides answering the research questions with the significance results found from the data analysis, it also presented the result of 12 themes being finalised from the two cycle coding analysis strategy (Saldaña, 2013), from first cycle of initial coding, to second cycle of focus coding.

The first section presented the results of the quantitative data derived from the pre- and post-test, which included using the quantitative data findings to answer Research Question 1: Is there an increase in knowledge and social connectedness for older adults while playing a multiplayer educational digital game? To answer this question, the author used the Sociability and Knowledge pre- and post-test, with a paired-samples t-test analysis to answer it. The analysis found significant increase in social connectedness ($t = 0.636$, $p = 0.032$), from the social gameplay with other players. For the pre-test, the result was mean = 3.535, SD = 0.431, and after playing the game, the post-test result was mean = 3.727, SD = 0.484. The 95% confidence interval for the difference was (0.367, 0.018). There were also significant increases in knowledge ($t = 5.93$, $p = 0.001$), from before they played the Bingo game (mean = 10.14 units, SD = 2.204) to after playing the game with other players (mean = 12.22, SD = 2.063). The 95% confidence interval for the difference was (1.375, 2.785).

The second section presented the results of the analysis of the qualitative data collected from the interview sessions conducted with a selective group of participants, including using the findings to answer Research Question 2: What is the social experience of older adult players while playing a multi-player educational digital game with other players? The results from analysing the interview transcripts provided valuable findings to answer this research question. To answer this question, the researcher used three of the

themes found from coding the interview transcripts: Social Co-play, Gameplay Excitements, and New Friends, together with their respective sub-categories to provide descriptions of the older adult players' experiences while playing socially during the Bingo digital gameplay. This section also presented various examples of the themes discussed, with participants' verbatim fragments from the interviews.

The third section presented both the quantitative and qualitative data, and how qualitative data support the quantitative data that were collected earlier. This section also answered the third research question using both forms of data, with a mixed methods interpretation of how both quantitative and qualitative are important to help address this study's research problem, as well as supporting one another. The Research Question 3: What elements help contribute to a positive gameplay experience for older adults while playing a multiplayer educational digital game with other players? The author responded to this question by explaining the quantitative results, together with the support of results of the qualitative analysis. The quantitative results showed significance in players' game attitudes, positive social connectedness, and increased knowledge gained, from playing the digital educational Bingo game. To support this, the author also used the qualitative results and was able to support this claim using mainly the relevant themes developed from the interview transcripts.

Chapter 5.

Discussion

5.1. Review of Research Aim and Purpose

This study adds to the ongoing research exploring the use of digital games to improve the wellbeing of older adults (Brady, 1987; Whitcomb, 1990; Nap, De Kort & Ijsselsteijn, 2009; Gajadhar, Nap, De Kort & Ijsselsteijn, 2010; De Schutter & Vanden Abeele, 2010; Marston, 2013). Rather than seeing older people withdraw from the benefits of modern day technology, digital games should be further explored and investigated, catering to this group of users and allowing them to keep up with technological developments (Brady, 1987). At the very least, games could assist older adults to overcome and handle the fast-pace of modern society, leading towards a better quality of life (Whitcomb, 1990).

This study fulfilled its purpose of investigating the usefulness of digital games by using a relevant game (Bingo), focusing on the social gameplay and learning opportunities for older adults to age well. Through the use of the customised digital Bingo game, with embedded relevant learning content on nutrition and health, the study was able to learn more about how this group of players experienced gameplay, and what they gained from it.

There remains a need for more studies to inform us, with better insightful information for this group of players, as research has pointed to this group of players' preference of being able to socialise while co-playing, and their high regard of the learning benefits found in digital game-playing (Nap, De Kort & Ijsselsteijn, 2009; De Schutter & Vanden Abeele, 2010; Marston, 2013). The ability to play games socially with other players and the opportunity to learn some serious topics from the gameplay, in turn leads to providing more meaningful game play for this group of senior players (Griffiths, 2005; De Schutter & Vanden Abeele, 2008; Nap, De Kort & Ijsselsteijn, 2009; De Schutter & Vanden Abeele, 2010). This study managed to contribute to providing useful information about this group of players, their social gameplay and learning experience.

The new knowledge acquired by the players, coupled with their feedback from the interviews, enabled the researcher to confirm the findings reported by Marston (2013) that learning gained was one of the key purposes for older adults to play a digital game, and this provided the goal and objectives for the gameplay. The educational benefits of the Bingo game kept them focused and engaged during the gameplay, as well as building up their self-confidence and knowledge.

This mixed methods study was helpful, in that it helped us to confirm the hypotheses that:

1. Playing a series of digital Bingo educational game with locale co-playing will improve players' social connectedness

2. Playing a series of digital Bingo educational game with serious learning content embedded will increase players' knowledge of the content.

The quantitative and qualitative results revealed that playing a series of digital Bingo educational games with local co-playing and serious learning content could improve players' attitude towards digital games. The interviews also helped us to uncover compelling outcomes from the group of players in the study, particularly excitement and engagement in their positive gameplay sessions. These findings could only be revealed by the players themselves, and the author connected these to the significant quantitative results with regard to social connectedness and knowledge gains.

5.2. Discussion of Major Findings

5.2.1. Knowledge acquired from gameplay

The pre- and post-tests provided evidence of increased knowledge acquired from the Bingo game's content on nutrition and health. With the support of qualitative data, it provided us with even better understanding of what they liked to learn from the gameplay. This included providing them with games that contain serious educational content and learning outcomes that are practical and relevant to their current needs. Other aspects included customising game design that provided them with learning feedback and co-playing ability with other players. The findings were consistent with those of other

researchers, that is, that older adults are particular about what they can gain from a learning activity, which most of the time should be practical to their current needs. This corresponds to Adult Learning Theory (Knowles, 1980), which suggests that adults prefer learning topics and skills that are beneficial to their current needs, or at least practically make sense to them. Table 5.1 further illustrates the findings to indicate the older adult players' learning experiences with the four principles of adult learning.

Table 5.1   Indications of the Four Principles of Adult Learning

Four Principles of Adult Learning	Indications in Bingo digital gameplay
Adults need to be involved in the planning and evaluation of their instruction	-Older players were involved in pilot testing, and evaluation of game's design and learning content. -Related Themes: Useful Game Content, Game Future Contribution.
Adults need learning activities with experiences (including trials and errors)	-Social co-playing aids in the discussion and sharing of learning experiences among the older players. Game questions, content and feedbacks help contribute to these learning activities. - Related Themes: Game-playing Excitement, Keeping Mind Active, Knowledge acquired.
Adults need learning topics that are relevance and applicable to their life	-Older players frequently discussed, negotiated, and commented on Nutrition and Health topics learned, as well as making changes toward healthy living. -Related Themes: Application to Daily Life, Continual Digital Game-playing, Worth Spending Time Playing.
Adult learning is problem-centered	-Older players frequently discussed on Nutrition and Health topics learned from gameplay, challenges and problems encountered from gameplay, including challenges in making nutrition and health changes. -Related Themes: Keep Mind Active, Game-playing Excitement, Useful Game Content.

The study also revealed that, despite only four weeks of game-playing sessions, the learning gained was not just factual information but also new meaning and knowledge

gained through social exchange with other players. This finding was also consistent with what was reported by Woo and Reeves (2007), that social gameplay allows older players to form knowledge through social participation where meaning making can occur.

The learning acquired was also not merely basic information, or retention of repeated information. It included the players learning on the topics about nutrition and health with other players through socialisation, negotiation, and agreement throughout the game-playing sessions. Ijsselsteijn, Nap, De Kort, and Poels (2007) also explained in a critical review of the literature on digital games for older adults, that social learning skills gained in digital gameplay included: negotiation, agreement, identifying of games' roles, and assisting others in gameplay. These were some of the common social interactivities among the players that represented new meanings formed socially. The quantitative results yielded a significant increase in knowledge gained, coupled with data from interviews; it also confirmed that the learnings gained were indeed meaningful and could be applied to their daily life of what was learned.

This study also confirmed that the knowledge acquired from game-playing and game content was influenced by the social opportunity offered to the players. The ability to make new friends, be connected and collaborate with other players are keys to learn well with other players, and better learning retention. These findings were also consistent with findings from earlier studies, in which sociability and learning benefits found in digital game were identified as two of the key contributing factors in motivating older adult players to play digital games (Pearce, 2008; Nap, De Kort & Ijsselsteijn, 2009; De Schutter & Vanden Abeele, 2010; Wang, Lockee & Burton, 2011; Marston, 2013).

The interviews further revealed older adults' perceptions of lifelong learning, that is, the importance to keep on learning, and learning what they liked to be taught; ensuring it is practical in everyday life, which also aligned with the principles of Adult Learning (Knowles, 1980). The findings also revealed a rich sense of older adults' perceptions of what they saw as important to them and what they want to learn from gameplay.

The findings from the pre-test, post-test, and interviews were also consistent with previous work reported by Wang, Lockee and Burton (2011). Older players did not just learn about the gaming content from the gameplay, but they also improved their computer

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skills and better understanding of the technology that ran the digital game. Wang et al. reported from their survey of a group of 40 Chinese older players, after a series of digital gameplay sessions that indicated positive results, with an increased understanding and interest of technology of how the Internet functions. This was also consistent with Nap, De Kort and Ijsselsteijn's (2009) findings that older players appreciate the educational content of digital games, and improved technology literacy, especially for those who have very basic computer skills. From this, we could see that when playing a digital game, older players did not just learn from the embedded content intended for them, but they were also prompted to learn more about what the game technology (agent) and gameplay (process) offered to them.

The findings also revealed positive gameplay due to the relevant multiplayer game content, social gameplay setting, and the formation of players who could play and interact with one another. The researcher in this study agreed with other researchers that a player would not learn as much from a single-player educational digital game, as compared to a multiplayer version; there were more benefits playing digital game in a co-playing face-to-face setting with other players (Nap, De Kort & Ijsselsteijn, 2009; Gajadhar, Nap, De Kort & Ijsselsteijn, 2010; De Schutter & Vanden Abeele, 2010).

5.2.2. Social gameplay experience with other players

The social experience of older adult players derived from their interview narratives was extremely helpful in providing more in-depth insight to the findings, as well as supporting the quantitative results analysed earlier. The significant gains found on the Sociability pre- and post-test, after the game-playing sessions, showed that social connectedness was an important component in digital game co-playing. The significance found in the game attitude assured us that the positive outcome of playing a customised educational game met the older players acceptance of the game. This also aligned with Adult Learning principles (Knowles, 1980) that positive outcomes from learning are necessities to attract older adult learners. Social capital theory (Putnam, 2001) also asserts that social capital is gained from venturing into a social community of people, comprising social networking resources that older players could access.

