



Faculty of Computer Science and Information Technology

**Andragogical Perspectives in Designing Digital Games for Older Adults:
Maximizing Interaction and Experience**

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**Master of Science
2023**

Andragogical Perspectives in Designing Digital Games for Older Adults: Maximizing Interaction and Experience

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A thesis submitted

In fulfillment of the requirements for the degree of Master of Science

(Computer Science)

Faculty of Computer Science and Information Technology

UNIVERSITI MALAYSIA SARAWAK

2023

DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Malaysia Sarawak. Except where due acknowledgements have been made, the work is that of the author alone. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

A handwritten signature in black ink, appearing to read 'Nurul Farinah Binti Mohsin', is written over a horizontal dotted line.

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Date :30th May 2023

ACKNOWLEDGEMENT

My sincere gratitude to Dr Suriati who helped me, give me opportunity to study under her grant and supervised my progress during my study. Without her support and guide, I might not be able to finish my study towards the end.

I also want to thank to Dr Imran, Madam Fauza, Dr Amelia, Dr Fatihah and Prof Sylvester who assisted and checked my research papers and thesis. Without their assistant, I might not be able to present and publish my research papers. To all lecturers and staffs at FCSIT, CGS staffs and UNIMAS administrators, who helped me since day 1 till now, thank you for your assistance. Not to forget to both of my internal and external examiners, Dr Irwandi and Dr Aslina for their time checking and examined my thesis.

I also want to thank to Kementerian Pengajian Tinggi (MOHE) for financial aid during my study under Fundamental Research Grant (FRGS).

My deepest gratitude goes to the most important backbone to my research study is my family especially for both of my parents, where they allow me to continue my study and gave support in term of emotional and financial. Without their support, I might not pursue master's degree.

My sincere thanks to all my friends, Izza, Ummi, Wada, Anis, Dayang, Saidatul, Mimie, Kee, Jasmine, and others for their support and comfort during my lowest point. Without them, I might lose during my study.

I might not put names for all contributors in my study, but I totally indebted to your assistance. Thank you very much! And last but not least, I want to thank myself for not quitting in the middle of this journey. Thank you all.

ABSTRACT

The revolution of digital games has been advancing years by years. Digital games no longer serve just as entertainment but can potentially be used in different areas, such as the healthcare industry. The worldwide population of older adults is increasing, leading to an ageing world. The advancement of digital game technology can help to facilitate this ageing population. However, the current commercialised digital games are not designed and developed based on older adults' limitations. In addition, there is limited of guideline on designing and developing games specifically for older adults that consider andragogy principles. Therefore, this study proposes the *Purpose, Design, Play* and *Experience* guideline as a guideline for designing and developing digital games for older adults by reflecting the key principles of andragogy. In this study, an application named Otak Me! has been developed based on the guideline in the proposed guideline and tested by the target group, the older adults in Malaysia aged 55 and above. Participants' gaming experiences and user interface satisfaction were measured using Game Experience Questionnaire (GEQ) and Questionnaire for User Interface Satisfaction (QUIS). Based on the finding, Otak Me! received positive feedback where the positive items include the participants' feeling toward the Otak Me! application have the highest mean score compared to other items in GEQ with a score 4.00 from the participants, which vastly helped evaluate and validate the game design for older adults. Therefore, by playing and engaging with games in the Otak Me! application give benefit towards the older population in term of enjoyment.

Keywords: Andragogy, digital games, older adults, interaction, gaming

***Perspektif Andragogi dalam Mereka bentuk Permainan Digital untuk Warga Emas:
Memaksimumkan Interaksi dan Pengalaman***

ABSTRAK

Revolusi permainan digital telah berkembang dari tahun ke tahun. Permainan digital tidak lagi berfungsi hanya sebagai hiburan tetapi berpotensi digunakan dalam bidang yang berbeza, seperti industri penjagaan kesihatan. Populasi warga emas di seluruh dunia semakin meningkat, membawa kepada dunia yang semakin tua. Kemajuan teknologi permainan digital dapat membantu memudahkan penduduk yang semakin tua ini. Walau bagaimanapun, permainan digital yang dikomersialkan semasa tidak direka dan dibangunkan berdasarkan had keupayaan warga emas. Selain itu, tiada garis panduan untuk mereka bentuk dan membangunkan permainan khusus untuk warga emas yang mempertimbang prinsip andragogi. Oleh itu, kajian ini mencadangkan rangka kerja Tujuan (Purpose), Reka Bentuk (Design), Bermain (Play) dan Pengalaman (Experience) sebagai garis panduan untuk mereka bentuk dan membangunkan permainan digital untuk warga emas dengan mencerminkan prinsip utama andragogi. Dalam kajian ini, aplikasi dinamakan sebagai Otak Me! telah dibangunkan berdasarkan garis panduan dalam rangka kerja yang dicadangkan dan diuji oleh kumpulan sasaran iaitu warga emas di Malaysia berumur 55 tahun ke atas. Pengalaman permainan peserta dan kepuasan antara muka pengguna diukur menggunakan Soal Selidik Pengalaman Permainan (GEQ) dan Soal Selidik untuk Kepuasan Antara Muka Pengguna (QUIS). Berdasarkan dapatan, Otak Me! menerima maklum balas positif di mana item-item positif yang termasuk perasaan peserta terhadap aplikasi Otak Me! mempunyai skor purata tertinggi berbanding item lain dalam GEQ dengan skor 4.00 daripada peserta, yang amat membantu menilai dan mengesahkan reka bentuk permainan untuk warga emas. Oleh itu, dengan bermain dan terlibat dengan

permainan dalam aplikasi Otak Me!, memberi manfaat kepada populasi warga emas dari segi keseronokan.

Kata kunci: *Andragogi, permainan digital, orang dewasa lebih tua, interaksi, permainan*

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LIST OF ABBREVIATIONS

CGS	Centre for Graduate Studies
DPE	Design, Play and Experience
GEQ	Game Experience Questionnaire
HCI	Human-Computer Interaction
iGEQ	In Game Experience Questionnaire
PDPE	Propose, Design, Play and Experience
QUIS	Questionnaire for User Interaction Satisfaction
SGDA	Serious Game Design Assessment
SLR	Systematic Literature Review
SUS	System Usability Scale
UNIMAS	Universiti Malaysia Sarawak
UX	User Experience

CHAPTER 1

INTRODUCTION

1.1 Study Background

The number of older populations is increasing from years to years. Tobi, Fathi, and Amaratunga (2017) stated that the ageing population in Malaysia is hit 28.3 million in 2010 and is expected to increase to 38.6 million in the following 30 years. Malaysia is predicted to be an ageing country by 2030 when 15% of the population is categorised as older adults (Yunus et al., 2017) which in Current Population Estimates Malaysia 2020 reported the number of people aged 60 years and above rose from 3.4 million in 2019 to 3.5 million and people aged 65 years and above from 2.2 million in 2019 to 2.3 million in 2020 (Department of Statistics, 2020).

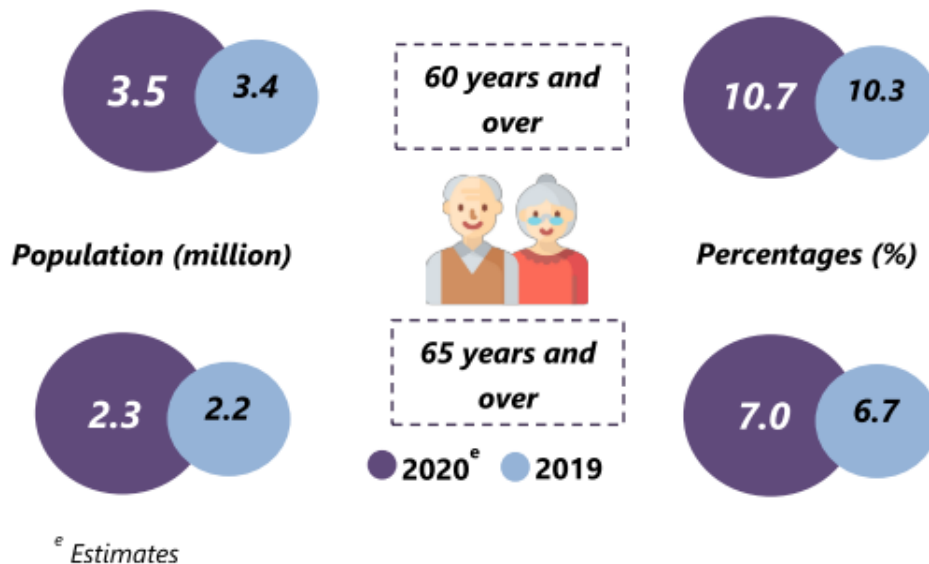


Figure 1.1: Number of older population in Malaysia 2020 (Department of Statistics, 2020)

According to Yunus et al. (2017), people aged 60 years old and above are categorised as older adults in Malaysia, based on the cut-off age adopted by the United Nations (UN). There are two main factors lead to an increasing number of ageing population in Malaysia, which are lower birth rates and declining Total Fertility Rate (TFR) (Ibrahim et al., 2017).

Older adults tend to experience negative ageing effects such as declining in cognitive abilities and physical abilities. The advancement of technology has brought many benefits to people including the older generation. The digital game is one of the examples of technology that can enhance older adults' life. Zhang and Kaufman (2016) point out that digital games have been used as a tool for psychological, cognitive, and neuropsychological rehabilitation for older adults since the mid-1980s. Digital games can boost older adults' fitness through the combination of enhanced motivation, gameplay, and fun and rhythm, and training and encourage them to improve their health (Wiemeyer & Kliem, 2012).

Although the advancement of technology is prevalent worldwide, few issues arise between older adults and technology, especially with digital games. There are few challenges face by older adults when dealing with digital game technology. Older adults are often unable to accept new technology and reject this technology entirely because of the psychological pressure caused by the fear that they cannot use it correctly (Yeh et al., 2019). Some of them are illiterate and have basic digital literacy on how to operate digital devices in an efficient manner (Blažič & Blažič, 2019).

Andragogy is related to the adults learning process, where it can be described as the art and science of helping adults learn (Jali & Arnab, 2017; Loeng, 2018). According to Malliarakis, Tomos, Shabalina, and Mozeliuss (2018), adopting principles of andragogy in education, especially for the educational digital games can offer substance to the learning

process through active experimentation. Six andragogical perspectives can be adopted to design an effective guideline focussing on older adults. In Section 2.8, a detailed principal andragogy is explained.

EMOTION framework, Serious Game Design Assessment (SGDA) framework and Design Play and Experience (DPE) framework are the examples of current frameworks to design and develop digital games. However, these three frameworks do not emphasise on the design and development digital games specifically for older adults with the consideration of andragogy principles.

When designing digital games specifically for older adults, it is essential to consider the impact of the game content, genres, and the benefits gained from engaging with digital games. Based on a study by Kathrin M. Gerling, Schulte, Smeddinck, & Masuch (2012), guidelines were developed, focusing on four domains: Players and Resources, User Interface, Core Mechanics, and Outcome. In the Players and Resources domain, older adults as the target group with limited gaming experience should be considered. Design aspects such as interesting visuals and familiarity for the target group are important. The User Interface should be adapted to cope with aging-related challenges, including device selection and adjustable graphical elements like font size and color. Core Mechanics should feature simple rules and objectives to facilitate learning, avoiding excessive cognitive load. Finally, in the Outcome domain, positive results like players' enjoyment, learning, and achieving objectives should be prioritized by considering the limitations of older players.

In this study, a guideline to design and develop mobile digital game is proposed. The guideline is divided into four quadrants, Purpose, Design, Play and Experience (PDPE). The differentiation between PDPE guidelines with the existing frameworks is the consideration

of andragogy principles for both phase which in design and development phase for development digital games specifically for older adults.

1.2 Problem Statement

The advancement of digital game technology brings many benefits to many people, including older adults. Apart from of digital games as an entertainment tool, digital games can be used and implemented in many sectors such as in the healthcare industry, social science study and many more. This study's target focusses on older adults in Malaysian society. The central problem to be researched by the proposed study is that the present game design is not suitable for older adults.

There are two key problems are identified. Firstly, most commercialised digital games are not designed and developed specifically for older adults where most of it developed for the general type of games and aim for the younger user in mind. Most of the games are rarely designed with an older adult user group in mind (Gerling et al., 2012) and do not consider the older adults' restrictions (Cota et al., 2015; Mohsin et al., 2022) Older adults require different guideline to develop digital games specifically for them due to the negative ageing impact that affected their daily life. Apart from that, games designed for older players are not commercially available yet (Khalili-Mahani et al., 2020).

Secondly, lack of research on designing and developing digital games for older adults. Most of the games have not fully taken the older adults' needs and interests into the design consideration (Wang et al., 2019). Lack of research correlating the attributes of game technology and the consideration such as andragogical perspectives and challenges faced by the targeted group. Based on the previous research, only a study by Jali and Arnab (2016) correlated the andragogical perspectives into game design considerations for older adults.

However, the focus of the study is on console, and mobile platform and the target participants are older adults in United Kingdom.

1.3 Research Questions

This study aimed to address the following research questions:

- i. What are the challenges related to the older adults interact with mobile digital game technology that needs to be considered?
- ii. How can their game experiences influence design considerations?
- iii. How to measure the effectiveness of the constructed guideline on the interaction and experience of older adults with mobile digital games?

1.4 Objectives

The main aim of this thesis is to identify user interaction and experience with digital games on mobile platforms focussing on older adults between the ages of 55 to 75. There are three objectives of this research:

- i. To identify the components or elements to design and develop mobile digital games specifically for older adults based on the interaction and experience using andragogical perspectives.
- ii. To construct a guideline to design and develop mobile digital games for older adults.
- iii. To evaluate the effectiveness of the guideline on design and develop mobile digital games using a prototype (digital game) on how older adults'

interactions and experiences with digital game technology influence their perceptions of technology.

1.5 Research Scope

The main purpose of this study is to identify the experience and interaction among older adults with mobile digital games and this study focussed on older adults in Malaysia. The target group is older adults who aged 55 years and above and reside in Malaysia. 55 years old is the minimum age for retirement in Malaysia as stated in the Retirement Act 1980 Clause 10. The selection of the age range is based on the retirement age in Malaysia, where the age range is suitable to let them experience digital games in their retirement era.

In this study, there are 56 responses were recorded in google form and 4 participants participated in the interview session for preliminary study. During the final study, there are 16 participants participated. Data collection took two years for both stage, preliminary and final study.

In this research study, a mixed-method research design is adopted, where it consisted of a qualitative and quantitative approaches. The rationale on the adoption of mix-method approaches in this study is to investigate older adults' perspectives on digital games and utilised the information obtained to construct a guideline on how to design and develop digital games specifically for older adults. There are four stages involved in the research design, including intensive literature review, pilot study, further investigation and validation, and final analysis and discussion. Different type of approaches was used in each stage, consisting of demonstration, gameplay, observation, informal interview, and dissemination of questionnaire. The questionnaire was distributed by using snowball and convenience sampling techniques.

1.6 Significance of the Study

Industry Revolution 4.0 (IR4) has been expanded worldwide and there are many evolutions in digital technology that can be seen. One of them is the advancement of virtual technology, where the main purpose of digital games is no longer limited to enjoyment but can be applied in the healthcare platform. Digital games offered many benefits to support older adults to overcome the negative ageing impact. It acts as a cognitive training tool (Mansor et al., 2019) and enhances older adults' quality of life (Kaufman et al., 2016).

This study aims to contribute to the growth of digital games for older adults by exploring their interaction and experiences with digital games. There are several important areas for this study where it becomes a steppingstone to provide guidelines for designing and developing games for older adults using andragogical perspectives to advance the understanding of older adults' needs and preferences. The findings should make an important contribution to the field of the gaming industry and healthcare where it has a social impact on innovative healthcare platforms.

1.7 Thesis Overview

Chapter 1 is an overview of the whole thesis, which provides the research background, research problems, aim and objectives, research questions, scope and methodology used, and significance of the study. Chapter 2 reviews the definition of older adults, general statistics of older adults in Malaysia, the interaction of older adults with digital technology, challenges that they faced when interacting with the digital game, benefits they gained from the digital game, and the relationship between andragogy and digital game. In addition, in this chapter the overview of three different existing frameworks is discussed. A detailed research design and methodology is discussed in Chapter 3. Chapter

4 is discussed on the system analysis and design, which explain the systematic literature results obtained in Stage 1 of the research method. Chapter 5 is a implementation chapter, which the findings from Stage 2 of the research design is discussed and a detail guideline to design and develop digital games is proposed. In Chapter 6, the results obtained from Stage 3 of the research design is discussed. Conclusion and summary of the whole chapter of this study was discussed in Chapter 7.

1.8 Summary

This chapter explains the brief introduction of the whole thesis. The idea of this thesis is to discover the user interaction and experience with digital games on mobile platforms focusing on older adults. The main problems to that lead to this topic are most of the commercialised games available in the market is not suitable for older adults' use and lack number of research address the issues related to designing and developing digital games for older adults. The research questions and the research objectives designing in order to align with the aim of this study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This study presents the result from the intensive literature review related to this research are presented. There are seven main sections for this chapter, which will focus on the definition of older adults, their challenges and benefits of interacting with the digital game and andragogical perspectives. Section 2.2 discussed the andragogical perspectives and the correlation between andragogy with the digital game. Section 2.3 discussed the definition of interaction and experience. Section 2.4 discussed the terms and definitions of older adults, statistics, and factors that lead to an increasing number of older adults in Malaysia and the intended target group. Section 2.5 discussed the interaction between older adults and digital technology. Section 2.6 is a detailed explanation of the challenges for older adults to interact with a digital game. Meanwhile, Section 2.7 is discussed the design consideration based on older adults' gaming experiences. Section 2.8 explained the impacts and benefits gained by older adults using digital games. Section 2.9 discussed on the existing frameworks and 2.10 explained the similarities and differences between the existing frameworks.