Table 5.2 illustrates the themes generated from the study, and how they relate to the targeted social capital values: trust, cooperation, and reciprocity, that could be developed from the gameplay. For instance, trust could be developed between the players through a series of social co-playing activities, and from new friendships made in the gameplay. Trust also could lead to continued digital gameplay, as well as promoting a positive game-playing mood.

Table 5.2   Social capital values in Bingo digital gameplay

Social capital values	Related Themes
Trust	Social Co-play, New Friends, Continual Digital Game-playing, Game-playing Mood
Cooperation	Social Co-play, New Friends, Game-playing Mood, Game-playing Enjoyment
Reciprocity	Social Co-play, New Friends, Game-playing Mood, Game-playing Excitement, Game-playing Enjoyment, Worth Time Playing

The findings have also given us further direction to look at how social gameplay could lead to players' positive learning outcomes. Besides what was reported about the many facets of social co-playing of digital games that include social interaction, social connectedness, social presence, and so forth; there was also other type of benefits of using educational content in a digital game. From the findings, we can also see that there are many other elements in gameplay that led to the positive outcomes. These include some of the themes derived: Game-playing Mood, Game-playing Excitement, and Game-playing Enjoyment. Despite these themes being explained in the earlier chapter, more detailed studies are needed to study more about them, as it is outside of the scope of this study to explain in deeper details about them.

One of the major findings in relation to the sociability of this digital gameplay was the information revealed by the older adults, on what they thought were worth spending time playing. We found that older adults in this study found their time worth investing in the game play: learning about nutrition and health, and at the same time socialising with other

players. This customised educational game was able to allow the players to co-play and socialise with one another. These were also the key contribution components that helped to promote a positive gameplay experience. From our findings, especially the qualitative data, we found that the sub-categories that were placed under the theme of Social Co-play included Player Connectedness, Player Interactivity, Player Collaboration, Player Positive Co-playing Experience, and Player Talking To Other Players. This explained the importance of various forms of interaction that happened between players during the game-playing events. We could see that social co-playing, with the ability to play with other players, both familiar and new, was an important element for older players, especially in a multiplayer playing environment.

The other major finding worth highlighting again was the social experience of making new friends. This was also another important element as it was highly regarded by the older players. The ability to develop new friendships and a circle of friends, including playing together with someone whom you can partner or interact with, often in a gameplay, was highly sought after by this group of older players. This was also one of the reasons that this group of players had good experiences playing socially with other players. From the interviewing sessions, six out of 10 participants being interviewed spoke about their experiences of making new friends during the gaming sessions. Besides that, the older players mentioned these were valuable encounters that enhanced their social experience of playing this Bingo digital game. The researcher also noticed that the ability to meet new friends, have a good circle of friends, and new partnerships were so important that these could have an effect on the gameplay events, which led to the significant results found in the quantitative findings on social connectedness and game attitude.

5.3. New Findings

This study also contributed to the digital game literature with new understandings of the social gameplay experiences of older adult players, as well as their knowledge acquired from an educational game. From the results of the data collected and analysed, the researcher has also generated a conceptual framework to explain new findings based on the qualitative data. The framework is an explanation of the gameplay experience of the older adult players, resulting in the outcomes as described in Figure 5.1. The

framework applies only to the older adult players about their experiences of gameplay sessions, playing the customised Bingo digital game according to the social settings of residential homes and community centres in Greater Vancouver area. It is not for generalisation, but for the contribution of better details to research and development, focusing on the sociability and learning of educational digital games, as well as for future studies to build on it.
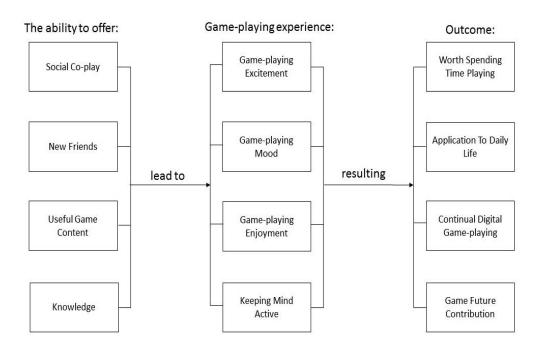
Figure 5.1.   A conceptual framework explaining the themes generated from the qualitative results

Figure 5.1 further explains the new findings revealed in this study. The main themes derived from the data analysis were Social Co-playing with other players, made New Friends, Useful Game Content, and useful Knowledge acquired. With this ability to offer these features to the older players, they were able to receive positive gameplay experiences, which largely included: the experience of Game-playing Excitement with other players, enhanced Game-playing Mood throughout the gaming sessions, valuable Game-playing Enjoyment, and at the same time Keeping the Mind Active. Such experiences also eventually resulted in unexpected findings from them. The older players found it Worth Spending their Time Playing the game, and game content learned was able

to be Applied To their Daily Life, and promoted Continual Digital Game-playing. These also eventually led the players to contribute their gameplay and learning experience for Game Future Contributions.

What we can learn from this conceptual framework is that, when we are able to provide digital game that could offer a relevant objective or goal to what the older adults want - in this case, learning about nutrition and health, and with good social locale co-playing setting, we can expect to provide them with good gameplay sessions and experiences. With good game-playing experience and encounter, this group of players would more likely have a valuable and lasting outcome experience, as in our example, the continual of playing digital game and contributing to digital game development. This framework also explains the procedures and how each individual theme (which can be further classified into gameplay objectives, process, and outcome) was connected to each other and influenced the entire gameplay eco-system when it comes to game development. As we can see, it wasn't just one part of the game that was studied here, but future research should consider studying every individual component of a game's eco-system. There may be more components in our digital game that were not even researched or known, but what we know currently is that current research must also focus on the process of gameplay, including the experience of players and not just the outcomes of the gameplay, or the ergonomic design of the game interface (Mubin, Shahid & Al Mahmud, 2008; Gerling, Schulte & Masuch, 2011; Hwang, Hong, Hao & Jong, 2011). There is much more research needed on digital games for the older adult population. The needs of this group of older adults are actually more complex than what researchers originally believed (Lindley, Harper, & Sellen, 2008).

It is important to understand what this group of older players want to play, rather than what game developers think they want. The mixed methods research approach established the importance of what we want to know about social gameplay and the learning experience, so that we could seek more deeply using qualitative data to help us learn more about the other nature of these two variables. The findings of this study, both quantitative and qualitative, revealed that when seniors played this digital game that included gameplay and learning topics, which they were familiar with (practical or beneficial to them), the gaming and learning result would be expected to be positive.

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Results were even better when they played together with players they liked and with whom they were familiar. This was also consistent with Gajadhar, de Kort, Ijsselsteijn and Poels' (2009) report about seniors' acceptance of digital game co-playing in various multiplayer settings. Older players' highest preference was still co-playing with the physical social presence of other players whom they could see, were familiar with, and were able to interact well.

In the past, many designers or researchers made the mistake of introducing digital games that were not what older adults wanted. This resulted in alienation and resistance to the game, and eventually led to unexpected outcomes. Older adults expected to gain something from the gameplay, and not just a handful of minutes or hours of fun and then be forgotten. They needed something that could impact their lives, that is, the social connectedness of close relationships that resulted from the gameplay, and the learning gained that were relevant to this golden period of their lives.

The current group of older adults also tends to have more exposure with technology and digital games (Ijsselsteijn, Nap, de Kort, & Poels, 2007). The researcher of this study agrees with Brady (1987) that digital games and digital technology are good tools to afford this group of users with many new and exciting ways of using them, as well as allowing them to keep up with new developments (Brady, 1987). These new technologies could also help them to handle the fast pace of modern society and move towards a good quality of life (Whitcomb, 1990). This could also help them to face the modern world rather than to withdraw from society (Brady, 1987).

Besides the fun of playing socially, the ability to learn and gain knowledge from digital gameplay also provided a purpose for the players, so that they themselves knew what were the end goal and objectives for them to play those games. This was also reported by Marston (2013) in her research that showed the educational benefits of digital games to keep older players focused and engaged during gameplay, as well as building up their self-confidence and knowledge derived from the game they played. For instance, in this study, one female player spoke a few times about how she gained self-confidence after a series of game-playing sessions, although initially she was fearful of been involved in the gameplay.

Player 03 shared: "I tried my very best and if I don't win, so what. Try again. It's about learning. I'm not afraid anymore, something opened up, and it is a giant step for me. Everything I do I want to do my best, I'm satisfied and done it."

The experience of learning about health and nutrition was exciting and enjoyable, rather than a boring activity for the older adults. For older adult players, the learning and enjoyment of playing with other players were two of the top motives that made them play the game continually and become regular players (Ijsselsteijn, Nap, De Kort & Poels, 2007). It was also confirmed in another study by Vasconcelos, Silva, Caseiro, Nunes, and Teixeira (2012) that it was not the rewards, or being able to achieve a certain level of gaming tasks that were important to this group of gamers. It was, however, the fun of playing with one another, along with the social benefits and gaming skills gained from the multiplayer social games that were most important to them. The experience of learning while playing sociably with friends is also tremendously desired for and highly valued by the older adult players.

The myth that older people have nothing to contribute is annoying (Merriam & Kee, 2014). In fact, in our study, we had participants informing us and recommending improvements to a digital game which they hoped to see. The theme Future Game Contribution was a result of participants informing and making recommendations of how a digital game could be better customised or improved for them.

Even though the results of this study are not meant for the purpose of making any recommendations, we could see from the results that a digital game can be a useful tool to keep this group of players socially engaged and active, which ultimately wlll help decrease elders' social isolation (Wollersheim, Merkes, Shields, Liamputtong, Wallis, Reynolds, & Koh, 2010). Digital game, as a technological tool, has great potential to help older players keep themselves active and continue learning, especially for those who are reluctant to learn something new and shy away from technology.

We still need more research on studying the social aspects of digital games, and using digital games as a learning tool for older adults. Instead of relying on our own interpretation, we need to learn more from the older players about digital games: what they want to play, how they play, and what keeps them playing. The hallmark of positive

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gameplay for this specific group of players lies in the ability to socialise, and the practical benefits derived from the gameplay.

5.4. Implications & Recommendations for Future Research

This study highlights many researchers' interests in providing social and learning capabilities as important components of digital games for older adult players. Besides the heavy emphasis on ergonomics and playability, learning can be achieved, and can be made fun, through social connected gameplay. The new findings of this study are meant to contribute to the limited information reported in the literature, so as to have a better awareness of the learning and social process during gameplay sessions of older adult players (Marston, 2013). It also informs future work on using related customised educational games. It particularly informs researchers and designers who are exploring the use of digital games for the purpose of enhancing sociability and co-playing features of digital games for this group of players.