2.2 Andragogy Perspectives

Andragogy is described as the art and science of assisting adults in their educational pursuits (Jali & Arnab, 2017; Loeng, 2018). However, a few important elements of andragogy must be followed to develop a successful framework designed particularly for older people learning. The following is a list of the essential principles of andragogy:

- i. Learner's need to know.
- ii. Self-concept of the learner.
- iii. Prior experience of the learner.
- iv. Readiness to learn.
- v. Orientation of learning.
- vi. Motivation to learn.

According to Malliarakis et al. (2018), embedding andragogy into digital games focussing on older adults can facilitate the learners throughout the learning process by active learning.

2.2.1 Andragogy and Digital Game

Adults' learners have different learning approach compared to children's learners. Andragogy approach is more suitable to be used to attract older adults compare to pedagogy approach. Based on the key principles of andragogy, it is important for the learners to acknowledge the importance of the digital game in their daily life and know the rationale of playing the game in order to reduce the challenges for older adults to interact with digital games in term of understanding.

By addressing the challenges in Section 2.5, it is important to highlight the principle of andragogy in designing digital game focussing on older adults. The needs of embedding andragogy perspective in digital game is to ensure the older adults can fully utilise the function of the digital games. Jali and Arnab (2016) stated that there is absence of any game specifically developed for older adults that correlates the attributes of the game technology

and consideration especially in andragogy perspectives and challenges faced by this target groups. They investigated the correlation between older adults and digital games using andragogical perspectives. Based on the results obtained from the pilot study with 14 older adults in England, they found older adults will enjoy the gameplay session when they in total control of utilising the platform. This line matched with the key principle of andragogy, “older adults have the knowledge and own styles and methods of game-based learning”.

Chin et al. (2017) developed game for older adult’s based on user interface guideline. They used Attention, Relevance, Confidence and Satisfaction (ARCS) survey with cognitive model to measure effectiveness of the game towards older adults. Figure 2.1 depicts the results obtained from study.

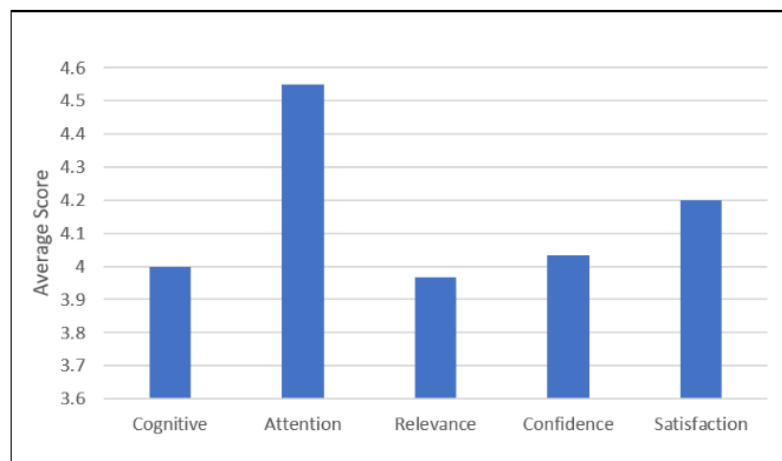


Figure 2.1: Average score for Cognitive and ARCS Model (Chin et al., 2017)

Based on the result obtained, attention has the highest score followed by satisfaction, confidence, cognitive and relevance. The game should be designed to attract older adults to play it. Hence, it can trigger older adults’ curiosity and as results, they able to keep their attention during the gameplay (Chin et al., 2017). However, based on their study, they found Bingo game is less relevant to their daily routines as they are having difficulty to understand the instruction in the game. In order to overcome the problem, the game should be developed

based on andragogy key principle “older adults need to know the rationale of playing the digital game”, where the instructor needs to demonstrate the game and explain the function of the button in the game to the player prior gameplay session.

2.3 Interaction and Experience

According to Nagalingam and Ibrahim (2015), user experience (UX) is a part of Human-Computer Interaction (HCI) and focusses on the interaction between users and products. UX is essential to evaluate the effectiveness of the UX design. In Nap et al. (2015) study, the result from experimental evaluation found the interaction devices and player experiences in digital games were high, which indicates the learning game has the potential to improve older adult’s quality of life.

Wang et al. (2019) stated that interface design is the first attraction for older adults to try experience and engaging with digital games. Therefore, to increase the engagement and user experience between older adults and digital games, it is essential to design the interface with the design consideration for older adults. The positive outcome or negative outcome from engagement with digital games are dependent on the game design interface itself.

2.4 Older Adults

There are different definitions of age for older adults, where according to Kowal (2014), the retirement age set by the country’s government where the person reside is the starting age for older adults which the a person become eligible for statutory and occupational pensions has become the default definition. Meanwhile, Orimo, Ito, Suzuki, Araki, and Hosoi (2006) stated that 65 years old and older is a chronological age for older adults, where 65 to 74 years old is considered early older adults and 75 years and later is late

older adults. People aged 60 years old are considered as ageing population in Malaysia (Department of Statistics, 2020).

In every country globally, the number of elderly adults is increasing. Department of Statistics (2020) reported the percentage of people aged 60 years and above in Malaysia is increasing from year to year. In the 2020 report, the number of older populations has increased from 3.4 million (2019) to 3.5 million (2020). Malaysia is expected to become an ageing country by 2030, with 15 per cent of the population being people aged 60 years and over (Department of Statistics, 2020).

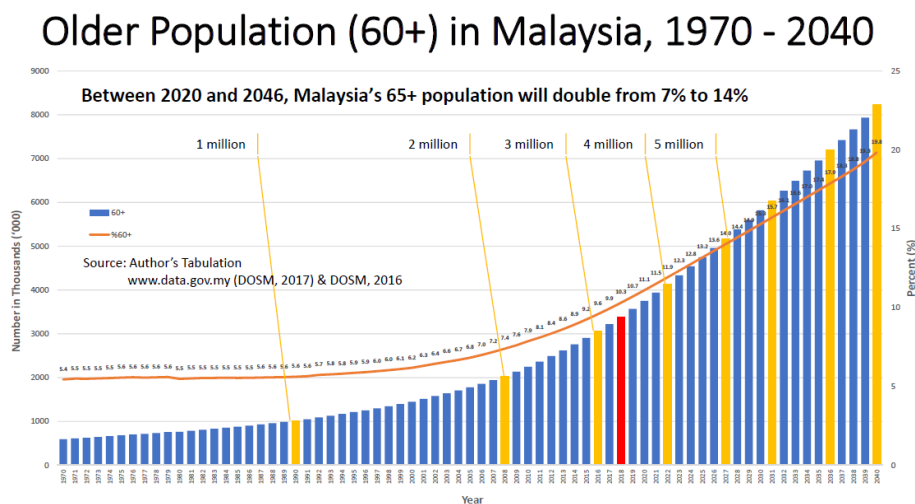


Figure 2.2: Older Population in Malaysia, 1970-2040 (Hamid, 2019)

Figure 2.2 shows the increasing number of older populations in Malaysia. Many factors influence the older population in Malaysia. Ibrahim et al. (2017) listed two factors leading to Malaysia's ageing population. First, lower birth rates and a declining Total Fertility Rate (TFR). Secondly, the increase in life expectancy. The first factor is lower birth rates and declining Total Fertility Rate (TFR) due to higher education and late marriage. According to Ibrahim et al. (2017), late marriage and higher education are, where women who gain higher education and better employment tend to consider late marriage or become

unmarried. The later the marriage, the higher the tendency for the couples to have fewer children. Ibrahim et al. (2017) found that the increasing life expectancy from 61.6 in 1970 to 74.7 in 2016 is due to outstanding healthcare, diets, and high quality of life.

This research focusses on older adults aged 55 to 75 years old in Malaysia. The intended target group is chosen to reduce the challenges for interacting with the digital game as addressed in Section 2.5. According to Retirement Act 1980 Clause 10, the minimum retirement age in Malaysia is 55 years to 60 years old. Therefore, it is a good opportunity to introduce digital technology primarily digital games to them, as digital games has benefits, especially in terms of socialisation (Santos et al., 2019). Refer to Section 2.8 for the impacts and benefits of digital games on older adults.

2.5 Older Adults versus Digital Technology

The usage of digital game technology can help to enhance the quality of life for older population. However, many studies highlighted the challenges faced by these population to interact and experience with digital games. Psychological factor is one of the factors affecting older adults to interact with digital game. A study by Yeh, Pai, and Jeng (2019) showed older adults declined the usage of digital technology due to the psychological pressure and incompetency to use the devices in a correct manner. Blažič and Blažič (2019) stated that older adults have minimal knowledge to use devices, where they tend to use their mobile phones limited to text and call purposes. Rapid development of digital technology made this population lose track with the current technology trends. Besides that, they know technology are important but it become useless to them due to lack of knowledge on how to use and have waste time to find the information needed, where some of the acronyms and terminology used can make them feeling frustrated (Khalili-Mahani et al., 2020).

Any form of games played using digital devices are considered as digital games (Hall and Marston, 2014). The commercialised digital games in the market are unable to accommodate older adults' needs. Some of the games requires players to perform physical activities, where it might put older adults who experience a decline in physical abilities with a risk of injury (Gerling et al., 2012).

2.6 Challenges for Older Adults to Interact with Digital Game

The ability of processing and generating information is one of the challenges for older adults to interact and experience digital games. Some of them might experience negative ageing impact, for example a decline in cognitive abilities. Most of the commercial digital games available in the market are designed and developed for the younger users in mind. Gerling, Schulte, Smeddinck, and Masuch (2012) stated that games are rarely designed based on older adults' preferences and perceptions. The games' interface becomes one of the barriers for them to adapt and interact with the digital games itself (Blažič & Blažič, 2019).

Tran, Bremond, and Robert (2016) proposed a serious game using Kinect to assist older adults. According to their research findings, older adults are more likely to feel discouraged or demotivated during a gaming session when they are unable to recall the game's rules. Some of the older adults were not interested in playing digital games and emphasised that the player of the games should be someone who has an interest in play games when designing a game specifically for older adults (Sayago et al., 2019). In Mohsin et al., (2022), participants were asked on their opinion on the usage of digital game among older population. The participants in the study point out that playing digital games does not give benefits towards their population and wasting their time.

One of the participants in the Mansor, Chow, and Halaki (2019) study, stated that she does not like games even though she know that the game will give enjoyment and beneficial for her brain function. This kind of enjoyment is related to the motivation factor, where some of them think that playing with digital games are a waste of time. The key to the usage of digital games application among older adults is their understanding on how the digital games can give benefits to them.

Chin, Lim, and Lee (2017) found that older adults are only interested in digital games that are relevant to their daily routines. Their study stated that the Bingo Game has less relevance to older adults' routine and some of the participants have faced difficulty understanding the game.

Result from interview conducted by Schell, Hausknecht, and Kaufman (2015) showed that one of the challenges affected by their participants is the sound effect produced by the Wii Bowling that had distract them from focussing during the gameplay. Brown (2017) focussed on identifying the aspects that influences older adults who restrained themselves from digital game engagement. The result revealed that older adults who participated in their study are not interested in digital games and feel the game engagement is too challenging for them.

Spatial cognition is related with the cognitive issues. Older adults might have affected the decline in processing new information. In Zadeh, Veloso, and Pereira (2019), they developed and evaluated multitasking digital game with 10 participants, which consists of older adults aged 66 to 80 years old in Portugal. Based on the result obtained from the post-test questionnaires, only 20% of the participants have answered the question related with the name of the game is correct. The researchers indicated that the text contained in the

game is not noticeable by the older adults as they might have face eyesight problems. A study by Schell et al. (2015) stated that one of the participants has impaired vision which might have affected gameplay session.

Motti, Vigouroux, and Gorce (2015) have identified that older adults experienced issues with using devices embedded with touchscreen technology. In order to overcome the problem, they evaluated the effect of the accuracy requirement specifically for older adults aged 65 to 86 years old, the drag and drop interaction. Based on the result, the lower the accuracy requirements embedded into a puzzle game, the lower the errors made by the older adults. Furthermore, when compared to someone unfamiliar with touch screen technology and has difficulty with vision correction, older adults who are familiar with touch screen technology and adequate sight correction, will have made fewer mistakes.

Older adults refuse the usage of digital game technology as they do not have any or limited knowledge of the platform used for the digital games (Brown, 2017; Kaufman et al., 2016; Merilampi et al., 2017). Moreover, Jali and Arnab (2017) suggested that the perspectives on the perceived difficulties and benefits of digital gaming are influenced by older adults confidence barriers related to their first impression, their perception of engaging with something new (i.e. technology), and their perspective towards the relevance of technology. Furthermore, Merilampi et al. (2017) highlighted that touchscreen technology is a new technology for older adults as they did not know how to use the function in the devices. Based on their observations, the researchers discovered that some of the participants were holding the tablet in an incorrect posture, as they were repeatedly placing their holding thumbs on the screen while typing. Aside from that, the researchers discovered that the participants exerted excessive effort while pressing the screen, which may cause the devices

to malfunction. Another challenge highlighted by Toprac and Hair (2016), is that some older adults do not prefer games as a platform for health management tools. The result from their pre-test and post-test studies revealed that 7 out of 26 participants did not prefer games or any digital media. One of the participants stated that he had difficulty in operating the tablet computer's touch screen as he experienced exacerbation of arthritis in his fingers.

Another negative aging impact that affects older adult daily activities is hearing problems. The game developed by Zadeh et al. (2019) named as Mr Dustman has only one specific audio setting. This might become problem for older adults who faced hearing problems as they might not adjust the volume in the game and might affect the gameplay session. Two of the participants in their study were having hearing problem, therefore the unable get better understanding on the audio feedback given in the game. Older adult with a history of surgery such as carpal tunnel surgery might have difficulty interacting with digital that requires their body movement (Schell et al., 2015). Another factor that is concern older adults to interact with digital game especially game that need physical interaction is body balance and chronic injuries. Some of them might have trouble during the gameplay sessions.

2.7 Game Experience versus Design Considerations

The commercial digital games in the market are developed and designed specifically for the younger user. On the other hand, older adults may have trouble adjusting to and enjoying digital games as a result of the adverse effects of ageing. Therefore, when designing and developing digital games, particularly for older individuals, a few design considerations must be considered to alleviate the issues.

Game designer should avoid designing a game with a timer as game goal. Recent evidence suggests that games should be designed with a slow timer to ensure the target

audience able to cope with the game and enjoy the game throughout the gameplay (Nap et al., 2015).

Zadeh et al. (2019) developed and evaluated the multitasking digital game for older adults. The game is named “Mr Dustman”. Based on the results obtained from the post-test questionnaires and discussion conducted with the participants in their study, only 20% of participants out of 10 participants managed to answer correctly the question asking the name of the city in the game. They indicated the text in the game is not noticeable for older adults who experience poor eyesight or have concentrating problem. The text in the game should be larger in size to occupy the needs of older adults who suffer visual impairment.

2.8 Impacts and Benefits of Digital Games Towards Older Adults

Most studies that used exergame were focusing on the benefits of the game towards older adult’s physical performance. Exergame is a type of game that combining exercise activity in a form of digital games and require physical activities perform by the player. Physical performance is including the ability to do physical activities without or less assistance from other people. Digital games can be used as a tool for rehabilitation purpose. A study by Dias, Veloso, and Ribeiro (2019) evaluates the digital game developed for rehabilitation with 4 older adults, who have history with stroke. They used leap motion game, which captures and track hand movements of the player in their studies, called “a Priest in the Air” to observe the performance of the participants. In different study conduct by Awad and Craig (2017), they also stated that exergame can become a new platform for rehabilitation and at the same time allow socialisation between the players.

Cruz, Kugel, Hewitt, and Salamat (2018) aimed to investigate the perception of older adults toward video games by using a custom-built interactive video game (IVG). Based on

results in their study, participants engaged with the game due to the positive impacts of the game, where it brings excitement and enjoyment for the players. *Coin Catcher* game used in the study has improved the participants' balance and help them to think and decide quickly.

Besides that, digital game can helps and encourage older adults with physical disabilities to perform exercises based on the suggestions by their therapist (Pyae, 2017). This view is supported by Wiemeyer and Kliem (2012) who stated that the game can help to improve older adult's health by enhancing physical fitness and coordinate abilities through combining fun and motivation experience.

As people become older, there are many negative aging impacts faced by them such as cognitive impairment, hearing and visual impairment, and reduce in mobility (Astell et al., 2014). Digital games have potential act as cognitive training tools to mitigate the decline of cognitive capacities (Zhang & Kaufman, 2016; Mansor et al., 2019). Chi, Agama, and Prodanoff (2017) developed a digital game to support the cognitive enrichment on older adults, called "Smart Thinker" as shown in Figure 2.3.

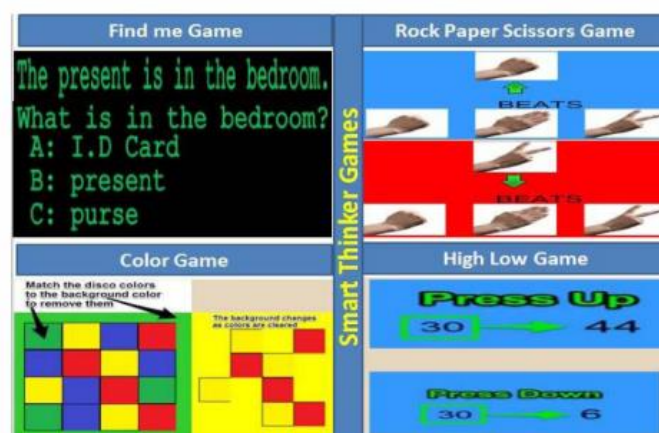


Figure 2.3: Smart Thinker Game (Chi, Agama, and Prodanoff, 2017)

Based on the results they obtained from the collection of data using questionnaires and informal meeting, they found that *Smart Thinker* has the potential to enhance memory

and attention skills among the participants. 45% out the participants stated that *Smart Thinker* helps for their short-term memory.

Digital games can provides the enjoyment to users (Hongmei et al., 2017; Radhakrishnan et al., 2016; Schell & Kaufman, 2017; Zhang et al., 2017) and helps in social interaction among the players (Awad & Craig, 2017; Kaufman & Sauve, 2019; Merilampi et al., 2017; Zhang et al., 2017a; Zhang et al., 2017b). Digital gaming is a technology driven to improve the enjoyment of life, whether played alone or in group (Schell et al., 2015).

Zhang, Hausknecht, et al. (2017a) investigated the effect of Wii Bowling tournament on older adults' perception towards digital game and the factors affecting the game experiences among older adults. Their study consisted of 142 older adults as the participants, aged 60 years and above. Based on the result obtained from the pre and post questionnaires, they found that digital game provide enjoyment, social support and help in enactive engagement.

Studies by Astell et al. (2014), Dupl  a, Kaufman, Sauv  , Renaud, and Ireland (2017), IJsselsteijn et al. (2007) and Kaufman et al. (2016) stated that the digital games enhance seniors' lives. In Malaysia, the most common retirement age is as early as 56 years old. Most of the time, older adults spend their time at home alone without socialising with society due to some constraints such as limited time to spend with their family and friends as they live in different house. In order to overcome the problems, the digital game helps older adults to connect with other players through online gaming and maintain their social relationships (Yeh et al., 2019).

Apart from excitement and enjoyment, the digital game also helps older adults to gain and valued new knowledge while playing it. Nap et al. (2015) claimed that most of the

participants in their studies learned new knowledge and stated that the game experiences is one of the learning experiences for older adults. In Guimarães, Pereira, Oliveira, Carvalho, and Peixoto (2018) studies, they identified exergame is an aid to help older adults to learn the correct steps to perform the exercise. Apart from that, they can learn and engage with new digital technology by playing game (Oppl & Stary, 2018).

Study conducted by Loos and Zonneveld (2016) with 15 older adults, aged 50 and above showed the participants learned new knowledge while playing the game. Based on the interview conducted among the participants, they stated they learn how to perform the correct way to exercise while playing digital game using Microsoft Kinect Xbox. A serious game developed by (Radhakrishnan et al., 2016) helped in improving older adults in self-management knowledge. There are few knowledge elements learned by participants, include heart failure (HF) self-management in domains of diet, physical activity, medication, symptom monitoring, and crisis recognition (Radhakrishnan et al., 2016).

2.9 Framework

In this section, three types of frameworks for designing serious game will be discussed. The first framework is EMOTION framework designed by Malliarakis et al. (2018). The second framework is Serious Game Design Assessment (SGDA) framework designed by Mitgutsch and Alvarado (2012). The last framework is Design, Play and Experience (DPE) framework is created by Winn (2009).

2.9.1 EMOTION Framework

EMOTION is a framework designed by Malliarakis et al. (2018). It is essential to keep instructional material connected to emotional context. According to Malliarakis et al. (2018), emotion in games can be implemented through three aspects, include emotional

context, emotional dialogue, and emotional interface. There are four factors to integrate emotion into learning content, include the game purposes, the purpose, target audience and term of use. EMOTION framework consists of seven elements, as shown below:

E- Engaging game

Engaging is the main element for EMOTION framework. Malliarakis et al. (2018) stated, the successful serious game should engage people, motivate action, promote learning, and solve problem. The game should have attractive and immersive scenario to engage player during gameplay session.

M- Motivation

There are two motivational factors for every serious game, include curiosity and challenges.

O- Opportunity of mastery

Players want to achieve goals and get better by experience meaningful growth. The game should be design with something that simple and easy, and if there are progress by the player, the level of difficulty of the game should be increase. Apart from that, the results presenting feedback that direct the next level should be displayed to the player itself to keep the players engaged during gameplay.

T- Theme and story

Apart from opportunity of mastery, the theme and story element are important to allow players to experience the game. The game should be designed with stories and plot

serves as a form of escapism. The important factor in this element is, there is no delay in its responds and able to produce appropriate feedback.

I- Intriguing learning

Malliarakis et al. (2018) defined intrigue as arousing the curiosity or interest of something. By implementing intrigue in game-based learning, it can captivate and keep player's interest during gameplay.

O- Objectives

According to Malliarakis et al. (2018), educational games that have been developed with the aim of learning by gaming, and serious games that more fundamentally are based on specified learning outcomes.

N- Natural flow between learning and fun

This element underlined the importance of the game flow, as a defining element for the success of an educational gameplay.

2.9.2 Serious Game Design Assessment (SGDA)

Serious Game Design Assessment (SGDA) framework is designed by Mitgutsch and Alvarado (2012). SGDA framework offers a structure to study the formal conceptual design of serious game in relation to their direct and indirect purposes (Mitgutsch and Alvarado, 2012). It consisted of six main components of the formal conceptual structure underlying, include purpose, content and information, game mechanics, fictional and narrative, aesthetics and graphics, and framing. The relationship between six components are impacts

the cohesiveness and coherence of the formal conceptual design of the holistic game system.

Figure 2.4 depicts the SGDA framework.

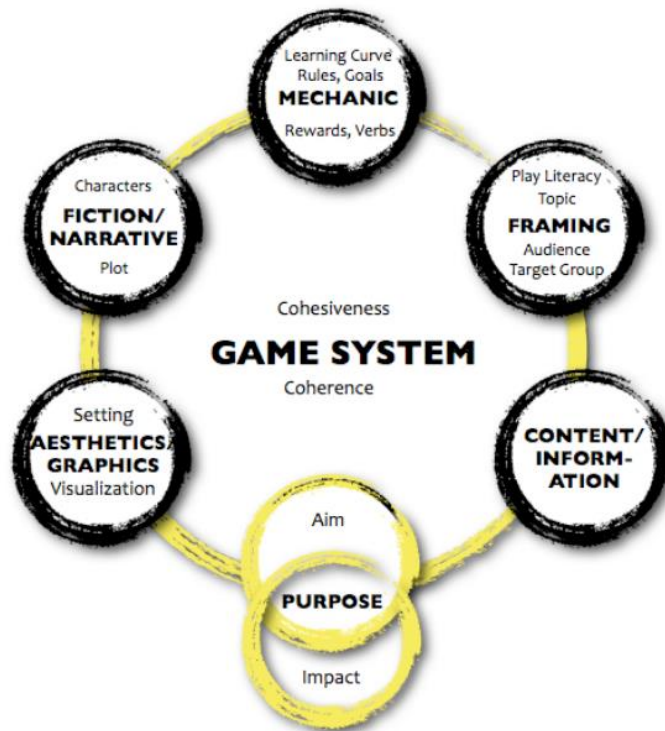


Figure 2.4: Serious Game Design Assessment (SGDA) Framework (Mitgutsch & Alvarado, 2012)

Purpose

Mitgutsch and Alvarado (2012) stated that the initial stage to design a purposeful game is from the investigation of the purpose of the game and how it impacts the player. Every game has its goal, and game designer should follow the explicit or implicit intention during designing the game. A serious game that has no impact to the player has missed the pivotal purpose (Mitgutsch & Alvarado, 2012).

Content and Information

Every content and information in the game must be visible and player can interact with it. According to Mitgutsch and Alvarado (2012), not all content is necessary to be relevant to the game.

Game Mechanics

Game mechanics in SGDA framework are include the pivotal in-game goal of the game, the operation of the reward system, the main playful obstacles and challenges, the difficulty balancing and win condition.

Fictional and Narrative

In SGDA framework, it focusses on the created fictional space and how it relates to the game purpose.

Aesthetics and Graphics

Aesthetics and graphics are fundamental to introduce game purpose and impact to the player. Mitgutsch and Alvarado (2012) refer aesthetics and graphics to the audio-visual language, conceptualised, where it was chosen by the game designer for visualisation and display the elements in the game. It consists of information, the world and character of the game, target group and instruction and reward.

Framing

Mitgutsch and Alvarado (2012) points out all components include purpose, content and information, mechanics, fiction and narratives, and aesthetics and graphics should be

frame together in term of their target groups, play literacy and the broader topic of the game. According to Mitgutsch and Alvarado (2012), play literacy of the player can influence the gameplay experience.

Coherence and Cohesiveness of the Game System

Every component in SGDA framework are related to each other and to the game's purpose. Mitgutsch and Alvarado (2012) conclude that SGDA framework is an integral entity that encircle the design element to produce the gameplay experience among players.

2.9.5 Design, Play and Experience (DPE) Framework

Design, Play and Experience (DPE) framework is created by Winn (2009). It was created as an expansion for MDA framework (Winn, 2009) to highlight the needs of serious game design for learning. DPE presents the language to describe design, methodology to analyse a design and a process to design a serious game for learning. Figure 2.5 depicts the DPE framework.



Figure 2.5: DPE Framework (Winn, 2009)

DPE visualise the relationship between designer and player. A designer is responsible to design the game, meanwhile player is responsible to play the game. As results, the player can experience during the gameplay. The designer has direct control over the design. According to Winn (2009), the designer should issue game goals for resulting experience during design of a game. Based on Figure 2.5, the arrow from experience to

design depicts the effect of goals on the original design and the iteration process until the game is tested against the experience goal. Figure 3.3 shows the extended DPE framework.

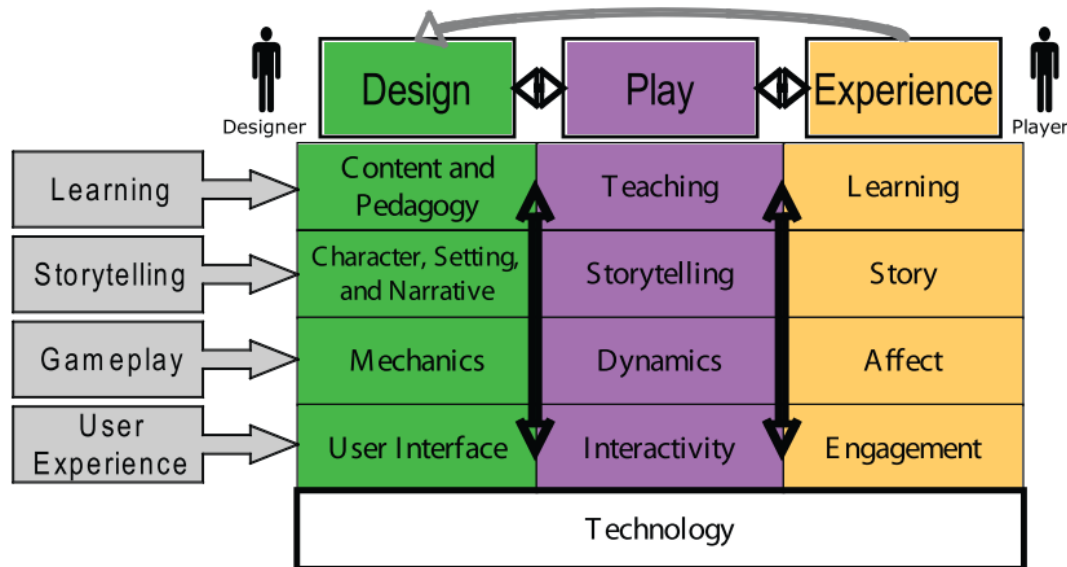


Figure 2.6: Extended DPE Framework (Winn, 2009)

There are four main layers in the extended DPE framework, consisted of learning, storytelling, gameplay, and user experience. The upper layer, learning layer is a layer for the designer to design the content and embedded pedagogy theory. The outcome of the game should be able to make the player learning throughout the gameplay and the learning outcome is derived from the player's experience. Storytelling layer is a layer for the designer to embed the story in the game. The story embedded in the game will combine with player's interaction during gameplay and resulting in the experience crafts the player's story. The designer should choose on type of story they want to create for the player to experience and design the setting, character design and narrative to achieve this.

Gameplay layer is a layer to describe player's behaviours in the game. It consists of three elements, include mechanic, dynamic and affect. *Mechanic* consists of the rules for the operation in the game, the player's activities, challenges they experience and goal. *Dynamic*

is the action that occurs when the rules are embedded over time with the influence of the player's interaction during gameplay. Meanwhile, *Affect* is where the experience or emotion is derived from the player during gameplay.

User experience layer is the deepest layer in the framework, the layer that can be seen by the player. According to Winn (2009), everything the user sees, hears, and interact with and how is where the interaction occurs.

2.10 Similarities and Differences between Frameworks

The similarities between EMOTION framework, SGDA framework and DPE framework is, it is developed to design serious game. Serious game is a game designed to serve for primary purpose apart from entertainment. To ensure the usage of digital games is utilised by the older adults, it is important to design it with purpose apart from entertainment.

EMOTION framework designed by Malliarakis et al. (2018) is focussed on emotional background and relate with the six key principles of andragogy. SGDA offers a structure to study the formal conceptual design of the serious game in relation to their direct and indirect purposes. The purpose of DPE framework designed by Winn (2009) is as a guideline to design serious game for learning purpose.

In SGDA framework, authors define aesthetics and graphics as the audio-visual language, conceptualised, chosen and developed by the designers for the visualisation and the display of the elements involved in the game (Mitgutsch and Alvarado, 2012). According to Wang et al. (2019), the design of the game interface gives impacts to older adults' interest to try the game. To cope with the challenges faced by the older adults, such as decline in cognitive and physical abilities, the interface should be design simple and easy to access

(Garcia et al., 2018; Gerling et al., 2012; Pappas et al., 2019; Wang, 2016). Apart from that, the game should be user friendly and interactive to attract older adults' attention (C. T. Lin & Chuang, 2019). Wang et al. (2019) found that older adults who experienced eye and ear impairment are interested to game that allow them to control the font, colour, and voice setting. Table 3.1 provides a tabular comparison of the three extant frameworks which are the EMOTION framework, the SGDA framework, and the DPE framework.

Table 2.1: Comparison between EMOTION, SGDA and DPE

	EMOTION	SGDA	DPE
Similarities	Developed to design serious game		
Differences	Focussed on emotional background	Offers a structure to study the formal conceptual design of serious game in relation to their direct and indirect purposes	Presents the language to describe design, methodology to analyse a design and a process to design a serious game for learning
	Relate with andragogy principle		Relate with pedagogy
	7 key elements	8 key elements	3 key elements (expansion of MDA)

EMOTION, SGDA and DPE were developed for serious game which does not focus on older adults and andragogy. Although EMOTION can be seen focussing on andragogy, it does not give the guideline on design which a crucial part for designing digital games for older adults. Designing digital games for older adults required the combination of design guidelines for each element in the game especially the interface, selection of suitable platforms and andragogy to ensure the older adults utilise the usage of the digital games.

2.11 Guidelines on Designing Digital Games for Older Adults

There are many aspects need to consider when designing digital games specifically for older adults, which includes impact of the game content, genres and benefits gained from

engaging with digital games (Kathrin M. Gerling, Schulte, Smeddinck, & Masuch, 2012). In a study by Gerling et al. (2012), a set of guidelines on how to design digital games for older adults was listed based on the structural games model of games in Figure 2.7.

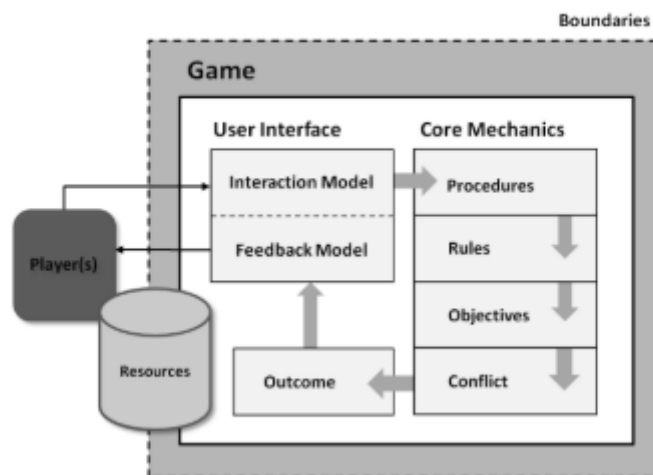


Figure 2.7: Structural Game Model (Gerling et al., 2012)

The guidelines given is considering the effects of the age-related changes of the player itself, which consisted of older adults. There are four domains emphasised in the guidelines given, which include players and resources, user interface, core mechanics and outcome.