The results of this study also inform other digital game researchers and developers that digital games catering to the needs of older adults' have a strong impact on their game acceptance, game-playing process, and the gameplay outcomes. The interview results of the participants concluded that the central focus of gameplay is not about winning but to have fun. The primary motive was to gain something useful for them, as well as suitability to their lifestyle. The investigation also realised the paradigm shift of this group of players, from seeing game as entertainment to being a useful tool with much potential for them.

This study helps to inform the future development of a digital game for this group of older adult players guided by quantitative and qualitative data. This study provides an explanation of what older adult players expect from digital gameplay sessions, and what factors can impact their decisions to become regular game players. The findings, based on older players' perspectives of what they want to gain from playing digital games, should be able to address some of the fundamental areas for future development of digital games targeting this group of users. This will help in the production of digital games that will be more appealing to this group of senior audiences, and which potentially include learning content and enhanced social co-playing features. This is consistent with what game

researchers, Bianchi-Berthouze, Kim, and Patel (2007) concluded that, "We are providing the game designer with a huge amount of information that could allow the creation of more social and entertaining games" (p.11).

The field of research on digital games for older adults is still young and it will take many studies to confirm findings. This study is just a chapter of more that is to follow, so as to build up further understandings of this area that focuses on the sociability of digital gameplay and learning from educational games. Future research should look at ways to study some of the social components including player interaction, player connection, and how learning takes place in an educational game. More studies are needed to further investigate the experiences of current older adult players, using different research instruments and methodologies.

With the change of demographic status for adults turning 60 years old, into their third and fourth ages, these findings will also offer valuable insights to digital game researchers. It will be useful for digital game researchers whose goal is to further design effective and tailored interventions, as well as improve potential gameplay sessions for older adults. From this study's findings, they can consider building up further research from the conceptual framework or themes identified from this study, according to their research goal. It will be valuable if further research shared the same goal to generate engaging gaming sessions for older adult players, as well as researching more studies to investigate what makes older adult players become regular game players.

Future studies can also work on defining and exploring players' enjoyment. The results of this study also revealed that positive players' enjoyment during gameplay was one of the reasons for older adults to co-play socially with other players. It was also suggested by the Gajadhar, De Kort, and Ijsselsteijn (2008) study that players' enjoyment, in regard to the role of co-playing with other players, was often being overlooked in many research studies. Hence, future research should conduct more in-depth investigation into this area of the gameplay enjoyment experience of older adult players.

5.5. Limitations of This Study

This study comes with several limitations. First of all, the results apply only in the social contexts and locations of this particular study, community centres and senior residential homes (independent and care-dependent) in the greater Vancouver area, Canada. The generalization of the results apply mainly to older players in similar social contexts and living conditions. To apply to other social contexts and environments, pilot testing of similar types of game and instrument should first be conducted, before implementation of an actual study. Building upon this study is encouraged, besides comparing the results of this study directly to another social context or environment.

It should also be noted that the selected participants were recruited from an invitation for voluntary participation in the gameplay sessions. However, the conditions to qualify them to participate were: being healthy, able to use computer mouse or touch screen, and having basic computer skill. This study is also limited to these items, where some were mentioned earlier: players with age 60 years and above, living in senior residential homes (independent and care-dependent), or go regularly to the participating community centres. The other limitation according to the demographical information is that this study has more female players (74% or 37 were female), than male players (26% or 13 were male). Despite this limitation, male players were able to provide valuable and exceptional feedback about their gameplay and learning experience.

Next, we acknowledge that there was only one Bingo game used in this experiment; hence, it is not meant for generalising the findings on other types or genres of digital games, or other games customised with educational content. The findings from this study are not meant for the purpose of making recommendations, but for improving our understanding of older adult players' experience with educational digital games. Again, future studies are encouraged to build upon what has been found with other types of research instruments, social settings, or, sampling variations.

Finally, the conceptual framework generated only represent the events that happened in the social context of this study. It is not meant to be used to generalise to the majority of older adult players in different social context and living conditions. The significant findings found in social connectedness, game attitude, and knowledge acquired

after playing the customised educational digital Bingo game is only applicable to this study's gameplay condition. Despite these limitations, further study is encouraged to build on this study, and to do further research on the findings and framework. More specifically, it would be helpful to build and strengthen this framework with more discoveries on digital games for this group of older gamers. Therefore, readers need to view this study's framework and findings with caution with regard to how it can be transferred to their own context or situations (Lincoln & Guba, 1985; Creswell, 2013).

5.6. Conclusion

The sequential explanatory mixed methods research methodology was helpful; it was designed to guide this study in answering the three research questions. The results of the quantitative data derived from the pre- and post-test were used for answering the first research question and part of the third research questions. On the other hand, the results of the qualitative data collected from the interviews, with a selective group of participants, were used to answer the second and part of the third research questions. Despite the many challenges faced when conducting a mixed methods study, such as being able to stay on track with the research design planned, all efforts were worthwhile when the results produced were what the researcher expected. This study has also taught the researcher with discipline to follow each sequence of steps laid out, and to ensure each step is accomplished before moving on to the next step, until the accomplishment of the study.

The 50 participants experienced statistically significant improvements in game attitudes and social connectedness. As for the Knowledge pre- and post-test, the paired-samples t-test analyses found a significant improvement in knowledge on nutrition and health from the Bingo gameplay sessions.

For the qualitative part of the study, 10 of the players were interviewed. The results of the qualitative analysis produced 12 themes, finalized from the two-cycle coding analysis. Further analyzing the themes, again allowed the researchers to generate a conceptual framework to explain a new finding. The framework generated explains the game-playing experience of the older adult players.

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Another major finding worth highlighting again is the social experience of making new friends, an important element that was highly regarded by the older players. The ability to develop new friendships and circles of friends, including playing together with someone with whom you can partner, venture, or often interact with in a game, is highly sought after by this group of older players. The researchers also noticed that the ability to meet new friends, having a good circle of friends, and partnership were so important that it might have affected the gameplay events, which lead to the significance findings in the quantitative findings on Social Connectedness and Game Attitude.

The other major and interesting finding also revealed that older adult players in this study have found it worth investing their time playing the Bingo game. From the conversations in the interview, they highlighted the worthiness in spending time for the gameplay which included learning about nutrition and health, and being able to socialise with other players. This assured us digital games which allowed players to co-play and socialise with one another were some of the key contributing factors towards a positive gameplay experience.

This study also revealed that, despite the four weeks of main game-playing sessions, the learning gained is not just factual information, but included new meaning and knowledge that replaced what was previously known. This was also consistent with what was reported by Woo and Reeves (2007), that social game-playing allows older players to form knowledge through social participation, where meaning making could occur. Older adults are concerned and selective about what they are able to learn and gain from digital gameplay, which should be practical and relevant to their current needs. This was consistent with the findings of Melenhorst, Rogers & Bouwhuis (2006) that older adults were more likely to use technology if they felt there was a benefit for them. Henceforth, we look forward for more research on digital games that include educational content relevant for older adult players, and those that have more learning opportunities for this group of players.

This study confirmed again that the knowledge acquired from the game-playing and game's content was influenced by the social opportunity offered to the players. The results also revealed that: the ability to make new friends, be connected with them, and

learn from one another, resulted in better learning experiences encountered by the players. These findings were also consistent with what was researched in a few earlier studies, in which sociability and learning benefits found in digital game were also identified as two of the key contributing factors to motivate older adult players to play digital games (Pearce, 2008; Nap, De Kort & IJsselsteijn, 2009; De Schutter & Vanden Abeele, 2010; Wang, Lockee & Burton, 2011; Marston, 2013). Hence, it would be helpful to see more research on digital games for older adult players focusing in these two areas of sociability and learning. This could include better understanding of older adults becoming regular digital game players, and taking advantage of digital games and technology, instead of shying away from it.

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Appendix A.

SFU Office of Research Ethics Approval Letter

SFU OFFICE OF RESEARCH ETHICS

Street Address	Mailing Address	Director 778.782.6593
Simon Fraser University	8888 University Drive	Associate Director 778.782.9631
Discovery 2	Discovery 2	Manager 778.782.3447
Room 230, 8900 Nelson Way	Burnaby, BC Canada	dore@sfu.ca
Burnaby, BC Canada V5A 4W9	V5A 1S6	http://www.sfu.ca/ore.html

Minimal Risk Approval

Study Number: 2015s0145
Study Title: Understanding the learning and social gameplay experience of older adults playing a Bingo digital game

Approval Date: 2015 May 7   **Expiry Date:** 2016 May 7
Principal Investigator: Seah, Tiong Wee   **Faculty Supervisor:** Kaufman, David
SFU Position: Graduate Student   **Faculty/Department:** Education

SFU-Collaborator: n/a
External Collaborator: n/a
Research personnel: Hausknecht, Simone; Zhang, Fan; Rutherford, Haley

Funding Source: SSHRC
Grant Title: Ageing well: Can digital game help?

Documents Approved in this Application:
- Centres Invitation, uploaded 2015 March 26
- Interview Questions, uploaded 2015 March 26
- Posttest Questions Knowledge, uploaded 2015 March 26
- Posttest Questions Social, uploaded 2015 March 26
- Pretest Questions Knowledge, uploaded 2015 March 26
- Pretest Questions Social, uploaded 2015 March 26
- Bingo Game Screenshot, uploaded 2015 March 26
- Consent Form, uploaded 2015 March 30
- Study Detail, uploaded 2015 March 30
- Recruitment Memorandum, uploaded 2015 March 30
- Recruitment Poster, uploaded 2015 March 30

I am pleased to inform you that the above referenced study has been approved by the Associate Director, Office of Research Ethics, on behalf of the Research Ethics Board in accordance with University Policy R20.01 (http://www.sfu.ca/policies/research/r20.01.htm). The Board reviews and may amend decisions or subsequent amendments made independently by the Associate Director, Director, Chair or Deputy Chair at its regular monthly meeting.

The approval for this protocol expires on the **Expiry Date**, or the term of your appointment/employment/student registration at SFU, whichever comes first. **An annual renewal form must be completed every year prior to the anniversary date of approval. Failure to submit an annual renewal form will lead to your study being suspended and potentially terminated.** If

Page **1** of **2**

you receive any grant for this protocol in addition to any funding listed above, please email dore@sfu.ca stating the funding source, the term of approval of the funding source and the title of that funding application if it differs from the title of your ethics application. If you intend to continue your protocol to collect data past the term of approval, you must contact the Office of Research Ethics at dore@sfu.ca and request an extension at least 6 weeks before the expiry date.

The Office of Research Ethics must be notified of any changes in the approved protocol. If you wish to revise your study in any way, please send an email requesting an amendment addressed to dore@sfu.ca. In all email correspondence relating to this application, please reference the application number shown on this letter, which should be included in square brackets at the beginning of the Subject Line; this will ensure that all correspondence is saved to the electronic study file.