Players and Resources

In this domain, player is defined as the one who will experience and engage with digital games, which is older adults. Resources is the ability of the player itself. It is crucial to design for a target group with limited gaming experience. There are many aspects that need to be considered and addressed for this group, such as portray interesting visual sceneries or designing digital games with something familiar by the target group. In term of

resources, the in-game challenges or mechanics should not be as restrictive as digital games which targeted for younger user or experienced player.

User Interface

User interface represents the devices used to engage and the interface offered by the devices. The devices selection must be able to cope with the negative ageing impact. They might have experiences with difficulty to handle game controller while pressing the button in it when playing digital games. Apart from the device's selection, the graphical interface which in-game screen or interface must be able to adjust the challenges or older adults such as the font size, audio, and colour selection.

Core Mechanics

In core mechanics, the procedure, rules, objectives and conflict, and the challenges for player to experience in the game is included. The procedures and the rules in-game should be design simple and easy to understand by the player to facilitate them in learning process. The process to input quick sequential reaction and parallel input need to be avoided to ensure there is no excessive cognitive load need to be processed by the player. The game objectives play the important roles on the direction of the game effects; therefore, it must be clearly defined.

Outcome

The outcome is dependent on how the digital game is designed. It is important to consider limitation of the player to ensure the positive outcome such as players' enjoyment, learning process and objectives is achieved.

2.12 Summary

This chapter covered the literature review related to topic covered in this thesis. There are two main topics covered in this chapter, the concept of andragogy, adult learning theory and the andragogical perspectives in digital games. The second part of this chapter covered the existing framework to design and develop digital games. Andragogy is an art and science to let adult learners to learn something new for them. By adopting the principles of andragogy in the process of designing and developing digital games for older adults, there is potential for older adults to utilise the usage of the digital games itself. There are three existing of framework that developed for designing serious game, however it does not compliment the andragogy and elements design specifically for older adults.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the research methodology for this study. The research design for this study is well explained with the selection of methods and techniques used for data collection. Section 3.2 described the research design and techniques used for data collection in brief. Section 3.3, Section 3.4, Section 3.5 and Section 3.6 discussed in detail the process of each stage for research design in this study. Section 3.3 to Section 3.5 summarised the target group, research area and the recruitment process in this study. Section 3.6 described the instruments used to measure and validate the effectiveness of the constructed guideline. A detailed data collection method and data analysis is described in Section 3.7 to Section 3.8. Section 3.9 describes the data protection in this study.

3.2 Research Design

This study adopted mixed-method design as research design. It consisted of four stages and combination of qualitative and quantitative method. The purpose of mixed method study is to investigate older adults' views with the intent of using this information to construct guideline for designing digital game specifically, to obtain statistical, quantitative results from a sample.

Combining quantitative and qualitative data allow researchers to probe or explore the results in more depth and to get better understanding on the research problem (Creswell, 2003). Apart from that, the adoption of mixed-method research design is to improve the

effectiveness of data collection and to detail the research information gathered from the different sides.

There are two techniques used to collect data for this research study as listed below:

- i. Qualitative: Demonstration, gameplay, observation, informal interview
- ii. Quantitative: Questionnaires

Table 3.1 described the data collection techniques used in this study. Refer Section 3.6 for further explanation process of each technique used in this study.

Table 3.1: Methodology description

Method	Description
Demonstration	Demonstration how the game will work and how to play and familiarise with the application to the target group.
Gameplay	Allowing the target group play with application and familiarise it.
Observation	Observe the whole process during gameplay session.
Informal Interview	Conduct interview with random older adults who involved with the study.
Questionnaires	Disseminate a set of questionnaires during pilot study and further investigation process.

There are four stages in our research design, include literature review, pilot study, further investigation and validation, and result and validation. Figure 3.1 shows the research design.

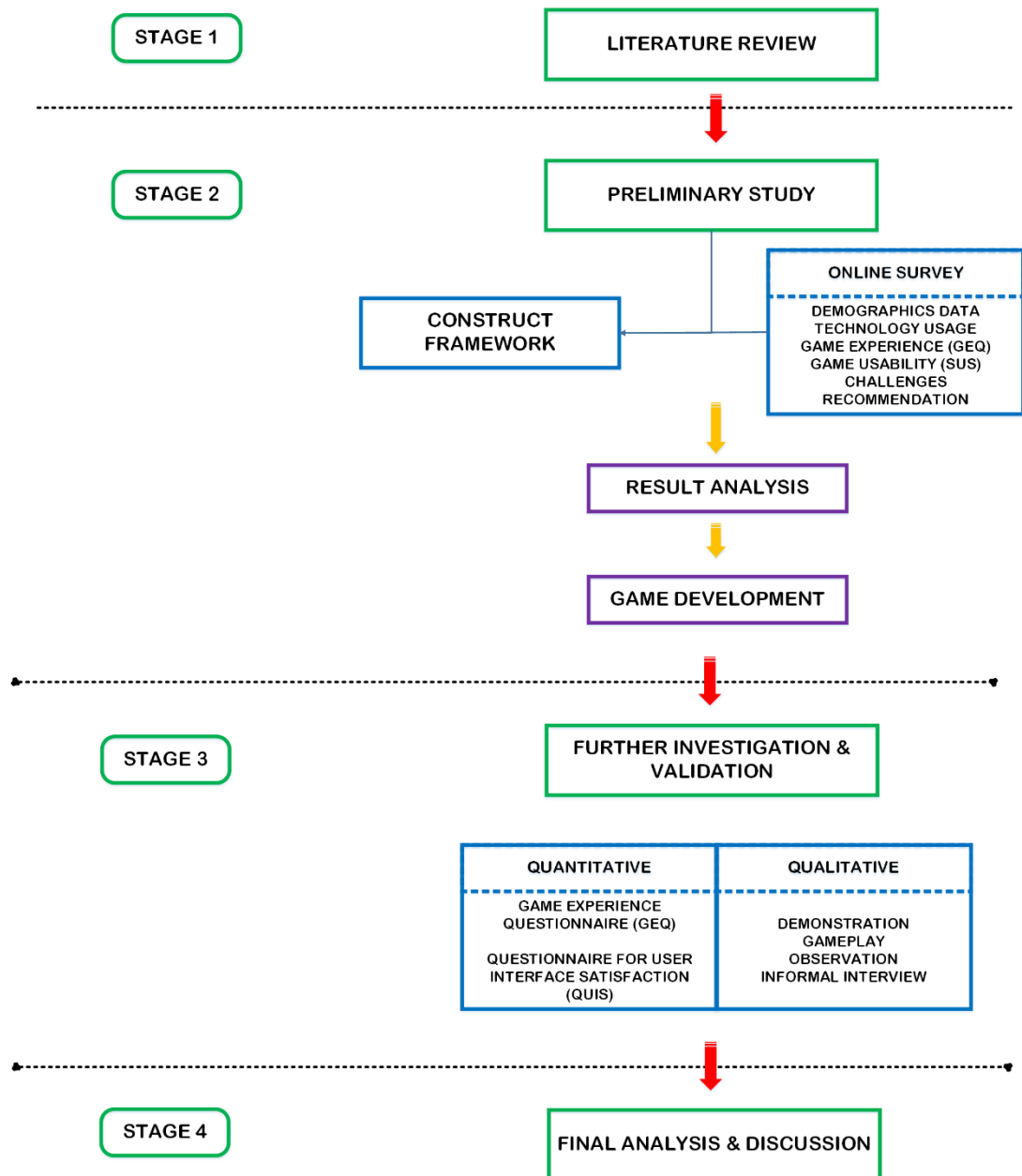


Figure 3.1: Research design

3.2.1 Stage 1: Literature Review

The first objective in this study is to identify component/element on designing and developing digital games for older adults based on the interaction and experience using andragogical perspective. In this stage, intensive literature reviews were conducted based on keywords used for this study. Previous studies related with older adults, challenges face by them when interact with digital game, benefits gained from digital games, andragogical

perspectives, game design and attributes are discovered without limitation years of study. The purpose of Stage 1 in this study is to investigate the gap between studies related with older adults and digital games. This stage is important for this study to highlight the recent issues and factor that influencing the development of digital game specifically for older adults. In addition, Stage 1 helps researchers to identify the specific game design and attributes for older adults. An intensive literature review is conducted based on the keywords listed for this study.

A systematic literature review was conducted in this stage using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) which developed by (Moher, Liberati, Tetzlaff, & Altman, 2009). There are four stages involves in PRISMA, identification, screening, eligibility and included. Figure 3.2 depicts the PRISMA flow diagram used during this stage.

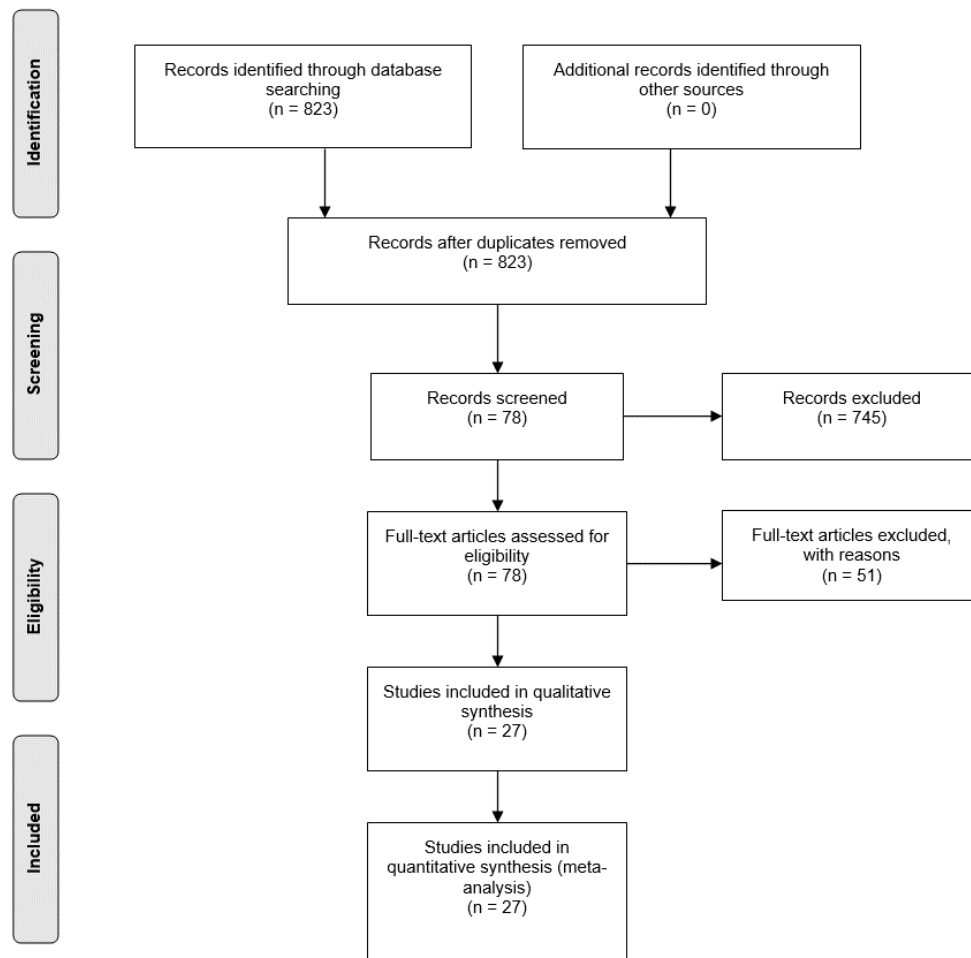


Figure 3.2: PRISMA Flow Diagram

The initial paper found in the Scopus database based on the keyword search was 823 papers. In the screening process, only 78 papers are included, and 745 papers are excluded based on the exclusion on the publication year, area of study, type of articles, and languages used in the papers. After screening process, only 27 papers are included and analysed in the systematic literature review paper. There are four data are analysed in this paper, game platform and technology, challenges related to older adults, benefits of digital games towards older adults and research purpose and methodologies used by the previous researchers on how to conduct study with older adults. This paper title is “Older Adults and Digital Game:

Trends, Challenges and Benefits” and has been presented and published in in 2021 IEEE Asia-Pacific Conference on Computer Science and Data Engineering (CSDE).

3.2.2 Stage 2: Preliminary Study

Stage 2 is where pilot study is conducted. The purpose of pilot study is to identify the game experience and consideration within Malaysian citizen aged between 55 and 75 years old. Two approaches used to conduct pilot study in Stage 2, online survey, and informal interview. There are two objective that needs to be achieve in this stage: to identify component/element on how to design and develop mobile digital games specifically for older adults based on interaction and experience using andragogical perspectives and to construct a guideline to design and develop mobile digital games specifically for older adults.

The process of identification of the components or elements to design and develop mobile digital games is continued from stage 1, intensive literature review. In stage 2, a preliminary study with older adults using two different methods, consisted of online survey and informal interview.

Figure 3.2 depicts the procedure occurred in Stage 2 in this study. The process of data collection and construction of guideline are in parallel, where it occurred in same time. The process of constructing guideline start from the intensive literature review in Stage 1 and online survey. There are four quadrants in the proposed guideline in this study (refer to Chapter 5), where it formed based on the data gathered from Stage 1 till Stage 2. The second quadrant (design) is considering the preferences of participants in this study.

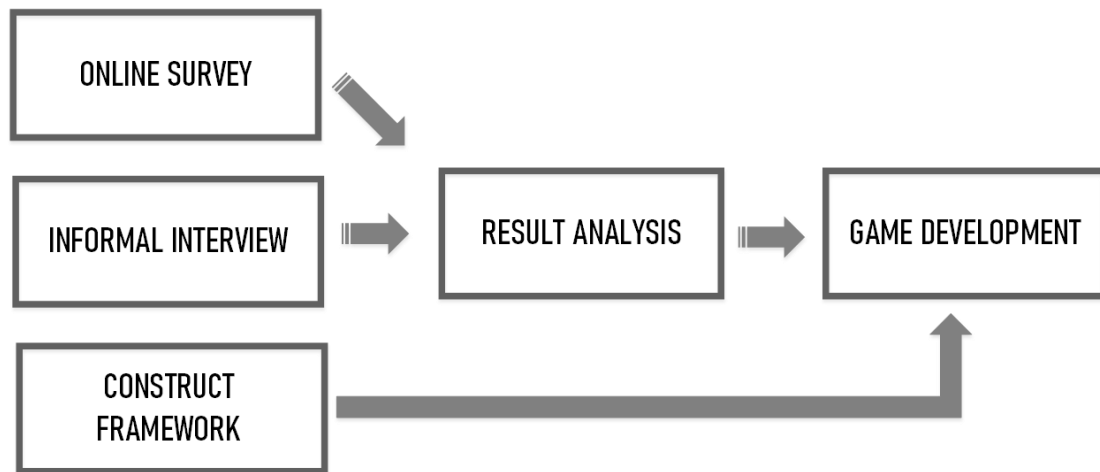


Figure 3.3: Stage 2 procedure

Respondents for the online survey were recruited using convenience and snowball technique. Researchers recruited respondents through online platform such as Facebook, LinkedIn and WhatsApp group. The process to recruit respondents in Stage 2 was carried out from March 2020 to January 2021. The selection of the respondents is limited to the requirement set by the researcher. Below is the list of the requirement listed by the researcher:

- Malaysia citizen aged 55 years old and above.
- Have experience plays with digital games (non-experience respondents are invited to share their thought on digital game).

There are 81 respondents were recruited during preliminary study. However, only data from 56 respondents were eligible in this study. There are few studies with same range number of respondents by previous researcher (Hersh & Leporini, 2019; Hongmei Chi et al., 2017). Another round of preliminary study was conducted to recruit participants for informal interview. The requirement for the informal interview is different from the online survey. Participant who participated in the informal interview session must be aged above 55 years

and have experience playing with digital games. Only 4 participants recruited for the informal interview session and there is one past study using small number of participants to conduct interview with older adults focused on human-computer interaction (HCI) (Zainal, Ahmad, & Razak, 2013).

Google form is used as a tool to collect data from online survey. A set of questionnaires with two different language (English and Malay language) was published in the google form to be distributed to target group. The requirement to participate in the online survey are Malaysian, reside in Malaysia and aged 55 years old and above. The survey is distributed using Snowball sampling and Convenience sampling technique. The rationale of choosing these two sampling technique is to gather more people to participate in our study and the target group is easier to approach (Taherdoost & Group, 2017). There are a few approaches used to gain respondents in pilot study, include sharing the link with friends and families, social media, and email to target group.

The questionnaires are consisted of demographic data, technology usage, game experience, game usability, challenges, and recommendations. The questions in the questionnaires are adopted from Game Experience Questionnaire (GEQ) and System Usability Scale (SUS) (Refer to Appendix D). There are few studies using (Boletsis & McCallum, 2016; Nap et al., 2015), SUS (Guimarães et al., 2018) and combination of GEQ and SUS (De Oliveira Santos et al., 2019) to conduct study with older adults on their interaction and experience with digital games. SUS questionnaire is effective and efficient to evaluate the usability of the game (Lewis & Sauro, 2018; Nuswantari et al., 2020; Peres et al., 2013). Data obtained from preliminary study is analysed using statistical analysis. The

data is processed in SPSS software. A statistical result is discussed based on the finding from the online survey.

An informal interview with older adults was conducted through phone call. Conversation during the interview was recorded with the consent from the participant. Older adults with experience with digital game were invited to join informal interview session. A set of questions related to their previous gaming experience were asked during the session. Data collected from the interview were analysed.

Results obtained during preliminary study (Stage 2) and intensive literature review (Stage 1) are used to develop digital games specifically for target group in this study. An application named Otak Me! was developed based on the guidelines in the constructed guideline. Please refer to Section 6.4 for description of Otak Me! application.

Results from the analysis and literature review is used to construct a guideline for designing and developing digital game specifically for older adults. The constructed guideline will be used as a guideline to design and develop digital game, and the digital game will become a tool to evaluate the effectiveness of the constructed guideline.

An application is developed in this stage, which named as Otak Me! application. The process on the application development is by using waterfall model, where it starts from planning to testing. In the planning phase, data gathered and listed in the guideline is used to develop the application. The application was designed based on the guideline constructed. Otak Me! application was developed using Unity software and run in Android mobile application. There are three different games embedded in the application, consisted of Trivia, Puzzle and Paint. The games serve different purpose for the player. Otak Me!

application was tested among participants in this study, consisted of 16 older adults. The process of testing is conducted in the Stage 3, further investigation and validation.

3.2.3 Stage 3: Further Investigation and Validation

In this stage, the process of the constructed game design and development guideline validation is conducted by testing the Otak Me! application with recruited participants consisted of 16 older adults. In this stage, mixed method between qualitative and quantitative method is used. A few studies with small number of participants and combination method has been conducted by other researchers (Chin et al., 2017; Garcia, Raffe, & Navarro, 2018b; Jali & Arnab, 2017b).

Recruitment process in Stage 3 is by using snowball and convenience sampling. Participants from the preliminary study in Stage 2 were invited to participate in testing phase. Apart from that, new participants were recruited to participate in testing phase. Below is the list of the requirement.

- i. Live in Malaysia and aged 55 years old and above.
- ii. No prior gaming experience required.

Figure 3.4 depicts the process on how the application testing procedure been conducted. There are five procedures to conduct the testing process, consisted of demonstration, gameplay, observation, questionnaire, and informal interview.



Figure 3.4: Stage 3 procedure

The flow for testing as shown in Figure 3.5. Testing procedure is sliced into three partitions: before, during and after. Prior the session, participants will be given a set of consent form along with the questionnaire, video (demo), and a set of Android Package APK file.

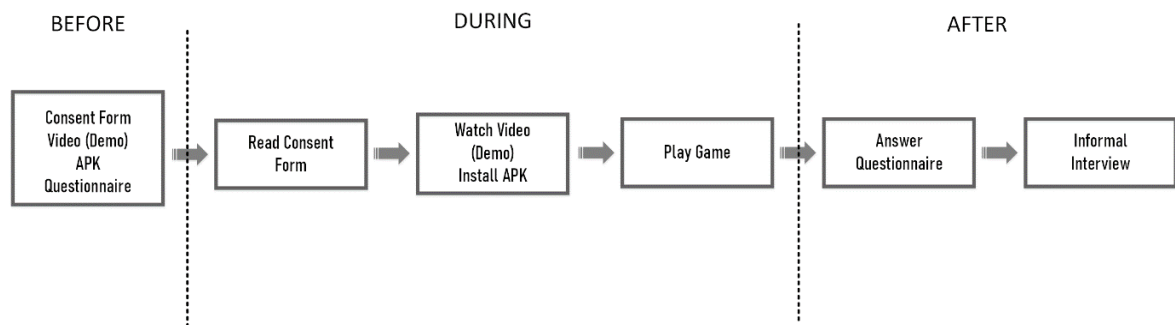


Figure 3.5: Testing procedure

Due to movement control order (MCO) in Malaysia, a face-to-face testing is not an option due to the target group is a higher risk to get infected with the Covid19 virus. Participants need to read and sign the digital consent form given to them before the testing procedure.

Researcher will demonstrate the game prototype to the target group before letting them use it during gameplay session. To make the demonstration process successful without the present of researcher, a recorded video on how the game work was given prior the session. The rationale of demonstration process is to ensure player understand the instruction and function in the game prior gameplay session (Chin et al., 2017). Player's understanding of the game instruction and function influences the game experience. The video includes

how the application work and which button they need to press during gameplay session. Player able to start learn game mechanisms by view and refer the video demonstration (Zhang et al., 2017b).

Every older adult who participated in the testing phase will experience using the Otak Me! application. Gameplay session was recorded to observe how older adults react using the game prototype. The purpose of observation is to understand player's UX during gameplay session by observing player's verbal and non-verbal behaviours (Law & Sun, 2012).

A set of questionnaires consisted of demographic questions, Game Experience Questionnaire (GEQ), Questionnaire for User Interface Satisfaction (QUIS) and open-ended questions (i.e., recommendation) will be distributed to the target group at the end of gameplay session. There are few studies used GEQ (De Oliveira Santos et al., 2019; Santos et al., 2019) and QUIS (Jali & Arnab, 2016, 2017b) to measure gaming experience and usability of digital games with older adults.

In the end of testing session, an informal interview was conducted to gather participants' opinions about the game prototype, their challenges while using the game prototype and recommendations on how to improve the design especially for their target group. The advantages of interview session is, it helps researchers to understand players perceived the learning value of the game and player's opinion whether it suitable to use for learning process based on the game design (Law & Sun, 2012). In addition, researchers can discover and acknowledge player's first hand experienced expressed by them (Astell et al., 2014; Poels et al., 2007). In Zainal, Ahmad, and Razak (2013) study, interviewing technique can help researchers to understand the confusion experiences among older adults during

gameplay session. They also suggested the interview session duration between 30 minutes and less than one hour to avoid ineffective session with older adults.

3.2.4 Stage 4: Final Analysis and Discussion



Figure 3.6: Stage 4 procedure

Data collected from Stage 3 were analysed. The results are compared, and results validate the effectiveness of the constructed guideline. Details result analysis is discussed in this Stage 4. The test to determine the validity and consistency of similar items on GEQ and QUIS used in Stage 3 is using Cronbach's Alpha.

3.3 Older Population in Malaysia

The main target group in this study is older adults aged between 55 years and above. The population of older adults aged 55 years old and above in Malaysia is increased from years to years and estimated by 2030, 15% of the population in Malaysia is older population. There is potential of digital game in healthcare platform that can bring beneficial towards older population.

3.4 Research Area

Malaysia population is the general population selected for this study. The selection of research area was influenced by the locality of the researcher and this study is focussed on the interaction and experience of older adults in Malaysia with digital games. In Stage 2 of this study, respondents were dominants from Sabah and Sarawak. Sabah and Sarawak are in East Malaysia.

3.5 Instruments

As mentioned in Section 3.2, this research adopted mixed-method design. There are three different instruments used to collect data for quantitative. In this study, we used three established questionnaires, Game Experience Questionnaires (GEQ), System Usability Scale (SUS) and Questionnaire for User Interaction Satisfaction (QUIS) to evaluate the effectiveness of the constructed guideline via the development of prototype (digital game).

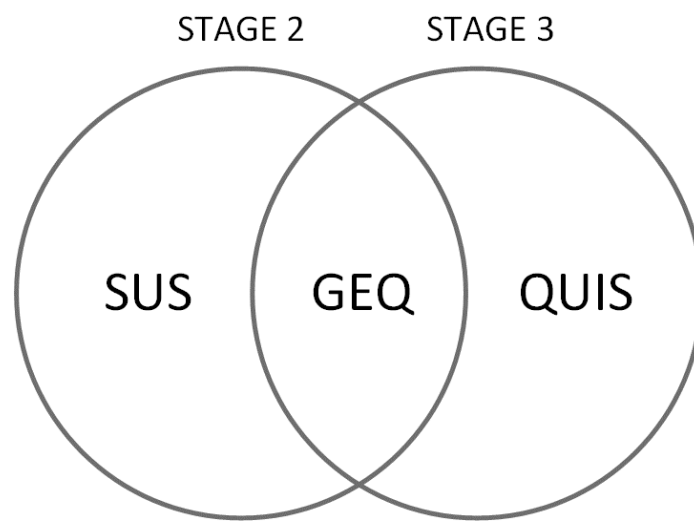


Figure 3.7: Instrument used in Stage 2 and Stage 3

3.5.1 Game Experience Questionnaire (GEQ)

To assess the player's experience during gameplay session, Game Experience Questionnaire (GEQ) is used. This questionnaire is adapted from the previous study, and developed by Ijsselsteijn et al. (2008). It has three modular structure and consists of core questionnaire, social presence module and post-game module (W. A. Ijsselsteijn, de Kort, and Poels, 2013).

Core questionnaire is consisted of 33 items, and it used to measure player's experience include immersion, flow, competence, tension, challenge, positive affect, and negative affect during gameplay session.

The second module which is social presence used to investigate psychological and behavioural involvement of the player with other entities such as virtual, mediated, and co-located. There are three elements measured in this module, include empathy and negative psychological involvement, and behavioural elements. This module is administered when there is presence at least one of the entities involved in the game.

Post-game module used to assess how player delt after they had stopped playing the game. This module is relevant to measure the naturalistic gaming. There are four elements are measured in this module, positive and negative experience, tiredness and returning to reality.

In the second stage of this study, Pilot Study, we used core module to assess the player's experience during gameplay session. In this study we used interval scale (strongly disagree, disagree, neutral, agree and strongly agree) to measure the player's experience during gameplay session (Refer Appendix D). GEQ is valid and reliable to measure user's experience and only focussing on the experience not on any aspects in the game (Barbara, 2014).

In regards of measuring older adults' gaming experience, Boletsis and McCallum (2016) used In-Game Experience Questionnaire (iGEQ) to measure the player's game experience in their study. iGEQ is consisted of 14 items and it was chosen due to the shorter number of question and reliable, so the participants not tire the participants.

3.5.2 System Usability Scale (SUS)

System Usability Scale (SUS) was developed by Digital Equipment Co Ltd, with a total of 10 items and it was created to have quick and reliable way to measure the usability

of a system or product (Peres et al., 2013). In this study we used ordinal scale (strongly disagree, disagree, neutral, agree and strongly agree) to measure the usability of the game. There are 10 questions in the System Usability Scale (SUS) used to assess the usability of the digital games played by the participants during pilot study (Refer Appendix D).

3.5.3 Questionnaire for User Interaction Satisfaction (QUIS)

Questionnaire for User Interaction Satisfaction (QUIS) was developed by America's Maryland University Human Computer Interaction Lab (HCIL) and it used to assess the user's subjective rating of the human-computer interface (J. P. Chin, Diehl, & Norman, 1988). There are five categories are measured using QUIS, overall reaction to software, screen, terminology, and information systems, learning and system capabilities. In this study, we used QUIS in Stage 3 research design, where we used to evaluate users' satisfaction and human computer user interface towards the developed prototype. Refer on Appendix F for the questions list. The rationale of adopting QUIS into this study is to identify the effectiveness of the constructed guideline through the developed prototype.

3.6 Data Collection Method

Two types of data collection method are adopted into this study, qualitative and quantitative method. As mentioned in Section 3.2a, the techniques used are questionnaire administration, demonstration, gameplay, observation, and informal interview.

3.6.1 Questionnaire Administration

Questionnaire administration method is a quantitative method used in this study. A set of questionnaires administrated to the target groups in Stage 2 and 3 in this study. The questionnaire was given along with the consent statement prior the gameplay session. The questionnaire needs to be filled by the respondents after the gameplay session. There are few

advantages using this method. Below is the list of the advantages using questionnaire in this study:

- i. Data are easy to analyse.
- ii. Time and cost effective.
- iii. Number of bias data can be reduced.

In Stage 2, the combination of GEQ and SUS instruments were used to assess the respondents gaming experience and the design consideration for digital game. There are six (6) sections in the questionnaire used in Stage 2. It includes personal information, technologies usage, game experience, game usability, challenges and game recommendation, and recommendation. The questionnaire was administrated using online platform due to Movement Control Order (MCO) imposed in Malaysia.

Game Experience Questionnaire (GEQ) and Questionnaire for User Interface Satisfaction (QUIS) were used in Stage 3. There are six (6) sections consisted of demographic data, technologies usage, game experience, game interface satisfaction, challenges and game recommendation, and respondents' feedback.

3.6.2 Demonstration

In Stage 3, demonstration method was adopted. A recorded video was given prior the session. The video will replace the present of researcher during the session. Participants can watch the video prior gameplay session to get better understanding how the games in the mobile application work.

3.6.3 Gameplay

APK file for the game prototype is given to the participants along with demo video prior the session. Participants must install the game in their android mobile devices before starting the session. Gameplay session was recorded for the purpose of observation.

3.6.4 Observation

Observation is one of method to collect primary data in this study. Gameplay session is recorded using video recording. The purpose of video recording is to observe participants' reaction during gameplay session. This method can help researcher to get better understanding on how participants react with digital game during gameplay session.

3.6.5 Informal Interview

An informal interview session is conducted after the gameplay session. Due to the movement control order (MCO), participants will be interview through phone call by the researcher. The session was recorded using audio recorder. Participants able to voice their opinion regarding the experience playing digital game and recommendation on how to improve the game design to satisfy their needs.

3.7 Result Analysis

To answer research questions in this study, all data collected during Stage 2 and Stage 3 were analysed. The process of data analysis was initiated after intended data have been collected. The results obtained will be reported and discussed in Stage 4. Quantitative data were derived from the questionnaire administered during pilot and final study. Qualitative data were obtained from the observation and informal interview conducted in this study.

3.7.1 Data Analysis

Data obtained from the questionnaire were stored in Microsoft Excel and analysed in IBM SPSS Statistics. Demographic and technologies usage data were examined using descriptive statistics (frequencies and percentage). Reliability of GEQ and SUS data in Stage 2 were test using reliability test (Cronbach Alpha). All the video and audio recording obtained from the observation and interview session were analysed.

3.8 Data Protection

Participants were given participant information sheet and consent statement form prior session. They must fill and sign the consent form before starting the session. Only researchers can have access to the raw data obtained throughout the study. Data obtained will be used only for academic purpose (thesis, journal publication and conference).

3.9 Summary

This chapter covers the method used for this study. A research design is introduced, a combination of mixed method (quantitative and qualitative study). The approaches used for data collection, gameplay, observation, informal interview, and questionnaires. The techniques used for dissemination of questionnaires are snowball sampling and convenience sampling. The outcome of this study is based on the result obtained in the research design. The process of constructing guideline is starting by defining the purpose of the study, where in the Stage 1 of the research design, an intensive literature review was conducted to acknowledge the gap between this study. The target group of this study is older adults; therefore, the goals and the game type are defined based on the results obtained during pilot study in Stage 2. The second quadrant of the constructed guideline is design. The challenges and the design consideration obtained from the intensive literature review and pilot study are

adopted in the guideline to ensure the digital games are design successfully by considering the limitation of older adults. Play quadrant is dependent on the most used devices by the older adults, where in this study, smartphone is the most used devices used by the participants. To ensure the successful of the constructed guideline, a set of questionnaires is being distributed in the Stage 3 of this study.

CHAPTER 4

SYSTEM ANALYSIS AND DESIGN

4.1 Introduction

Chapter 4 explains the results obtained in Stage 1 in the research design. A Systematic Literature Review (SLR) was conducted based on keyword search.

4.2 Result Analysis

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method was used to conduct SLR in this study. Figure 4.1 depicts the process to conduct SLR.

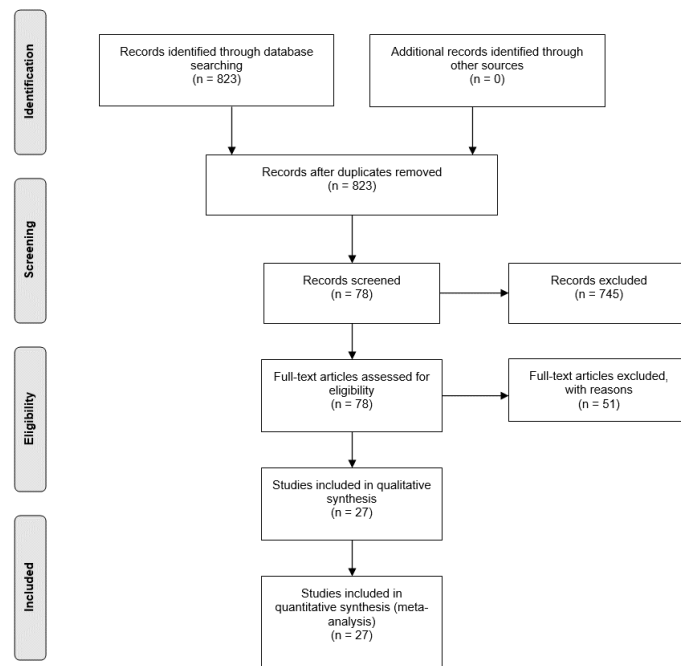


Figure 4.1: SLR Flow Diagram

There are four phases in the PRISMA flow diagram, identification, screening, eligibility and included. The first phase is identification, where based on the keywords search

used in this study, only 823 papers were found in the Scopus database. Screening phase and eligibility phase is a process to exclude papers based on the years of publication, area of studies, articles type and language used. The selected paper included in the review is limited to paper published between 2015-2020, computer science area of studies, conferences, and articles papers and only paper written in English language. There are 27 papers were review in the SLR paper, and it was published in IEEE Asia-Pacific Conference on Computer Science and Data Engineering (CSDE) 2021.

There are four main data were analysed in the paper, game platform and technology, challenges related to older adults, benefits of digital games towards older adults, and research purpose and methodologies.