Your application has been categorized as "Minimal Risk". "Minimal Risk" occurs when potential participants can reasonably be expected to regard the probability and magnitude of possible harms to be no greater than those encountered by the participant in those aspects of his or her everyday life that relate to the research. Please note that it is the responsibility of the researcher, or the responsibility of the Student Supervisor if the researcher is a graduate student or undergraduate student, to maintain written or other forms of documented consent for a period of 1 year after the research has been completed.

The REB assumes that investigators continuously review new information for findings that indicate a change should be made to the study protocol or consent documents and that such changes will be brought to the attention of the ORE in a timely manner.

If there is an adverse event, the principal investigator must notify the Office of Research Ethics within five (5) days. An Adverse Events Form is available electronically by contacting dore@sfu.ca.

All correspondence with regards to this application will be sent to your SFU email address.

Please notify the Office of Research Ethics at dore@sfu.ca once you have completed the data collection portion of your project so that we can close the file.

This Notification of Status is your official ethics approval documentation for this project. Please keep this document for reference purposes and acknowledge receipt of this Notification of Status by email to dore@sfu.ca and include the study number in square brackets as the first item in the Subject Line.

Best wishes for success in this research.

Sincerely,

Holly Longstaff, PhD
Acting Associate Director
Office of Research Ethics

Appendix B.

Summary of Pilot Testing of Hardware
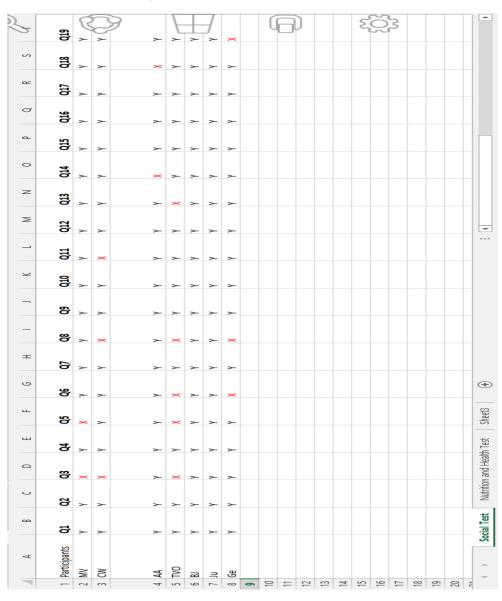
Player & Gender	Age	Preference (Touchscreen, Mouse-click, or Both)	Players' Feedbacks	Other Observation/ information
RD, Male	63	Both	Need double tapping (Selection) on touchscreen. But after playing 1 Bingo game, touch tapping got improved.	Play games often and have good PC background.
TA, Female	98	Touchscreen	No PC experiences, touchscreen easier to use for her. Difficulty using mouse-clicking and maneuver mouse selector.	Slow motor movement, easier to use touch features.
GE, Male	86	Touchscreen	Very little PC experiences. Touchscreen easier for him with stiff fingers.	Long finger nails obstruct touchscreen tapping.
LY, Male	61	Mouse	Mouse clicking is faster. Nice to have touchscreen features. Some buttons difficult to use touch selection.	Play games often, can handle most gaming equipment well.
FS, Female	98	Touchscreen	Very little PC experiences. Need longer time to handle, or the use of mouse-clicking.	Stiff fingers make mouse-clicking difficult
BA, Female	63	Touchscreen	Very little and limited PC experiences. Easier to get started with touchscreen	Long finger nails obstruct touchscreen selection
DN, Female	95	Both	Have PC and gaming experiences. Play digital games especially Wii often.	-
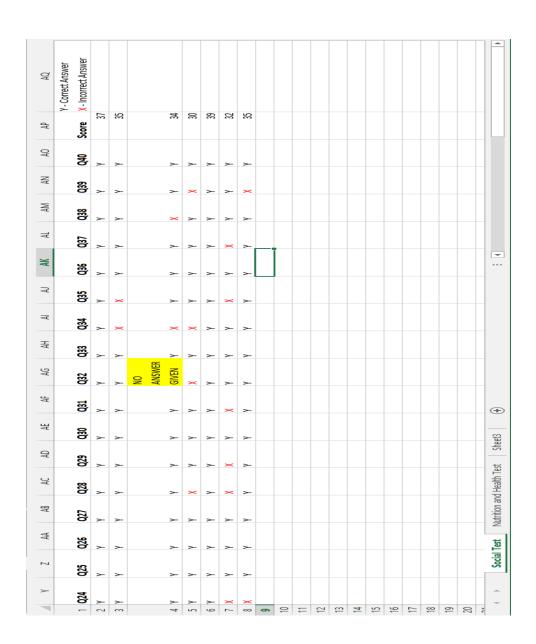
Summary of Pilot test result: All the seniors have no problem with the screen size, or text size display by the Bingo game. Speed of playing of the Bingo game is also acceptable. One senior needs some interpretation on the nutrition content. Overall, the RA noticed that those seniors in the 60s can handle mouse clicks, while those above 80s prefer the touchscreen. So, it's a good idea to have a touchscreen laptop to cater to those who prefer mouse-clicking and those who have difficulty using mouse-clicks.

Appendix C.

Sample Results of Pilot Testing of Pre and Post-test

Sample results of Pilot testing of both Social and Knowledge tests with non-participants, before the actual study.

Participants	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19
MV	Y	Y	X	Y	X	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
CW	Y	Y	X	Y	Y	Y	Y	X	Y	Y	X	Y	Y	Y	Y	Y	Y	Y	Y
AA	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	X	Y	Y	Y	X	Y
TVO	Y	Y	X	Y	X	X	Y	X	Y	Y	Y	Y	X	Y	Y	Y	Y	Y	Y
BJ	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ju	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ge	Y	Y	Y	Y	Y	X	Y	X	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	X

Social Test | Nutrition and Health Test | Sheet3

	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40	Score	
																			Y - Correct Answer X - Incorrect Answer
	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	37	
	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	X	X	Y	Y	Y	Y	Y	35	
	Y	Y	Y	Y	Y	Y	Y	Y	NO ANSWER GIVEN	Y	X	Y	Y	Y	X	Y	Y	34	
	Y	Y	Y	Y	X	Y	Y	Y	X	Y	X	Y	Y	Y	Y	X	Y	30	
	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	39	
	X	Y	Y	Y	X	X	Y	X	Y	Y	Y	X	Y	X	Y	Y	Y	32	
	X	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	X	Y	35	

Social Test | Nutrition and Health Test | Sheet3

Participant	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Score
CW	X	Y	X	Y	X	Y	Y	Y	Y	Y	OMIT	Y	Y	X	Y (DIDN'T ANSWER AS THEY DON'T DRINK)	10
AA	X	Y	X	Y	Y	Y	X	Y	Y	X	OMIT	Y	Y	Y	Y	9
TVO	X	Y	Y	Y	X	Y	Y	Y	Y	X (DIDN'T UNDERSTAND)	OMIT	X	Y	X	Y	7
BJ	X	Y	Y (GAVE TWO ANSWERS)	Y	Y	Y	Y	Y	Y	Y	OMIT	Y (GAVE TWO ANSWES)	Y	Y	Y	11
Ju	X	X	Y (GAVE TWO ANSWERS)	Y	X	Y	X	X	X	X	OMIT	X	X	X (GAVE TWO ANSWES)	X	3
Ge	X	X	Y	Y	X	Y	X	X	X	X	OMIT	X	X (DIDN'T ANSWER)	Y	Y	4

Social Test | Nutrition and Health Test | Sheet3

Appendix D.

Sociability Pre and Post-Test

Section 1

1. Gender

   ☐ Male   ☐ Female   ☐ Transgender

2. How old are you?

   ☐ 55-59   ☐ 60-64   ☐ 65-69   ☐ 70-74   ☐ 75-79   ☐ 80-84   ☐ 85-89   ☐ 90+

3. Your current relationship status:

   ☐ Married / Common law   ☐ Single / Widowed

4. Who do you live with? (Check all that apply)

   ☐ Alone   ☐ Spouse /Common law   ☐ Family   ☐ Room or housemate

   ☐ Other (specify _____)

5. Where do you live?

   ☐ House   ☐ Apartment / Condo   ☐ Independent/Assisted living home
   ☐ Other_____

6. 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)
   ☐ 4-Year degree (BA, BS)
   ☐ Master's Degree
   ☐ Doctoral Degree (e.g., PhD, EdD, MD, JD)

Section 2

7. Have you played any video or digital games in the past 5 years?

☐ Yes   ☐ No

If yes, name the game(s) you played _____

If no, go to Section 3 (Next page).

8. If you play video game(s), who do you play with?

☐ On my own

☐ Family members (spouse, partner, children, relatives…)

☐ Friends

☐ Members of a club or association

☐ Others (specify_____)

9. How do you rate your level as a video game player?

☐ Beginner

☐ Intermediate

☐ Expert

10. Did you participate in a weekly organized social group activity, for example, a bridge club or a book club or sports or arts organization during the last two months? (Do NOT include this Bingo game project.)

☐ Yes

☐ No

Section 3 Opinions about playing Digital games

Select the option that best describes your opinion about each statement below.

	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
1. Playing digital games is a good way to spend more time with friends.					
2. Playing digital games is a waste of time.					
3. Playing digital games is a good way to improve existing friendships.					
4. Playing digital games is NOT a good way to socialise with other people.					
5. Playing digital games regularly keeps a person active and positive in thinking					
6. Digital games are suitable for learning a new task or topic.					
7. I have good impression of digital games after the Bingo game study.					
8. I think and talk more about digital games after the Bingo game study.					
9. I will make playing digital games a regular activity in future.					
10. Playing a digital Bingo game has changed my way of thinking about digital game.					

Note: Questions 7-10 only used in Post-test

Section 4 How sociable am I?

Select the option that best describes your opinion about each statement below.

	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
1. I find it easy to relate to others.					
2. I feel isolated from people.					
3. I have someone to share my feelings with.					
4. When I'm with other people, I feel separate from them.					
5. I find it easy to get in touch with others when I need to.					
6. I feel alone and friendless.					
7. I believed I have spent my time wisely in the Bingo game study					
8. I am able to interact better with other players after the game play sessions					
9. I found the type of role I like when playing digital games with others					
10. I feel motivated to play more digital game					

Note: Questions 7-10 only used in Post-test

Section 5 About my social connectedness

Select the option that best describes your opinion about each statement below.