4.2.1 Game Technology and Platform Used

There are many types of game technology and platform used in previous studies. Based on the result obtained in the SLR, there are three game technology, mobile, console and web-based technology. As for game platform, each game technology has different platform. Table 4.1 described the platform and used in the game technology.

Table 4.1: Game Technology and Platform

Game Technology	Game Platform	Previous Studies
Mobile	Smartphone	(Neto, Cerejeira, & Roque, 2017; Radhakrishnan et al., 2016)
	Tablet	(Boletsis and McCallum, 2016; Mihajlov, Law, and Springett, 2016; Neto, Cerejeira, Leite, Roque, and Neto, 2016; Neto et al., 2017)
Console	Microsoft Kinect Xbox	(Awad and Craig, 2017; Codreanu and Florea, 2016; Garcia, 2018; Loos and Zonneveld, 2016; Tran et al., 2016; Zadeh, Veloso, and Pereira, 2019)
	Wii	(Hausknecht et al., 2015; Schell et al., 2015; Schell and Kaufman, 2017; Zhang, Hausknecht, et al., 2017; Zhang, Kaufman, et al., 2017)

Table 4.2: continued

Web-Based	Personal Computer (PC)	(Chi et al., 2017; Dias et al., 2019; Ku, Huang, & Li, 2016; H. Lin, Hou, Yu, Shen, & Miao, 2016; Y.-H. Lin, Mao, Tsai, & Chou, 2018)
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4.2.2 Challenges Related to Older Adults

There are many challenges for older adults to interact and experience with digital games. In the reviews, there are four categories of challenges were found related to older adults, such as memory and attention, spatial cognition, understanding and physical. Table 4.2 shows the studies that emphasise on the challenges based on the categories given.

Table 4.3: Challenges Related to Older Adults

Category	Previous studies
Memory and Attention	(Brown, 2017; Jali and Arnab, 2016; Loos and Zonneveld, 2016; Neto et al., 2017; Schell et al., 2015; Tran et al., 2016)
Spatial Cognition	(Schell et al., 2015; Zadeh et al., 2019)
Understanding	(Brown, 2017; Kaufman et al., 2016; Merilampi et al., 2017; Radhakrishnan et al., 2016)
Physical	(Schell et al., 2015; Zadeh et al., 2019)

4.2.3 Benefits of Digital Games Towards Older Adults

Apart from known as an entertainment tool, digital games can be use as tool to improve the quality of life for older adults. There are many benefits older adults can gain while engaging with digital games. In the SLR, there are four categories of benefits were found, physical, cognitive, social, and emotional, and education and learning. Table 4.3 summarised the benefits gained based on the categories and list of the related previous studies that emphasise on the benefits.

Table 4.4: Benefits of Digital Games

Category	Benefits	Previous Studies
Physical	Can be use as rehabilitation tools	(Awad and Craig, 2017; Codreanu and Florea, 2016; Dias et al., 2019; Garcia, 2018; Kaufman et al., 2016; Y. H. Lin et al., 2018; Zadeh et al., 2019), (Jali and Arnab, 2016)
Cognitive	Helps to enhance cognitive skills	(Chi et al., 2017; Garcia, 2018; Kaufman et al., 2016; Ku et al., 2016; H. Lin et al., 2016; Y.-H. Lin et al., 2018; Mihajlov et al., 2016)
Social and Emotional	Give enjoyment during gameplay session	(Awad and Craig, 2017; Boletsis and McCallum, 2016; Chi et al., 2017; Garcia, 2018; Hausknecht et al., 2015; Kaufman and Sauve, 2019; Kaufman et al., 2016; Kaufman and Zhang, 2015; Loos and Zonneveld, 2016; Merilampi et al., 2017; Mihajlov et al., 2016; Radhakrishnan et al., 2016; Schell et al., 2015; Schell and Kaufman, 2017; Zadeh et al., 2019; Zhang, Hausknecht, et al., 2017; Zhang, Kaufman, et al., 2017)
Education and Learning	Learning new skill while using digital games in digital devices.	(Loos and Zonneveld, 2016; Mihajlov et al., 2016; Neto et al., 2017; Radhakrishnan et al., 2016; Zhang, Kaufman, et al., 2017)

4.2.4 Research Purpose and Methodologies

The purpose to review on the research purpose and methodologies used in previous studies is to learn the gap knowledge in the topic of this research study. Different studies used different type of approach to conduct study with older adults. Table 4.4 summarised the research method and approaches used in the previous study.

Table 4.5: Research Method ad and Approaches Used

Research Method	Approach	Previous Study
Quantitative	Survey	(Kaufman et al., 2016; Kaufman and Zhang, 2015)
	Questionnaire	(Boletsis and McCallum, 2016; Chi et al., 2017; Hausknecht et al., 2015; Ku et al., 2016; Y. H. Lin et al., 2018; Mihajlov et al., 2016; Neto et al., 2016, 2017; Radhakrishnan et al., 2016; Zadeh et al., 2019; Zhang, Hausknecht, et al., 2017)
Qualitative	Observation	(Dias et al., 2019; Garcia, 2018; Zadeh et al., 2019; Zhang, Kaufman, et al., 2017)

Table 4.6: continued

Qualitative	Interview	(Brown, 2017; Hausknecht et al., 2015; Loos and Zonneveld, 2016; Merilampi et al., 2017; Schell et al., 2015; Schell and Kaufman, 2017)
	Meeting	(Chi et al., 2017)
	RCT	(Awad and Craig, 2017; Ku et al., 2016; Y. H. Lin et al., 2018; Neto et al., 2016, 2017; Tran et al., 2016; Zhang, Hausknecht, et al., 2017)
	Video Recording	(Mihajlov et al., 2016)

4.3 Discussion

There are 27 papers were reviewed in the SLR paper. Four main topics were covered, game platform and technology, challenges for older adults to interact with digital games, benefits they gained while playing and research method and approaches used in the previous studies.

The main purpose of SLR is to identify the gap knowledge within the selected topic in this thesis, which is older adults and digital games. The importance to investigate the game technology and platform used in previous research is to identify the suitable platform used to introduce digital games towards older adults which can reduce the challenges for them to interact with it. Based on the results obtained, most of previous studies used console technology, which include Wii and Microsoft Kinect Xbox. However, based on the results obtained for challenges, one of the challenges for older adults to interact with digital games is physical disabilities, where some of them experience with decline in physical abilities, which include unable to perform excessive physical activities. Most of game played in the console platform required physical activities for the player. Therefore, for older adults with limitation, their might not able to experience digital game. To reduce the challenges, it is important to choose the right platform to let older adults interact and experience with digital games. Mobile platform such as smartphone and tablet are suitable for these populations as

it has simpler interface and easy to navigate. Apart from that, it does not require excessive physical activities to handle the devices.

Research purpose and approaches from the previous research is reviewed to identify which methodologies and approaches are suitable to conduct study with older population. Based on the result obtained, mixed method with combination of qualitative and quantitative method is suitable for this study.

4.4 Summary

This chapter covered the results obtained in the SLR paper. The method used to conduct SLR is by using PRISMA flow diagram, where there are four phases in it, identification, screening, eligibility and included. There are 27 papers were included in the review and the are four topics covered in the review.

CHAPTER 5

IMPLEMENTATION: THE DEVELOPMENT OF OTAK ME!

5.1 Introduction

This chapter discussed the proposed guidelines to design and develop digital games, and results obtained in Stage 2 of the research design.

5.2 Proposed Guidelines to Design and Develop Mobile Digital Games for Older Adults

Figure 5.1 depicts the proposed guideline to design digital game for older adults using andragogy perspectives. There are four quadrants in this proposed guideline, consisted of *purpose*, *design*, *play*, and *experience*. The designer is responsible to design the digital game to ensure it can captivate older adult's interest to play the game.

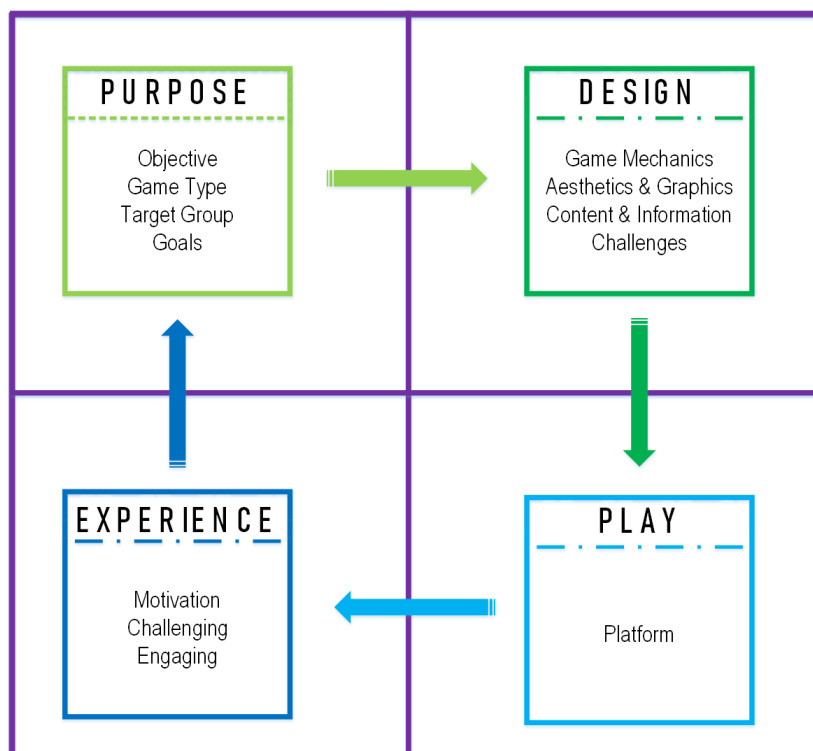


Figure 5.1: The Purpose, Design, Play and Experience guideline

5.3 Purpose

The first quadrant in this guideline is purpose. Designing a purposeful game starts with investigating the purpose of the game and how it can impact the player (Mitgutsch and Alvarado, 2012). There are four elements that the game designer should define before starting to design a game. These elements are the objectives, type of game, target groups and game goals.

Game designers need to define their objective before designing a game for their target group. The objectives should relate to the learning outcome that they want the player to experience during the gameplay session. This line is related to the key principle of andragogy where the need to acknowledge the importance of games design for their challenges. Concerning games targeted at older adults, game designers should design games capable of dealing with the negative effects of ageing (i.e.: the decline in cognitive or physical ability).

Therefore, developers need to address the need of their target group (Gerling et al., 2012). Knowing the target group before designing a game help ensure the players have a good gaming experience without being distracted from the challenges during the gameplay session.

The enjoyment factor is one of the crucial factors that need to be considered while designing and developing games for older adults. One of the motivations for older adults to play digital games is to relieve stress (Razak et al., 2017). Therefore, one of the goals to design games is to develop a game with emotional benefits.

5.4 Design

The design quadrant is the crucial element in this guideline. Many games designs and attributes need to be considered in designing games for older adults to ensure the players have a positive gaming experience. Four game designs and attributes are highlighted in this guideline: game mechanics, aesthetic and graphics, content and information, and challenges. Each aspect is discussed as follow:

5.4.1 Game Mechanics

Game mechanics or game value is essential in ensuring the game's success. Therefore, it needs to be designed with crucial consideration as it affects game balance (Shi & Shih, 2015). Thus, game designers must be carefully considered three aspects of game mechanics, including the game goals, the procedure, and the rules. The games must be design with specific guideline to ensure the utilisation of it among older adults as it aligns with the key principle of andragogy, where they need to know the rationale of playing.

Game goals are referred to the meaningful experience for players to experience throughout the gameplay session. Game designers need to define their purpose in the first element of this guideline. The experience varies according to the type of games played by the players. Regarding games for older adults, they are more familiar with puzzle games as they could correspond to their offline activity (Wang et al., 2019). A puzzle game's procedure and rules are easy to grasp, and it requires less effort for older adults to understand and learn the game mechanics. According to Wang et al. (2019), manageable goals and operations with simple instruction can entice older adults to play the game. Apart from that, game instructions and technical jargon should be clarified (Khalili-Mahani et al., 2020).

Game rules and procedures depend on the type of game selected by the game designers. Game designers should avoid designing excessive game procedures that require physical activity from the players. Complex game rules or procedure might discourage older adults from interact with digital games.

5.4.2 Aesthetics and Graphics

Aesthetics and graphics refer to sensation, which the user experience depends on when playing games. The central problem of this research is that some commercialised games are not designed specifically for older adults. In addition, some older adults lack computer literacy and may experience a cognitive and physical decline. Therefore, to reduce the challenges and enable older adults to interact with and experience digital games, it is essential for game designer to consider the challenges.

The game interface is the first thing the player sees. Therefore, the interface of a game designed for older adults must be simple and easy to understand. In addition, to entice

older adults with hearing or vision impairments to play the game, the games should allow the players to control the colour, font, and audio-visual elements.

The sound and music selection in game are important factor in game design. The excessive sound effect can distract older adults during gameplay session (Schell et al., 2015). Razak et al. (2017) discovered that older adults preferred to play games in silence and with the game sound muted.

Apart from that, game designers should also avoid using small fonts in the games. The implication of utilising small fonts in games will make players unable to view the game's contents and information. Additionally, game designers should reduce the number of graphics elements to avoid distracting older adults during gameplay sessions (Barenbrock et al., 2015). Finally, game designers should avoid putting too many superfluous graphics onto a single interface.

5.4.3 Content and Information

Game designers have wanted players to learn and experience the narrative, that is, the content, and information, throughout their gameplay. Therefore, the game's content is crucial in attracting older adults to play games. According to andragogical perspectives, older adults will only use and learn something new if it provides them with the benefits and relevance to their daily lives (Jali & Arnab, 2017).

The game content should be straightforward not too complex for older adults to let players feel the game experience and be satisfied. According to Wang et al. (2019), a game with relevant themes can attract older adults to play it. Moreover, Santos et al. (2019) stated

that choosing the game's theme and visual style is important to ensure that older adults understand the rules and goals during gameplay session.

Apart from that, the content and information in the game should contain less text (Pappas et al., 2019). Additionally, it is vital to embed fantasy and curiosity elements where it can be one learning element in the game (van der Spek et al., 2014). Finally, game designers must avoid including advertisements so that older adults are not irritated during game play sessions due to an accidental click.

5.4.4 Challenges

The importance of challenges in encouraging players to play the game regularly cannot be overstated. Neto et al. (2017) revealed that healthy older adults would become demotivated during gameplay if the game was not challenging. Therefore, game designers should design games with different challenges. Merilampi et al. (2018) asserted that the game must be a simple design to ensure it suitable for different players (i.e., age, cognitive ability, physical ability). They advised that the game's first level, Level 1, should be easy enough for players with cognitive disabilities to participate. The rationale of providing game challenges encourages older adults to play again (Barenbrock et al., 2015). Aside from that, the game's increasing difficulty might help keep players' attention throughout the gameplay session and reduce boredom (Leporini & Hersh, 2016). A player immersed during a gameplay session is more focussed on solving the problems and achieving the game's goal. The game designer needs to avoid designing a game with too fast pace and timer in terms of game pace. The rationale for avoiding these two elements is to prevent older adults from feeling pressure during gameplay sessions and resulting in a loss of enjoying the gaming experiences (Mohsin et al., 2022).

5.5 Play

The third quadrant in the guideline is play, which refers to the platform used to allow older adults to interact and experience digital games. The motor decline is one of the negative ageing impacts. Older adults who are affected by it may have difficulties using a mouse and keyboard (Razak et al., 2013). Therefore, it is essential to choose the right platform to ensure older adults are comfortable and enjoy the gaming experience. Jali and Arnab (2017) stated that consoles and tablets have advantages and disadvantages as game platforms. However, according to Dupl  a et al. (2017), tablets are better suited for older adults due to their simpler interface. Oppl and Sary (2018) supported Dupl  a et al. (2017) claim, stating that older adults had a positive experience playing digital games on a tablet platform when tablet devices are more convenient and less expensive than console platforms. Older adults with physical disabilities such as poor body balance should play digital games on console platforms, particularly those that use Kinect technology, as it requires physical activity.

5.6 Experience

The last quadrant in the proposed guideline is players' experience. To ensure the success of digital games, players must feel motivated, challenged, and engaged during gameplay sessions. Therefore, in this guideline, we proposed demonstrating the digital game to the target group, allowing them to play and experience the games during gameplay, and evaluating the digital game to determine the level of experience during gameplay session.

The gameplay session is to expose older adults to digital games designed for their demographic. According to the andragogy principles, older adults must experience digital games to learn about digital technology especially digital games. Furthermore, gameplay

sessions can assist in recognising players' satisfaction towards the game based on their playing experience (Razak et al., 2017).

This element has three sub-elements including motivation, challenging, and engaging. One of the goals to design games for older adults is to relieve their stress. Therefore, game designers need to address players' gaming experience and the challenges they experience during gameplay session.

In this guideline, we suggested using Game Experience Questionnaire (GEQ) and Questionnaire for User Interaction Satisfaction (QUIS) to measure player experience and game usability among older adults. The evaluation element in this guideline's purpose is to ensure the developed game meets the game goal. As a result, we have demonstrated and proven the effectiveness of the constructed guideline. In our study findings, a reliability test was conducted to test the internal consistency of GEQ and QUIS, where both values are accepted with Cronbach's alpha value 0.878 for GEQ and 0.962 for QUIS.