	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
1. I would like to have a larger circle of friends.					
2. I feel a lack of company.					
3. I would like to have a close relationship with more people.					
4. I feel a lack of contact with people in my social network.					
5. I am satisfied with the number of people with whom I have social contact.					
6. I am satisfied with the amount of contact I have with the people in my social network.					
7. My relationships with people in my social network feel superficial.					
8. I derive little satisfaction from my social contacts.					
9. I feel that people in my social network often think of me.					
10. I often think of people in my social network.					
11. I don't feel I have a lot in common with people in my social network.					
12. I feel that people in my social network do not share my interests and ideas.					

Note: Question 12 only used in Post-test

Appendix E.

Knowledge Pre and Post-Test

How much do you know about Nutrition and Healthy Living?

1. According to the Canadian Food Guide how many servings of fruits and vegetables does a person over the age of 55 have to consume per day?
   - ☐ 5
   - ☐ 6
   - ☐ 7
   - ☐ 8-10

2. What is the best way to stay hydrated?
   - ☐ Drinking fruit juice
   - ☐ Drinking sports drink
   - ☐ Drinking water
   - ☐ Drinking tea

3. In which of the following foods do you find the most Vitamin D?
   - ☐ Broccoli
   - ☐ Milk
   - ☐ Turnips
   - ☐ Salmon

4. Which of the following menu offers the most balanced dinner?
   - ☐ Vegetable soup – spaghetti with meat – bread – a glass of pop/soda
   - ☐ Salmon – brown rice – mixed vegetables – glass of milk
   - ☐ Ham and cheese omelette – French fries – glass of milk – strawberry turnover
   - ☐ Salmon – white rice – vanilla yogurt – beer

5. Which of these foods contain the most fibre?
   - ☐ White rice
   - ☐ Steak
   - ☐ Whole grain pasta
   - ☐ Carrots

6. Appetite tends to decrease as you get older. What is a good habit to engage in to maintain appetite?
- ☐ Eat a lot of food frequently
- ☐ Taking a walk before dinner
- ☐ Have a stimulating discussion with a loved one
- ☐ Continuously eat throughout the day

7. Some activities such as walking, dancing and weight training are good because they?
- ☐ Control your emotions
- ☐ Strengthen muscles
- ☐ Improve you attentiveness
- ☐ Prevent sickness

8. Which activity requires the least physical effort:
- ☐ Mowing the lawn
- ☐ Taking a dance class
- ☐ Playing a card game
- ☐ Walking a dog

9. Moderate daily physical activity allows you to:
- ☐ Reduce your socialization with others
- ☐ Helps you control your emotions
- ☐ Makes you feel energetic
- ☐ Prevents you from sleeping through the night

10. Physical activity such as mowing the lawn, taking a dance class or raking the leaves is beneficial to your overall health because?
- ☐ It helps you move continuously
- ☐ It helps you breathe deeply
- ☐ It reduces the number of falls and injuries
- ☐ All the above

11. Which of the following benefits can be gained from physical exercise?
   - ☐ Decrease in likelihood of heart disease
   - ☐ Increases the chance of falls
   - ☐ Increases feelings of loneliness
   - ☐ Decrease in ability to make new friends

12. How can you prevent food poisoning?
   - ☐ Ensure foods are at least half-cooked
   - ☐ Wash fruits, vegetables before eating
   - ☐ Use automatic dishwasher to wash dishes, utensils etc.
   - ☐ Use cold water to clean knives, cutting board, etc.

13. Regular physical activity can reduces:
   - ☐ A 95% decrease in breast cancer cases
   - ☐ A 90% decrease in colon cancer cases
   - ☐ A 95% decrease in skin diseases
   - ☐ A 50% in heart disease

14. Gardening is an activity that can promote:
   - ☐ Increase the risk of falls
   - ☐ Lowers cholesterol
   - ☐ Isolation
   - ☐ Self-esteem

15. What is considered one serving of alcohol?
   - ☐ 90mL of wine, 75 mL of beer
   - ☐ 140mL of wine, 340 mL of beer
   - ☐ 500mL of wine, 300 mL of beer
   - ☐ 15mL of wine, 30 mL of beer

Appendix F.

Game Rules

The following is a sample set of game rules used for the game, abstracted from SAVIE, and translated into English:

1. The game is played with a minimum of three players and a maximum of 12 players.

2. Before starting the game, the initiator (designated player) selects the degree of difficulty of the learning content (Easy, Medium and Hard) and the object of the game that determines how the game ends.

3. The player who has a vertical, horizontal or diagonal row of boxes completed and who clicks on the Bingo button first wins.

4. The player who has all the boxes on their card completed and who clicks on the Bingo button wins first.

5. The player who covers all numbers that go around the card (top row, and the bottom rows on each side of the card) and is first to click on the Bingo button wins.

6. The player who covers all the numbers in two diagonals across the card (from one corner to the other in both directions) and is first to click on the Bingo button wins.

7. To start the game, the initiator of the game clicks on the "Start Game" button.

8. In each turn, the computer randomly picks a ball with a number or a bonus card with a number that appears on the screen for all players.

9. If a ball is drawn and the number of the ball is on the card of one or more players, they click on the number to view a question.

10. If the player answers the question correctly, the chip appears on the box and they earn points (20 points for an *Easy* question, 30 points for a *Medium* question and 50 points for a *Hard* question).

11. If the player does not correctly answer the question, the chip will not appear on the box and they lose half of the points allocated to the question).

12. If a Bonus card is drawn, each player clicks on the box corresponding to the number on the bonus card (the number is different from one player to another); x number of points are automatically earned.

13. The game ends when a player places his pieces in a way that was determined at the beginning of the game, either:

    -in a row of vertical, horizontal or diagonal boxes specified,

    -on all fields of the card,

    -all the boxes around the card (the top row, and the bottom row and on each side of the card)

    -on all boxes of the two diagonals (from one corner to the other in both directions).

14. The first player who clicked on the Bingo button after correctly placing their chips on the Bingo card earns 50 points. Players who have a "Bingo" at the same time but were not quick enough to click on the "Bingo" button first receive 25 points.

15. Should a player click the bingo button and has not placed their chips properly, the game continues and they loses 25 points.

16. The winner is the player who has the highest score when the game is over.

Appendix G.

Game Question Sample

The game has 100 questions and 10 Events. It was abstracted from SAVIE, translated into English language, and modified according to the language, font-size, and display structure.

General Purpose: To determine the benefits of adopting a healthy lifestyle (nutrition and physical activity) and the contribution of social relationships on quality of life

Table G.1.   Questions based on the game's learning objectives

Specific objectives	Question number that supports each objective
Recognize the contribution to one's well-being of adopting healthy eating habits and consumption of alcoholic beverages.	1-2-3-4-5-9-10-19-23-25-26-27-28-29-30-44-50-51-52-55-64-69-73-84-86-87-88-89-90-91-92
Recognize the effects of physical activity on quality of life.	11-15-17-21-31-32-38-39-40-41-42-43-46-47-48-49-53-54-56-57-59-81-82-83
Recognize the importance of developing relationships with friends and family to improve quality of life.	6-7-8-29-33-34-35-36-37-45-60-61-62-63-65-66-67-68-70
Determine the risks (prevention) to health including poor nutritional habits and lack of physical activity.	12-13-14-16-18-20-22-24-58-71-72-74-75-76-77-78-79-80-85-93

We also varied the degree of difficulty of the questions to ensure that the game is adapted to the capabilities of the target audience. Thirty-one questions are considered "Easy"; 29 "Medium" and 33 "Hard".

Type of question: Multiple choice 4. Difficulty: Easy. Category: Nutrition.

How many servings of fruits and vegetables does a person over the age of 55 need to consume per day?

1. 6
2. 8-10
3. <u>7</u>
4. 5

Feedback Correct Answer:

Congratulations! At age 55, women and men have the same needs in terms of fruits and vegetables, the equivalent of seven fruits and vegetables a day. A serving size of fruit is of medium size, like an apple, a kiwi or orange, or a half cup of berries: 10 grapes, a handful of blueberries, etc. One trick: to remember serving size, think of what can be held in the palm of your hand: half a grapefruit, a slice of pineapple, a handful of raspberries ... Enjoy!

Feedback Wrong Answer:

Sorry! The correct answer is number 4. After 51 years of age, women and men have the same needs in terms of fruits and vegetables, the equivalent of seven fruits and vegetables a day. A serving size of fruit is of medium size, like an apple, a kiwi or orange, or a half cup of berries: 10 grapes, a handful of blueberries, etc. One trick: to remember serving size, think of what can be held in the palm of your hand: half a grapefruit, a slice of pineapple, a handful of raspberries ... Enjoy!

Reference material : Santé Canada. (2011). Bien manger avec le Guide alimentaire canadien. Retrieved 02/08, 2013, from http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/print_eatwell_bienmang-fra.pdf

Appendix H.

Sample of Bingo Game Interface & Gaming instruction

Welcome to digital BINGO. These steps are here to help you play and learn the game.

Step 1: Go to the game website: http://www.savie.qc.ca/Eau/

Step 2: To play the game in English select the British flag. This will change the game to English.

Step 3: Enter your e-mail address and password, then select Play.

Note: This is the e-mail address you used when you registered for the game. If you have forgotten, your e-mail address or your password we have them! You can do this either by using the mouse or by touching the screen.

Step 4: You will be brought to the "Ready to play" screen. Select Play online.
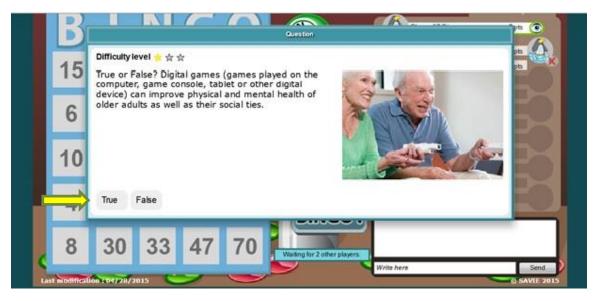
…. Skip to Step 9: The new game panel will appear. Select Level, Objectives, and Start the game.
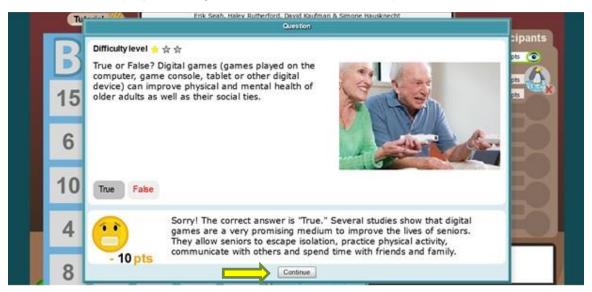
Step 10: The game has now started. The first ball will be drawn. Match the numbers on your Bingo card with the number on the ball. If yes, click on the numbers on the card; if the numbers do not match, wait until the next ball is drawn. The next ball will be drawn once all participants with a matching number mark their cards.

Step 11: If a ball is drawn and the number on the ball corresponds to a number on your card, you will get a question about health and nutrition. To select your answer, you will either left-click the cursor on the correct answer or touch the correct answer on the screen.

Step 12: If you answered correctly, a marker will appear on your card and you will receive positive feedback about your answer. However, if your answer is incorrect, the correct answer will be displayed, along with information about the question.

… Skip to Step 14: You will repeat this process until you get a BINGO. If you get a BINGO, you will select the BINGO box in the middle of the player screen.

When one of the participants gets a BINGO, a score card shows who got the BINGO and how everyone else placed.

Step 15: To play again, select "continue" and play another game. Enjoy and have fun!

Appendix I.

Sample Photographs of Gameplay Setting

Appendix J.

Sample of Quantitative Data Analysis Guide Used

Quantitative Data Analysis Guide			
Coding Name:	Bingo research study	**Coding Version No. :**	Quan060515

Coders:	1. Principal Researcher 2. Research Assistant 1 3. Research Assistant 2
Communication Mode:	Email and Face-to-face meeting
Duration:	2 Weeks (06-05-15 to 06-19-15)

Coding Purpose:
1. To find significance in data for the study. 2. For answering research question 1 and 3.

What to achieve:
1. Mean difference of Pre and Post-tests.

Coding source:
1. 1 set of Sociability Pre and Post-test, 2. 1 set of Knowledge Pre and Post-.

Software/ Equipment:

1. Statistical Package for the Social Sciences (SPSS) software, version 23

Analysis methods/ strategies:
1. Mean differences using Paired-Samples T-test,
2. Scale's items reliability test using Cronbach's Alpha.

Coding procedures:
1. Distribute the 2 sets of Pre and Post-test amongst coders,
2. Each coder enter assigned test's data of the Pre and Post-test into SPSS,
4. All Coders check the data entered for all the tests,
5. Assign 2 coders to run the T-test, followed by Crohbach's Alpha
6. All Coders check the test results, meet to discuss, liaise using email, recode or finalise results.

Notes:

Appendix K.

Quantitative Data Analysis

A comparison of the 11 items used (Post test got 12 items) in the Social Connectedness Scale showed significance result t(10)= 5.621, p= .000, with a paired mean difference of M=0.19636, SD=0.11587, between the Social Connectedness of Post and Pre-test, after the gameplay sessions.

Social Connectedness Pre-test

	S5Q1Pre	S5Q2 Pre	S5Q3 Pre	S5Q4 Pre	S5Q5 Pre	S5Q6 Pre	S5Q7 Pre	S5Q8 Pre	S5Q9 Pre	S5Q10 Pre	S5Q11 Pre
Mean	3.38	3.60	3.30	3.50	3.76	3.70	3.40	3.58	3.68	3.46	3.52
N	50	50	50	50	50	50	50	50	50	50	50
Std. Deviation	.945	.948	.995	.931	.657	.763	1.010	.971	.794	.908	.839

Social Connectedness Post-test

	S5Q1Post	S5Q2 Post	S5Q3 Post	S5Q4 Post	S5Q5 Post	S5Q6 Post	S5Q7 Post	S5Q8 Post	S5Q9 Post	S5Q10 Post	S5Q11 Post	S5Q12 Post
Mean	3.48	3.94	3.48	3.72	3.86	3.86	3.72	3.80	3.64	3.80	3.74	3.68
N	50	50	50	50	50	50	50	50	50	50	50	50
Std. Deviation	.974	.890	1.129	.970	.904	.833	1.011	.969	.693	.639	.876	.891

Paired Samples Test

	Paired Differences							
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Pair 1 PostSocialConnectedness - PretSocialConnectedness	.19636	.11587	.03494	.11852	.27420	5.621	10	.000

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PostSocialConnectedness	3.7267	50	.48388	.06843
	PreSociaConnectedness	3.5345	50	.43098	.06095

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PostSocialConnectedness & PreSociaConnectedness	50	.103	.479

Paired Samples Test

	Paired Differences							
				95% Confidence Interval of the Difference				Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	
Pair 1 PostSocialConnectedness - PreSociaConnectedness	.19212	.61409	.08685	.01760	.36665	2.212	49	.032

Computed T-test of Knowledge Pre and Post-test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	TotalPost	12.22	50	2.063	.292
	TotalPre	10.14	50	2.204	.312

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	TotalPost & TotalPre	50	.325	.021

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	TotalPost - TotalPre	2.080	2.481	.351	1.375	2.785	5.928	49	.000

Computed T-test and Alpha coefficients of Sociability Pre and Post-test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-test score of game attitude	3.6533	50	.58790	.08314
	PostGameAttitude	3.9760	50	.63005	.08910
Pair 2	PreSociable	3.9533	50	.48916	.06918
	PostSociable	3.9160	50	.52035	.07359
Pair 3	PreSociaConnectedness	3.5345	50	.43098	.06095
	PostSocialConnectedness	3.7267	50	.48388	.06843

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Pre-test score of game attitude & PostGameAttitude	50	.198	.167
Pair 2	PreSociable & PostSociable	50	.400	.004
Pair 3	PreSociaConnectedness & PostSocialConnectedness	50	.103	.479

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	PostGameAttitude – PreGameAttitude	.32267	.77176	.10914	.54200	.10333	2.956	49	.005
Pair 2	PostSociable - PreSociable -	.03733	.55360	.07829	.12000	.19466	.477	49	.636
Pair 3	PostSocialConnectedness - PreSociaConnectedness -	.19212	.61409	.08685	.36665	.01760	2.212	49	.032

Alpha coefficients: Reliability Statistics

Pre-test of game attitude

Post-test of game attitude

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.687	.683	6	.911	.913	10

Pre-test of sociable

Post-test of sociable

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.653	.641	6	.813	.811	10

Pre-test of social connectedness

Post-test of social connectedness

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.670	.676	11	.771	.799	12

Appendix L.

Sample of Qualitative Data Analysis Guide Used

Qualitative Data Analysis Guide			
Coding Name:	Bingo research study	**Coding Version No. :**	Qual062515

Coders:	Coder 1 - Principal Researcher Coder 2 - Research Assistant 1
Communication Mode:	Email and Face-to-face meeting
Duration:	5 Weeks (06-19-15 to 07-24-15)

Coding Purpose:
1. To probe for more in depth results from players' interview, on social gameplay and learning experience, 2. To reveal result to support quantitative results analysed earlier, 3. For answering research questions 2 and 3.

What to achieve:
1. Themes that represent players' social gameplay and learning experience, 2. A theory that explains the themes generated.

Coding source:
1. Interview transcripts

Software/ Equipment:
1. QSR NVivo software, version 10

Analysis methods/ strategies:
1. Saldaña (2013) two cycle approach of coding: The first cycle uses an initial coding and recoding of data; followed by the second cycle of focused coding.

Coding procedures:
1. All Coders meet to discuss plan and strategies to code the interview transcripts,   2. Coder 1 starts with Initial coding, line by line coding into representative codes,   3. Coder 1 performs member checking of codes and transcripts with interviewees,   4. Both Coders meet to verify coding, and discuss next coding procedures,   5. Coder 2 starts Focused coding: classification, integrating, synthesising, abstracting of categories, and respective sub-categories,   6. Both Coders meet to verify coding,   7. Coder 1 performs second member checking of codes with interviewees,   8. Both coders meet to finalise coding with themes, and generate a theory to explain the themes.

Notes:
Code book to be attached

Appendix M.

Sample of Qualitative Data Analysis Code Book Used

	Code	Definition	Example from Transcript	Inclusion Criteria	Exclusion Criteria
1					
2	Analysing Games' Questions	Players shared how they approached, attempt, analysed the game's questions during the gameplay. The process of dealing with the questions.	I like the thinking process while reading the questions.	Include words that represent how they analysed the questions: Approach, attempt, think, deal, discuss about the questions.	Exclude comments and feedbacks on how to improve the questions
3	Answering Games' Questions Correctly	Players shared about their feelings, emotions, reactions, when they answered the questions, correctly, or, wrongly; include how they should have answered the questions in the right way, and what happened after they answered the	Yes, the answering part of the questions. I like attempting the answers. I like when you call out the numbers, when you came to the questions, I had an idea what's the answer, a good feel.	Include words that demonstrate their reactions, emotions, and feelings, when answering the questions.	Exclude comments and feedbacks on how they analysed the question, but, what happened when they answered the questions.
4	Apply To Everyday Life	Players shared about how the gameplay sessions, and what they learnt about Nutrition and Health and be applied to their daily life.	I find it useful to learn new knowledge about all this nutrition and food that we do in our everyday life, and keep us aware of it.	Include daily life, even before this study was finished.	NA
5	Building Relationship	Players shared about how playing this Bingo game, and joining the gameplay sessions have helped to build up relationship with other players.	Next, I think if this group of Bingo players were to have a more playing sessions, I believed our relationship and closeness with each others should improve further, as time can help us know one another better.	Include building new friendship, improve current relationship with other players.	Any negative opinions towards individual that is not relevant to this study.
6	Change of Perspective in Nutrition and Health	Players shared how they change their perspective, view, understanding about Nutrition and Health, after playing the Bingo game.	I think I have learned quite a lot from the Nutrition and Health content, despite that I study a lot about those topics. The particular helpful portion is when the content from the Canadian Food Guide corrected my previous understanding of what I know, which are incorrect or outdated, including those I am not aware of. For example, it is alright to consume one egg a day for seniors, unless you have health related issue.	Include what they learned from gameplay were able to replace what was learnt earlier.	Exclude comments and opinions not related to nutrition and health.
	Changed Perspective of Digital		Yes, Digital game is good for training		

Appendix N.