5.7 Framing

Co-design allows game designers to actively engage older adults as users during the design process (Muhamad et al., 2018). During the co-design process, game designers showed the ability to comprehend and address the needs of older adults during gameplay experience. The design process must be iterative and constant to ensure that the game is well suited for older adults.

All elements in the proposed guideline are framed by one another. The rationale for framing all elements in the proposed guideline is to assure the guideline's success and

effectiveness. According to Mitgutsch and Alvarado (2012), players' literacy can influence their gaming experience.

5.8 Purpose: Demographic and Technologies Usage

There are 81 responses were recorded but only 56 responses are taken into this study. 25 responses were rejected due to the data are not match with the requirements stated in this study. Participants recruited in the preliminary study using snowball and convenience sampling technique, where random people who matched with the requirement stated in the recruitment form are eligible to participate to contribute to this study. Study by Chi et al. (2017) managed to recruited 54 older adults but only approved 42 responses after denied to be counted in their study. Therefore, the number of responses in this study is acceptable as there is previous study conducted with the same range number of responses taken.

There are 33 female, and 23 male respondents were participated in this study. The number of responses is varying from each age range. Based on the findings, responses from age range 55-60 years old are the dominants in this study. There were 41 of the respondents are aged between 55-60 years old, followed by age range between 61-65 years old (9), 66-70 years old (5) and 71-75 years old (1). The number of genders and age range in this study is unbalanced due to the technique used to gathered participants. Convenience and snowball sampling techniques is part of random sampling techniques; therefore, the number is not fixed and unbalanced.

Based on the marital status of the respondents, 45 of the respondents are married, 9 are widowed, 1 single and 1 divorced. The employment status of the respondents is 20 of the respondents are full time worker, 20 are retired, 13 are unemployed and 3 work as part time worker.

23 of the respondents are Malay, followed by 17 of Bumiputera Sabah, 12 Bumiputera Sarawak, 2 of India and 2 Chinese ethnicity. Table 5.1 summarised the finding obtained from the section 1 of the questionnaire.

Table 5.1: Demographic results for pilot study

		Age			
		55-60	61-65	66-70	71-75
Marital Status	Single	0	1	0	0
	Married	35	8	2	0
	Divorced	1	0	0	0
	Widowed	5	0	3	1
Gender	Female	23	6	3	1
	Male	18	3	2	0
Ethnicity	Malay	17	5	1	0
	Chinese	2	0	0	0
	India	1	1	0	0
	Bumiputera Sabah	11	3	2	1
	Bumiputera Sarawak	10	0	2	0
Employment Status	Full time	19	1	0	0
	Part time	2	1	0	0
	Retired	12	5	3	0
	Unemployed	8	2	2	1
Skills	Expert	4	0	0	0
	Competent	14	3	0	0
	Novice	21	2	1	0
	None	2	4	4	1
Experience Digital Game	Yes	9	1	0	0
	No	32	8	5	1

In this study, 4 out of 9 older adults who experienced with digital gamse were recruited for informal interview session, 2 females and 2 males. The age range for all participants is 55-60 years old. The rationale to recruited them is to discover their gaming experience. The other 5 participants were unable to be contacted for the interview session. Data collected during the interview used to support to develop the guideline to design and develop digital games.

The first element in the constructed guideline is purpose, which include objectives, type of game, target groups and game goal. Based on the results obtained from questionnaire administration and interview session, we found older adults age range from 55-60 years old have experience playing with digital game. With regards of purpose elements, we can see the target group is refer to older adults who have the number experience with digital games.

The age range is considered as an early age for older adults. Most of older adults in the age range are either still working or retired. The transition from employed to retired may change older adults' routine. One of the benefits of digital game is enjoyment, where it offers enjoyment towards the player. From the age range, we can derive that the objective and game goals are to let older adults to experience digital games and enjoy during gameplay session.

Respondents were asked either they want to try play digital game in the future regardless their computer skills and experience playing digital game before. Based on the results obtained, 14 of the respondents are willing to try play digital game, 21 are not willing to try play digital game. 11 responds maybe where in between yes and no to try play digital game. Table 5.2 represents the responses of the respondents on their willingness to try play digital game in future. There are 10 items is reported missing due to the respondents did not answer the question.

Table 5.2: Respondents on their willingness to try play digital game in future

Do you want to try play digital game?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	14	25.0	30.4	30.4
	No	21	37.5	45.7	76.1
	Maybe	11	19.6	23.9	100.0
	Total	46	82.1	100.0	
Missing	System	10	17.9		
Total		56	100.0		

Based on the findings shown in Table 5.1 and Table 5.2, the number of older people who have experience with digital game and want to try play digital game is relatively small compared to the total number of respondents who participated in this study. The results were influenced by their perceptions on digital games, where most of them indicating playing digital games as something that wasting time and have no interest to play with it. To overcome the challenges, the selection of game type and goal should be related to the target groups. In term of andragogy perspectives, older adults will learn to play digital games if they understand the rationale of playing the game and recognise digital games as relevant to their situation and goals in life.

Table 5.3: Game name, type played by respondents and the number of respondents played

Game Name	Game Type	Frequency (n)
Candy crush	Puzzle	7
Word Search	Puzzle	3
Bubble	Puzzle	2
Toybear	Puzzle	1
Bubblesoap	Action	1
Deer Hunter	Simulation	1
Galaxy Force	Third Person Shooter Game	1
Player Unknown Battle Ground (PUBG)	First Person Shooter Game	1
Mobile Legend (ML)	Adventure	1
Farm Ville	Simulation	1
Angry Bird	Puzzle	1
Mario	Adventure	1
Word Puzzle	Puzzle	1
Ragnarok Mobile Eternal Love	Role Playing Game	1
Pirate Code	Role Playing Game	1
Zynga Poker	Card Game	1

Type of game is determine based on the most played game by the older adults. We found the most played game based on the results obtained in the pilot study, puzzle game type is preferable by the older adults. Puzzle game is designed with simple operation and

manageable goals; therefore, it does not burden older adults with decline in physical and cognitive abilities.

5.9 Design

In Section 5 of the questionnaire, respondents who have experience play with digital game are required to state their challenges faced during gameplay session and their recommendation on the game design specification to captive their attention to play digital game and overcome the challenges they faced.

Challenges Faced

There are many challenges faced while playing digital game were listed by the respondents. Below is the list of the challenges faced by the respondents.

Table 5.4: Challenges faced by the respondents

ID	Quote
1	“Battery drain faster”
4	“Too hasty to find words”
5	“Does not know how to play game”
10,11,20	“Internet connection”
14,15,18,19	“Small screen”
18	“Small fonts”
21	“Difficult mission”
22	“Visual less visible and small screen”
23,24	“Small device and not enough time”
27	“Screen too small, eyes easily get tired”
30,34	“Too much advertisement”
39	“Small screen and eyesight”
54	“Not portable”

One of the key principles of andragogy is orientation of learning. To design a digital game that can captive older adults’ attention, the challenges faced by the respondents while playing digital game are addressed. Based on the challenges listed in Table 5.4, the major challenges faced by the respondents related with the physical issues of the devices used by

them. Most of them stated the screen size is the challenges for them to play and experience digital games. To overcome the challenges, the selection of devices plays the important aspect to let older adults to interact and experience with digital games. The technical issues such as internet connection and the amount of advertisement can be reduced by develop digital game that does not require internet connection. The disadvantage of developing a game with no internet connection is, the player itself cannot interact with other play from other devices.

Game Design Recommendation

Respondents are allowed to state the game design recommendation to captive their attention to play digital game and overcome their challenges based on their previous gaming experience. Below is the list of the design recommendation by the respondents.

Table 5.5: Game design recommendations

ID	Quote
1	“The layout should be in a portrait layout”
2	“Make it easy to understand”
4,30,34	“Reduce the number of advertisements”
18	“Bigger screen, bigger fonts”
20	“Improve graphics”
22	“Make it colourful and reduce level of difficulty”
22,23	“Make the items bigger and easier”
27	“Anti-ultrabright screen which does not give pressure to eyes”

The design recommendation in Table 5.5 can be taken into consideration to design digital game for older adults. In term of aesthetics and graphics in game, few suggestions made by the respondents such as the size of the items, and the colour selection in game. The mechanics of the game, such us the difficulty level can be design with few levels, from easy to hard. It can be considered as a motivation element to encourage older adults to play digital game. One of the key principles of andragogy is motivation to learn. By providing different

level of difficulty in game, it can help to facilitates older adults to interact and experience with digital game.

There are four items need to be considered to design and develop digital games for older adults, which include game mechanics, aesthetics and graphics, content and information, and challenges. Table depicts the results obtained from Stage 1 and Stage 2 in this study and grouped based on the items.

Table 5.6: Game Design Recommendation

Item	Design Recommendation	Justification
Game Mechanics	The game is design based on the needs of older adults.	To ensure older adults utilised digital games and gain benefits when playing digital games.
	Simple and easy instruction	To ensure older adults understand the rules and able to follow in-game instruction. The gaming experience will influence with the understanding of older adults when playing digital games.
Aesthetics and Graphics	Avoid use small graphics and fonts	Older adults have difficulty to view the content in game, instructions due to the negative ageing impact- decline in physical (eyesight)
	Avoid design interface with too many graphics in one screen (simple interface)	To reduce the possibility for older adults to confuse which button to click due to excessive graphics.
	Avoid use loud or excessive sound	To avoid older adults feel distracted during gaming session.
Content and Information	Relevant and suitable for older adults' routine	To ensure older adults utilised the usage of digital games
	Avoid put advertisement in-game	To reduce the possibility for older adults clicking the ads which may disrupt their gaming experience
Challenges	Design with vary level of difficulty	To let older adults with different gaming experience level enjoy the gaming session

With regard the content and information in the game, respondents were asked regarding their experience play with any popular childhood game (i.e., Scribbles, Saidina,

UnoCard, etc...). Based on the results obtained, 67.9% (n=38) of the respondents were play childhood and 32.1% (n=18) were not play with any popular childhood game.

Table 5.7: Number of respondents played popular childhood games

Do you play any popular childhood games? (Scribble, Saidina, UnoCard, Jigsaw Puzzle, Mahjong, etc...)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	38	67.9	67.9	67.9
	No	18	32.1	32.1	100.0
	Total	56	100.0	100.0	

To design the content and information in the digital game, the users itself need to have knowledge on the content in the game to ensure they can feel the gaming experience. This is associated with andragogy where older adults need to have prior experience with the learning materials. To facilitate the learning process to interact and experience with digital game, it is important for game designer and developer to design and develop game that familiar with their target group.

5.10 Play

The third element in the guideline is play, which refereed to platform used for interaction with digital game. Based on the data collected in the pilot study (questionnaire administration), most of the respondents owned smartphone (n=41) and only one of them does not own any devices. With regards the number of respondents owned smartphone, most of the respondents are familiar with the smartphone interface and have experience to handle the devices. According to key principles of andragogy, older adults must have self-concept and experience with the platform used to play digital game to ensure them fully control the gaming experience.

41 out of 56 respondents owned smartphones. Based on the result, it can be concluded they have the knowledge and experience on how to use smartphone. One of the andragogy principles is older adults will only use devices if they know how to operate the devices (Mohsin et al., 2022).

Smartphone is a suitable platform to be used as a platform to let older adults to interact and experience with digital game. Apart from smartphone, tablet can be used as platform to interact and experience digital games. Besides the screen size, it is considered portable and can be used anywhere and anytime.

Table 5.8: Devices owned by respondents

	Devices Owned						
	Desktop PC	Laptop	I-pad	Smartphone	Tablet	Mobile Phone	None
Frequency	15	22	10	41	4	19	1

During the interview session with the participants, they were asked regarding their opinion on which device is suitable to interact with digital game. The participants stated that smartphone is the suitable device due to the nature of the devices where it can be used anytime and anywhere. One of the participants added, he can bring the smartphone with him and can play anywhere he wants.

5.11 Experience

Based on the findings, only 10 out of 56 respondents have experience playing digital game. To measure their experience during gameplay session, a set of GEQ and SUS questionnaire is given. The questions are measured using 5-Likert Scale.

5.12 Game Experience Questionnaire

In Section 3 of the questionnaire, respondents who have experienced with digital game are eligible to answer questions in this section. There are 33 questions based on GEQ and the items are separated into 7 categories. A reliability test was conducted to identify the internal consistency and specified measurement's usability. Cronbach's Alpha defines the internal consistency or average correlation of items in the GEQ. The Cronbach's Alpha value is 0.820 where it is acceptable and reliable (Niksadat et al., 2019). GEQ is a well-established questionnaire used in many previous studies (Barbara, 2014; Barenbrock et al., 2015; Merriman et al., 2018; Santos et al., 2019). Santos et al. (2019) used GEQ to report their participants' experience during game play and their sense of social presence.

Table 5.9 presents the results obtained from the preliminary analysis of user's gaming experience. Mean for positive items is the highest ($M=3.68$) among seven items in the GEQ with standard deviation ($sd=0.59$). This mean score indicated that the respondents are agreed on positive gaming experience they feel during gameplay session. The second highest mean is competence ($M=3.34$). Mean score for immersion, flow and challenge items are 3.23, 3.16 and 3.04 accordingly. Mean score for negative and tension items are 2.65 and 2.50 accordingly. This indicates that the respondents were not feel negative experience and tension during gameplay session.

Table 5.9: GEQ results based on category

	Mean	Standard Deviation
Positive	3.68	.59
Competence	3.34	.34
Immersion	3.23	.71
Flow	3.16	.69
Negative	2.65	.64
Challenge	3.04	.74
Tension	2.50	.92

5.12.1 GEQ: Positive Effect Items

Figure 5.1 presents the overview of results obtained for positive items. Y-axis is referred to the number of respondents and X-axis referred to the questions in positive effect items. The score trend of in positive items is agree, where it represents the respondents' opinions on their experience on playing digital games. However, one of the respondent's responses shows that she disagrees with certain questions in positive items. According to her current played game list, it showed that she played few digital games with different type of genres. The result might influence by her experience on current played game.

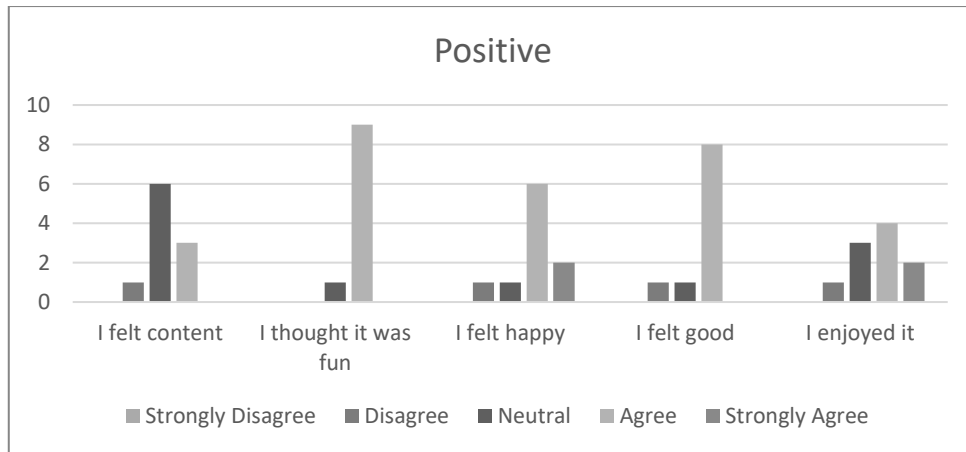


Figure 5.1: Positive items

The findings showed items 2 and 3 have the highest mean ($M=3.90$) for positive item. This indicates that the respondents' gaming experience were fun, and they feel happy during gameplay session. Items 4 and 5 have the same mean ($M=3.70$) where it indicates that the respondents were enjoyed the gameplay sessions. Item 1 has the lowest mean ($M=3.20$) where it might influence by the game theme. Every respondent was given a different game theme to play, which may have influenced their feeling towards the game.

Table 5.10: Positive items

Item	Questions	N		Mean	Std. Deviation
		Valid	Missing		
1	I felt content	10	0	3.20	.632
2	I thought it was fun	10	0	3.90	.316
3	I felt happy	10	0	3.90	.876
4	I felt good	10	0	3.70	.675
5	I enjoyed it	10	0	3.70	.949

5.12.2 GEQ: Competence

Figure 5.2 shows the results obtained from 10 respondents who have experience playing with digital game for competence items. Competence is measured based on the respondents' achievement during gameplay session. In our findings, the tendency score for items in competence is neutral except for item 4 "*I felt successful*". We found the game played by the respondents who agree on this question is puzzle game type. Puzzle games were designed with easy goal and simple operations where they can simply achieve the game goals.