Qualitative Data Analysis Steps & Result

1st Cycle of Initial Coding result

Table N.1.   Compilation of Codes developed during Initial Coding

Changed Perspective of Digital Game	Importance Of Digital Game
Comparing With Other Games	Improved Mood of Playing
Concerns For Other seniors	Improving of Social Skill
Connect With Players	Social benefits
Reinforce Learning	Good Social games
Trying To Get The Right Answer	Interaction With Other Players
Increasing Of Knowledge	Excited About Bingo Game
Fun Game	Coordination With Other Players
Doing Several Things Together	Interested In Learning Nutrition And Health
Bring People Together	Keep Brain Active
Competitive Game	Learned About Technology
Succeeding In Gameplay	Learned New Knowledge
Game Reward	Learning With Other players
Player Working Together	Make New Friends
Gameplay Competition	Making Nutrition And Health Changes
Continue Playing Digital Game	Motivated To Learn About Nutrition And Health
Deep Playing	New Learning Methods
Paying Attention in Gameplay	Not About Winning
Enthusiastic Playing Bingo Game	Cheering For Other Players
Waiting For Other Players	Feel Excited When winning
Feeling Comfortable	Positive Co-playing Experience
Feeling of Accomplishment	Sharing Of stories
Good Company Of Players	Talking To Other Players
Importance To Know Other Players	Useful Game Content
Fun To Play	Worth Spending Time Playing
Future Investment in Digital Games	Recommendation Of Game Improvement
Game As Regular Activity	Following Bingo Numbers
Game As Pastime	Need To Change Nutrition & Health Habits
Game As Hobby	Avoiding Social Isolation
Game Content Challenges	Need To Do Something Frequently
Game Flow	Game Challenges
Game Interface challenges	
Gameplay Rewards	
Good Game Questions	

2nd Cycle of Focused Coding (1st Attempt)

Table N.2.   Coding of Interview's transcript to various classifications or nodes

	Classification (First Attempt)		Classification (First Attempt)
1	Nodes\\Analysing of Questions	24	Nodes\\Helpful Technology
2	Nodes\\Answering the Questions correctly	25	Nodes\\High Positive Expectation for Future Digital Game
3	Nodes\\Apply to Everyday Life	26	Nodes\\Importance of Digital Game
4	Nodes\\Building Relationships	27	Nodes\\Improved Mood of Playing
5	Nodes\\Change of Perspective in Nutrition and Health	28	Nodes\\Improving of Social Skill
6	Nodes\\Changed Perspective of Digital Game	29	Nodes\\Interaction_Coordination with Other Players
7	Nodes\\Comparing with Other Games	30	Nodes\\Interested in Learning Nutrition and
8	Nodes\\Concerns for other seniors	31	Nodes\\Keep Brain Active
9	Nodes\\Connect with players	32	Nodes\\Learned about technology
10	Nodes\\Continue Playing Digital Game	33	Nodes\\Learned New Knowledge
11	Nodes\\Deep Playing_Pay Attention in	34	Nodes\\Learning with other players
12	Nodes\\Enthusiastic Playing Bingo Game	35	Nodes\\Make New Friends
13	Nodes\\Excited about the Bingo Game	36	Nodes\\Making Nutrition and Health changes
14	Nodes\\Feeling Comfortable	37	Nodes\\Motivated to Learn more about
15	Nodes\\Feeling of Accomplishment	38	Nodes\\New Learning Methods
16	Nodes\\Fun	39	Nodes\\Not about winning
17	Nodes\\Future Investment in Digital Games	40	Nodes\\Positive Co-playing Experience
18	Nodes\\Game as Regular Activity_Hobby_Pastime	41	Nodes\\Sharing of stories
19	Nodes\\Game Content Challenges	42	Nodes\\Talking to Other Players
20	Nodes\\Game Flow	43	Nodes\\Useful Game Content
21	Nodes\\Game Interface challenges	44	Nodes\\Worth Spending Time Playing
22	Nodes\\Gameplay Rewards		
23	Nodes\\Good Game Questions		

2nd Cycle of Focused Coding (2nd Attempt)

Table N.3.   Nodes being renamed and arranged according to their types

Reanalysing & Renaming	Reanalysing & Renaming
1 Nodes\\ Question Analysing	24 Nodes\\ Digital Game Future Expectation
2 Nodes\\ Question Answering Correctly	25 Nodes\\ Digital Game Importance
3 Nodes\\ Application To Daily Life	26 Nodes\\ Game-playing Mood (Mood, In Vivo)
4 Nodes\\ Relationship Building	27 Nodes\\ Game-playing Social Skill
5 Nodes\\ Learning with Perspective Changed in Nutrition And Health	28 Nodes\\ Player Interactivity
6 Nodes\\ Digital Game Perspective Changed	29 Nodes\\ Player Collaboration
7 Nodes\\ Digital Game Comparison	30 Nodes\\ Learning Increased Interest In Nutrition and Health
8 Nodes\\ Care For Other Seniors	31 Nodes\\ Game-playing Keep Mind Active
9 Nodes\\ Player Connection (Connected, In Vivo)	32 Nodes\\Learning About Technology
10 Nodes\\ Post Bingo Study Continual Playing	33 Nodes\\Learning New Knowledge
11 Nodes\\ Game-playing Immersion	34 Nodes\\Learning With Other Players
12 Nodes\\ Feeling of Enthusiastic	35 Nodes\\ Make New Friends (Make New Friend, In Vivo)
13 Nodes\\ Feeling of Excitement (Excited, In Vivo)	36 Nodes\\ Make Nutrition and Health changes
14 Nodes\\Feeling Comfortable (Comfortable, In Vivo)	37 Nodes\\ Post Bingo Game Motivation to Learn more about Nutrition and Health
15 Nodes\\Feeling Of Accomplishment (Accomplished, In Vivo)	38 Nodes\\ Learning Game as New Learning Methods
16 Nodes\\Feeling Fun (Fun, In Vivo)	39 Nodes\\ Game Winning (Winning, In Vivo)
17 Nodes\\ Digital Game Potential Investment	40 Nodes\\ Player Positive Co-playing Experience
18 Nodes\\ Post Bingo Study Playing Game As Regular Activity	41 Nodes\\ Player Sharing Of stories
19 Nodes\\Game Content Challenges	42 Nodes\\ Player Talking To Other Players
20 Nodes\\Game Flow	43 Nodes\\ Learning Useful Game Content
21 Nodes\\Game Interface Challenges	44 Nodes\\ Worth Spending Time Playing (Worth Spending Time Playing, In Vivo)
22 Nodes\\Game Rewards	45 Nodes\\ Game As Helpful Technology
23 Nodes\\ Good Game Questions (In Vivo)	

2nd Cycle of Focused Coding (3rd Attempt).

Table N.4.   Nodes being regrouped and integrated according to types

Integration (Re-grouping)		Integration (Re-grouping)	
1	Nodes\\ Question Analysing	24	Nodes\\Helpful Technology
2	Nodes\\ Question Answering Correctly	25	Nodes\\High Positive Expectation for Future Digital Game
3	Nodes\\ Good Game Questions (Vivo)	26	Nodes\\Game Content Challenges
4	Nodes\\ Digital Game Perspective Changed	27	Nodes\\Game Flow
5	Nodes\\ Digital Game Comparison	28	Nodes\\Game Interface Challenges
6	Nodes\\ Digital Game Potential Investment	29	Nodes\\Game Rewards
7	Nodes\\ Digital Game Future Expectation	30	Nodes\\ Game As Helpful Technology
8	Nodes\\ Digital Game Importance	31	Nodes\\ Game Winning (Winning, In Vivo)
9	Nodes\\ Player Connection (Connected, In Vivo)	32	Nodes\\ Learning with Perspective Changed in Nutrition And Health
10	Nodes\\ Player Interactivity	33	Nodes\\ Learning Increased Interest In Nutrition and Health
11	Nodes\\ Player Collaboration	34	Nodes\\Learning About Technology
12	Nodes\\ Player Positive Co-playing Experience	35	Nodes\\Learning New Knowledge
13	Nodes\\ Player Sharing Of stories	36	Nodes\\Learning With Other Players
14	Nodes\\ Player Talking To Other Players	37	Nodes\\ Learning Useful Game Content
15	Nodes\\ Feeling of Enthusiastic	38	Nodes\\ Learning Game as New Learning Methods
16	Nodes\\ Feeling of Excitement (Excited, In Vivo)	39	Nodes\\ Post Bingo Study Continual Playing
17	Nodes\\Feeling Comfortable (Comfortable, In Vivo)	40	Nodes\\ Post Bingo Study Playing Game As Regular Activity
18	Nodes\\Feeling Of Accomplishment (Accomplished, In Vivo)	41	Nodes\\ Post Bingo Game Motivation to Learn more about Nutrition and Health
19	Nodes\\Feeling Fun (Fun, In Vivo)	42	Nodes\\ Application To Daily Life
20	Nodes\\ Game-playing Immersion	43	Nodes\\ Relationship Building
21	Nodes\\ Game-playing Mood (Mood, In Vivo)	44	Nodes\\ Care For Other Seniors
22	Nodes\\ Game-playing Social Skill	45	Nodes\\ Make New Friends (Make New Friend, In Vivo)
23	Nodes\\ Game-playing Keep Mind Active		

2nd Cycle of Focused Coding (4th Attempt)

Table N.5.   Nodes being regrouped and synthesised according to their types or representation

	Synthesising 1		Synthesising 1
1	Nodes\\ Question Analysing	19	Nodes\\Game Content Challenges
2	Nodes\\ Good Game Questions (In Vivo)	20	Nodes\\Game Flow
3	Nodes\\ Digital Game Perspective Changed	21	Nodes\\Game Interface Challenges
4	Nodes\\ Digital Game Future Expectation	22	Nodes\\Game Rewards
5	Nodes\\ Players Connectedness (Connected, In Vivo)	23	Nodes\\ Game As Helpful Technology
6	Nodes\\ Player Interactivity	24	Nodes\\ Game Winning (Winning, In Vivo)
7	Nodes\\ Player Collaboration	25	Nodes\\ Learning with Perspective Changed in Nutrition And Health
8	Nodes\\ Player Positive Co-playing Experience	26	Nodes\\Learning About Technology
9	Nodes\\ Player Talking To Other Players	27	Nodes\\Learning New Knowledge
10	Nodes\\ Feeling of Enthusiastic	28	Nodes\\Learning With Other Players
11	Nodes\\ Feeling of Excitement (Excited, In Vivo)	29	Nodes\\ Learning Game as New Learning Methods
12	Nodes\\Feeling Comfortable (Comfortable, In Vivo)	30	Nodes\\ Post Bingo Study Continual Playing
13	Nodes\\Feeling Of Accomplishment (Accomplished, In Vivo)	31	Nodes\\ Post Bingo Study Playing Game As Regular Activity
14	Nodes\\Feeling Fun (Fun, In Vivo)	32	Nodes\\ Post Bingo Game Motivation to Learn more about Nutrition and Health
15	Nodes\\ Game-playing Immersion	33	Nodes\\ Application To Daily Life
16	Nodes\\ Game-playing Mood (Mood, In Vivo)	34	Nodes\\ Relationship Building
17	Nodes\\ Game-playing Social Skill	35	Nodes\\ Care For Other Seniors
18	Nodes\\ Game-playing Keep Mind Active	36	Nodes\\ Make New Friends (In Vivo)
		37	Nodes\\ Make Nutrition and Health changes
		38	Nodes\\ Worth Spending Time Playing (In Vivo)

2nd Cycle of Focused Coding (5th Attempt)

Table N.6. **Second stage of Synthesing nodes to regroup and synthesised according to their types or representation**

Synthesising 2		
Nodes\\Question Analysing Nodes\\Good Game Questions (In Vivo)	Nodes\\ Game-playing Immersion Nodes\\ Game-playing Mood (Mood, In Vivo)	Nodes\\ Application To Daily Life Nodes\\ Make Nutrition and Health changes
Nodes\\ Digital Game Perspective Changed Nodes\\ Digital Game Future Expectation Nodes\\ Care For Other Seniors Nodes\\ Game As Helpful Technology	Nodes\\Game Content Challenges Nodes\\Game Flow Nodes\\Game Interface Challenges Nodes\\Game Rewards Nodes\\ Game Winning (Winning, In Vivo)	Nodes\\ Post Bingo Study Continual Playing Nodes\\ Post Bingo Study Playing Game As Regular Activity Nodes\\ Post Bingo Game Motivation to Learn more about Nutrition and Health
Nodes\\ Player Connectedness (Connected, In Vivo) Nodes\\ Player Interactivity Nodes\\ Player Collaboration Nodes\\ Player Positive Co-playing Experience Nodes\\ Player Talking To Other Players Nodes\\ Game-playing Social Nodes\\ Relationship Building Skill	Nodes\\ Feeling of Excitement (Excited, In Vivo) Nodes\\Feeling Comfortable (Comfortable, In Vivo) Nodes\\Feeling Of Accomplishment (Accomplished, In Vivo) Nodes\\Feeling Fun (Fun, In Vivo)Nodes\\ Feeling of Enthusiastic	Nodes\\ Learning with Perspective Changed in Nutrition And Health Nodes\\Learning About Technology Nodes\\Learning New Knowledge Nodes\\Learning With Other Players Nodes\\ Learning Game as New Learning Methods
Nodes\\ Make New Friends (In Vivo)	Nodes\\ Worth Spending Time Playing (In Vivo)	Nodes\\ Game-playing Keep Mind Active

2nd Cycle of Focused Coding (6th Attempt, Final)

Table N.7. **An abstraction of nodes to name each of the synthesised and cluttered group according to their types or representation**

Abstraction		
Game Questions	Game-playing Mood	Application To Daily Life
Game Future Contribution	Game Content	Life after Bingo Study
Social Co-playing	Gameplay Excitement	Knowledge acquired
Make New Friends	Worth Spending Time Playing	Keep Mind Active

Appendix O.

Summary of Key Empirical Studies Cited In This Study

Research Work	Game Type	Research Purpose	Subjects	Methods	Key Finding
Zwarikruis-Pelgrim and Ruyter (2008)	Redesigned and developed customised adaptive maze memory game application	To improve memory and cognitive decline based on players comments and earlier game evaluation	14 participants all living independently (11 males and 3 females), between the ages of 46 to 78 with a mean age of 65	Two week intervention in a field experiment	1. Positive improvement in their cognitive performance as a result of the cognitive challenge from the maze game. 2. Positive experience of the engagement the players had, which in turn boosted the players to put in more effort to do well in the game
Gerling, Schulte, and Masuch (2011)	SilverPromenade, a prototyping game designed for frail health adults suffering from cognitive and physical limitations, through iterative and participatory design methods	To improve memory and cognitive decline, using game with iterative and participatory methods of improved game design	Fourteen residents permanently living in full-care nursing homes, with an average age of 80	Participatory-design prototyping experiment workshop with participants	Key result pointed to many aspects of the game prototype design to meet the needs of the frail elderly players, including the interaction design for players and the complexity of game mechanics for their special needs. To "Carefully explore the abilities of your target audience to provide accessible gameplay" (p. 6)
Whitlock, McLaughlin, & Allaire, 2011	Nintendo Wii Boom Blox game	To investigate older adult users' physical and cognitive limitations when playing this game	56 participants of age 65 to 93, $M=$ 79.77	Observed video recordings of game play sessions and questionnaire responses	Adaptive difficulty: physical accessibility and mental capabilities of playing is still a real and common issue for this group of players. Participants disclosed that motivation in games especially through rewards and feedback provided by the gaming systems can occasionally reduce frustration for this group of elderly players and push them further to achieve a higher level gaming task.
Hwang, Hong, Hao, and Jong (2011)	A customised interactive software program using Macromedia Flash to generate, draw, and create animations for older adults in multiple settings.	To understand senior adults' experiences of game playing, with refinement made to the users' usability level of the gaming system	30 older adults (above 60 years old, 14 males and 16 females) from the 3 different settings (rural community centre, an urban community centre, and full-time nursing homes in Taiwan)	Structured interview and observations of the gaming sessions	Older adults from the nursing home have higher user satisfaction of playing the game, whereas those who were from the rural community centre have the lowest; instead, those from the urban community centre have mid-range user satisfaction. Female older gamers preferred playing with others than playing alone, and their flow experiences (playing games uninterruptedly) came from the process of sharing and interacting with others. In contrast, the male older adults preferred playing alone, and the flow experiences came from indulging in their personal preference of gaming style of playing.

Author	Game	Objective	Participants	Method	Findings
Mubin, Shahid, and Al Mahmud (2008)	Walk 2 Win, a mobile memory game	To customize a mobile game for promoting players' interact with each other during game play.	8 healthy voluntary participants (5 males and 3 females), average age of 71 (from 67 to 78) in a local community centre.	Micro ethnographic study, with focus group session with the senior participants. Interviewing the caregivers who took care and supported the senior community members	Senior users in this non-residential community centre expressed a strong interest to build a team of players amongst themselves as long as the game is simple, uncomplicated, and socially entertaining.
Cheok, Lee, Kodagoda, and Tat (2005)	Age Invader, customised inter-generation digital game	To conduct an observational study to investigate the gaming experience of a customised intergeneration digital game for older adults.	35 healthy males and females, average 60 years old, living in a full-time nursing home in Asia.	Observation, coupled with open interviewing with participants.	The interactive features were very well accepted and provided social engagement, where other games lacked. Social and physical interactions, including verbal and body signals during gaming, were reported as vital towards the enjoyment and engaging moments of playing games together.
Vasconcelos, Silva, Caseiro, Nunes, and Teixeira (2012)	Simple customized cognitive puzzle game built on a tablet-based gaming platform	To investigate the enhancement of quality-of-life and psychological well-being of seniors playing a simple cognitive puzzle tablet game together.	13 older adults (10 females & 3 males, 74-88 years old) in an adult day care centre.	Observing naturally and interviewing.	1. These groups of players favoured playing experiences that promote gameplay interaction, competition, and developing teamwork with other players. 2. Most older players in this study have an average game playing endurance of 30 minutes to perform maximally in gaming tasks on most types of digital games. 3. Senior players also expressed their preference not to play games that required a lot of physical and mental effort to play with. The physical size, portability, and touch screen on the tablet made it very comfortable to play with.
Shim, Baecker, Birnholtz, and Moffatt (2010)	TableTalk Poker, an online social game	To rework on the game user interaction designed to suit the senior players based on the weaknesses and deterrents learned from various previous research studies.	72 to 86 years old, with online browsing experiences, who were enrolled in a continual education program.	Treatment group with conversational partners; and a Control group with no partners nor a communication facility. Interviewing.	1. Social interaction and connectedness in gameplay is one of the most important key elements in gameplay for this group of gamers. This was all credited to the voice conversation function, which allowed senior gamers to communicate and interact while playing games. This also provided senior players to play different roles in the poker game such as peer, mentor, or learner.

Study	Objective	Game/Tool	Participants	Method	Findings
Derboven, Gils, and Grooff (2012)	To investigate video chat communication influence in gaming experience, while playing simple intergenerational games with younger players.	A brain training shopping game	Senior participants (60+, average age of 68)	Observation, with video recorded, timed, and tagged of gameplay. Post-game questionnaire.	1. All the participants, both elderly and younger players, explained their preferences based on the availability of the video chat, rather than their familiarity with the game. 2. Players communication and social content found on the chatting feature, of the shopping game was more motivating than the user interface. Usability can be familiarized with gradual exposure to a new or unfamiliar gaming system.
Engelhardt, Buber, Skirbekk, & Prakawetz, 2010	Investigating social-related activities effect on cognitive performance in the later life of elderly folks.	Survey data Collection, for Health, Ageing, and Retirement in Europe (SHARE) from 11 European countries and Israel between 2004 and 2006	22,949 people, consisting 10,902 men and 12,047 women, mixture of day care & full-time nursing home), with a mean age for men of 62 years and of 63 years for women	Large scale Survey.	1. Improvement in cognitive performance (memory power and reasoning abilities) was correlated to the elderly social lifestyle, social involvement, and the way they interacted with other elderly people. 2. The level of social involvement and size of social network were positively correlated with the cognitive abilities of the older adults. 3. Technology including digital games are ideal media for improving and maintaining older adults' fluid abilities, which often decline over their adulthood lifespan.
Marston (2013)	To identify gaming interaction and content suitable for older adults to achieve effective gameplay and engaging experiences.	Nintendo Wii and Sony PlayStation	Group 1 (n=24, mean=64 years, sd=6.21, 10 males & 14 females) and Group 2 (n=68, mean=57.4 years, sd=10.75, 40 males & 28 females).	Mixed method study with ethnography focused, conducting game design workshops and observations on two separate groups of participants.	Older adults took into account the benefits of digital games which included social enjoyment, competitiveness, feeling connected, education for oneself and other players. Marston also recommended integrating player interaction and learning content in digital game design.
De Schutter and Vanden Abeele (2010)	To explore the use of digital games among older adults and provide a set of "benchmark data " with respect to the uses and gratifications of these players.	Digital game developed through contextual inquiries and participatory design sessions, that reflect game concepts of elderly life	Ten 68 to 80 year old Flemish senior citizens (7 men and 3 women)	Contextual inquiries and participatory design.	Game's Activity component should not be the priority that designers spend the most time on. The other three components which included Connecting people, Cultivating personal growth, and Contributing to society were equally important components of game design according to the perspectives of the elderly participants.
Majumdar, Koch, Lee, Contento, Islas-Ramos & Fu, 2013	To investigate the impact on how playing digital game with nutrition and health objectives, can have an impact on a group of middle school adolescents' diet and physical wellbeing.	Creature-101, a nutrition and health customised digital game	590 students (11-13 years of age, 51.6 percent male), from a New York City low-income public middle schools	Pre-post intervention-control study, measured with validated online instrument. Participants play seven gameplay sessions, 30 minutes each session for 1 month.	Significant decrease on negative behaviours, especially the reduced consumption of sweetened beverages and processed snacks, after a series of gameplaying. As revealed by the researchers, such improved behaviours, when consistently maintained, can eventually lead to promoting many health benefits, awareness and knowledge in nutrition, and enhance motivation in the gameplay and future implementation of such related game.