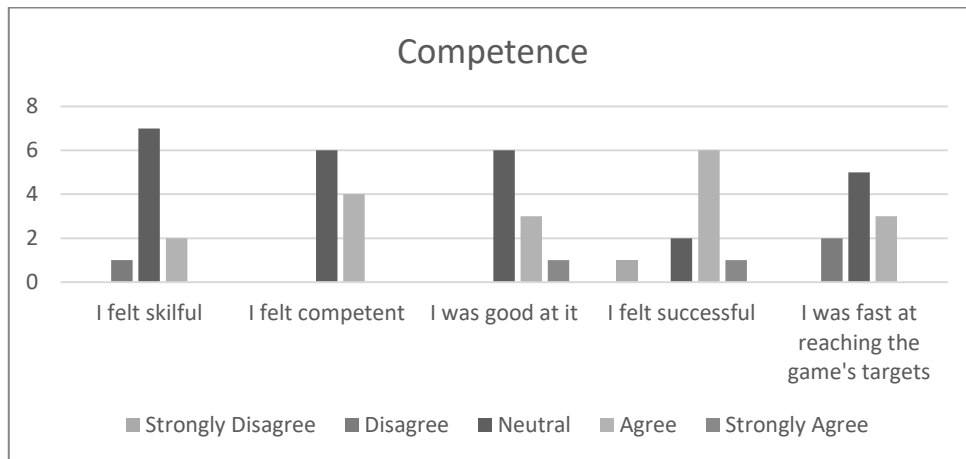
**Figure 5.2:** Competence items

Table 5.11 illustrates the results for competence items based on means and standard deviation. Based on the results obtained, item 4 ("I feel successful") has the highest mean (M=3.60). This represents the respondents had a success gaming experience during

gameplay session. The second and third item that has highest mean are item 3 and 2 accordingly with mean value $M=3.60$ and $M=3.50$. The lowest mean value is item number 1 and 5 with mean value $M=3.10$. The values are lowest due to the different game type played by the respondents.

Table 5.11: Competence items

Item	Question	N		Mean	Std. Deviation
		Valid	Missing		
1	I felt skilful	10	0	3.10	.568
2	I felt competent	10	0	3.40	.516
3	I was good at it	10	0	3.50	.707
4	I felt successful	10	0	3.60	1.075
5	I was fast at reaching the game's targets	10	0	3.10	.738

5.12.3 GEQ: Immersion

Figure 5.3 depicts the results obtained from 10 respondents who have experience with digital game based on immersion item in GEQ. To know the level of players' immersion into digital game played by the respondents, six questions were asked related to their previous gameplay session. One respondent disagreed on two questions in immersion items: "*It was aesthetically pleasing*" and "*I found it impressive*". Based on the list of game played by the respondent, we found that she played with more than two different game genres. The results might influence with the game type. Item 4 "*I felt that I could explore things*" has one respondent disagree on this question. We found the game played by the respondent is Word Search, where it has limited function with simple operation required for the player to explore in the game.

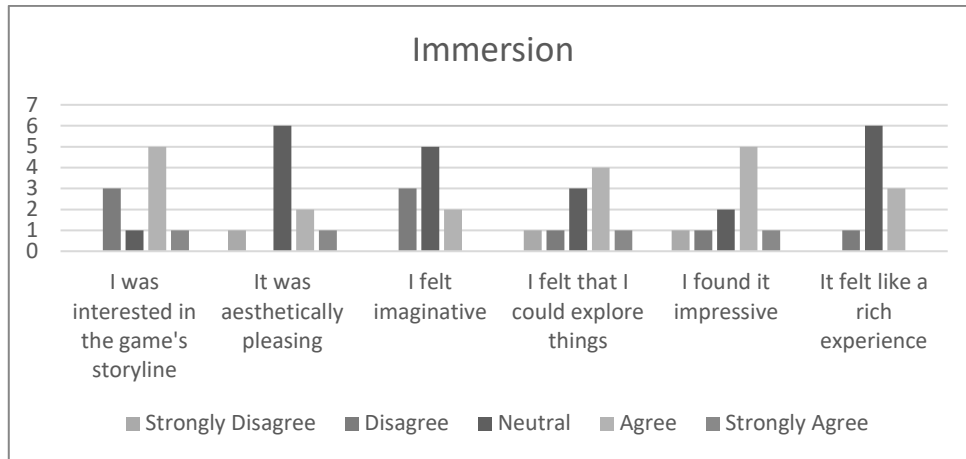


Figure 5.3: Immersion items

It can be seen from the data in Table 5.12 that items 1 and 5 have the highest mean value ($M=3.40$). It represents the game's storyline in the game played by the respondents are suitable with their thought and it attract the respondents to play it. According to key principle of andragogy, when older adults will be motivated to learn something if it can attract their attention and beneficial to them.

Mean value for item 4 is $M=3.30$ while items 2 and 6 have same mean value ($M=3.20$). Item 2 is depending on the interface of the game itself while 4 and 6 are dependent on the mechanics of the game. Item 3 has the least mean value ($M=2.90$). Based on the game type played by the respondents, most of the game are categories as puzzle game with limited storyline, where it does not allow the player to experience imagination during gameplay session.

Table 5.12: Immersion items

Item	Question	N		Mean	Std. Deviation
		Valid	Missing		
1	I was interested in the game's storyline	10	0	3.40	1.075
2	It was aesthetically pleasing	10	0	3.20	1.033
3	I felt imaginative	10	0	2.90	.738
4	I felt that I could explore things	10	0	3.30	1.160
5	I found it impressive	10	0	3.40	1.174
6	It felt like a rich experience	10	0	3.20	.632

5.12.4 GEQ: Flow

Results obtained for flow items collected from 10 respondents are shown in Figure 5.4. Y-axis represents the number of respondents while X-axis represents the questions in the flow item. Question 3 and 5 in flow items have the highest number of respondents who disagree on the questions.

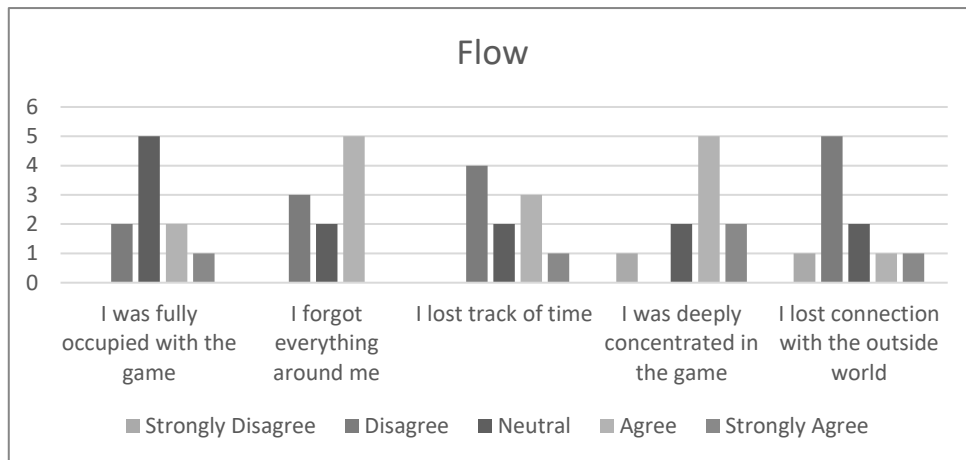


Figure 5.4: Flow items

Table 5.13 provides the results from preliminary analysis of flow items. Item 4 has the highest mean value (M=3.70). It represents that the respondents who have played digital game are focused during gameplay session as 5 of them are agree that they are deeply concentrated with the game and 2 of them are strongly agree. Older adults will give their full attention during the gameplay session if they understand the flow of the game itself. This line is reflecting the key principle of andragogy, learner's self-concept, and readiness to learn

something new. Based on the results, the game played by the respondents can attract the respondents' attention and as result make them concentrate during gameplay session.

Items 1 and 2 have same mean value (M=3.20) while mean value for item 3 is M=3.10. Item 5 has the lowest mean value (M=2.60). This result contradicts the results in item 4. Result obtained from item 5 might be influenced by the storyline and theme of the game played by the respondents.

Table 5.13: Flow items

Item	Question	N		Mean	Std. Deviation
		Valid	Missing		
1	I was fully occupied with the game	10	0	3.20	.919
2	I forgot everything around me	10	0	3.20	.919
3	I lost track of time	10	0	3.10	1.101
4	I was deeply concentrated in the game	10	0	3.70	1.160
5	I lost connection with the outside world	10	0	2.60	1.174

5.12.5 GEQ: Negative

Negative effects during the gameplay session are measured and the results are shown in Figure 5.5. Y-axis represents the number of respondents while X-axis represents the items in the negative effects.

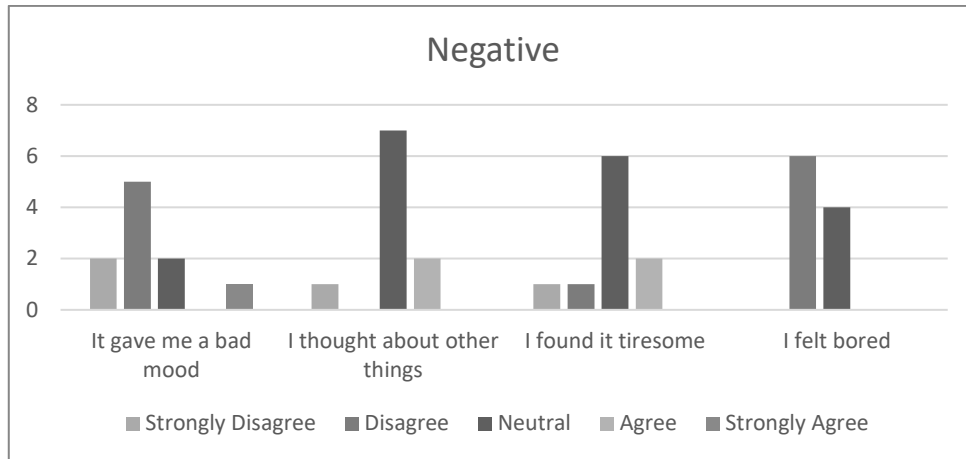


Figure 5.5: Negative items

There are four items were measured in negative effect. Item 2 has the highest mean value (M=3.00). The second highest mean value is item 3 (M=2.90).

Table 5.14: Negative items

Item	Question	N		Mean	Std. Deviation
		Valid	Missing		
1	It gave me a bad mood	10	0	2.30	1.160
2	I thought about other things	10	0	3.00	.816
3	I found it tiresome	10	0	2.90	.876
4	I felt bored	10	0	2.40	.516

5.12.6 GEQ: Challenge

There are five questions in challenge item. The challenges faced by the respondents during gameplay session were measured using 5-Likert scale. Figure 5.6 depicts the results of the challenges item based on the 5-Likert scale.

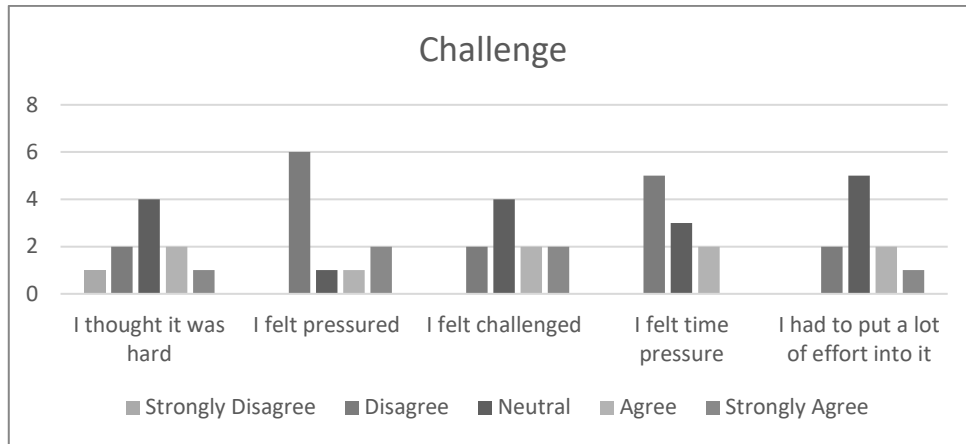


Figure 5.6: Challenge items

Item 3 has the highest mean value (M=3.40), followed by item 5 and 1 with mean value M=3.20 and M=3.00, respectively.

Table 5.15: Challenge items

Item	Question	N		Mean	Std. Deviation
		Valid	Missing		
1	I thought it was hard	10	0	3.00	1.155
2	I felt pressured	10	0	2.90	1.287
3	I felt challenged	10	0	3.40	1.075
4	I felt time pressure	10	0	2.70	.823
5	I had to put a lot of effort into it	10	0	3.20	.919

5.12.7 GEQ: Tension

Figure 5.7 shows the results for tension item. There are three questions in the tension item.

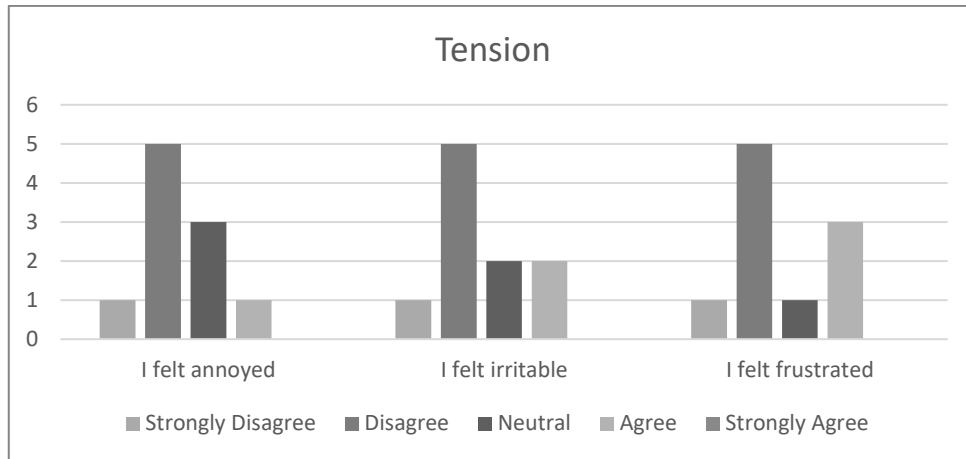


Figure 5.7: Tension items

The highest mean value is item 3 ($M=2.60$) and followed by item 2 and 3 with $M=2.50$ and $M=2.40$, respectively. Respondents were asked either they were felt annoyed, irritable, and frustrated during gameplay session. Based on the results obtained, most of the respondents were disagreed on the questions asked in tension item.

Table 5.16: Tension items

Item	Question	N		Mean	Std. Deviation
		Valid	Missing		
1	I felt annoyed	10	0	2.40	.843
2	I felt irritable	10	0	2.50	.972
3	I felt frustrated	10	0	2.60	1.075

5.13 System Usability Scale

The game usability was measured using 5-Likert scale System Usability Scale (SUS) questionnaire. There are ten items in SUS questionnaire. The results obtained is vary due to the different type of game were played by the respondents. Figure 5.8 depicts the number on respondents answered the SUS question based on 5-Likert scale.

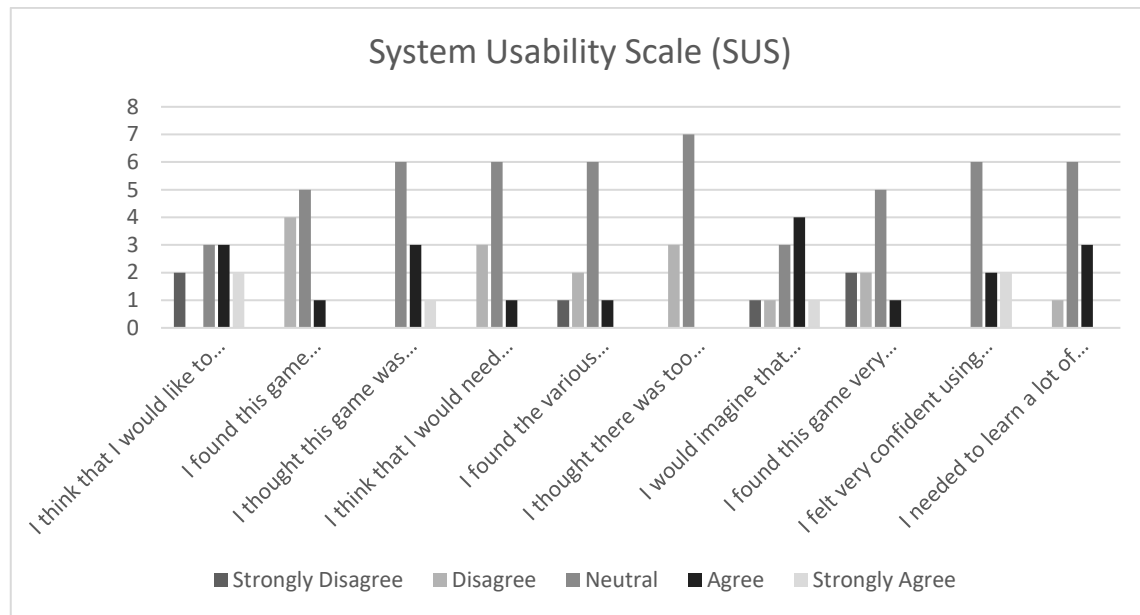


Figure 5.8: SUS results

Based on the results obtained, item 9 has the highest mean value, $M=3.60$. The question in item 9 is “*I felt very confident using this game*”. This indicate that respondents were confident using digital game played by themselves. Table 5.17 showed the mean and standard deviation of each question in the SUS items.

Table 5.17: SUS Items

Items	Question	N		Mean	Std. Deviation
		Valid	Missing		
1	I think that I would like to use this game frequently.	10	0	3.30	1.418
2	I found this game unnecessarily complex.	10	0	2.70	.675
3	I thought this game was easy to use.	10	0	3.50	.707
4	I think that I would need assistance to be able to use this game.	10	0	2.80	.632
5	I found the various functions in this game were well integrated.	10	0	2.70	.823
6	I thought there was too much inconsistency in this game.	10	0	2.70	.483
7	I would imagine that most people would learn to use this game very quickly.	10	0	3.30	1.160
8	I found this game very cumbersome/awkward to use.	10	0	2.50	.972
9	I felt very confident using this game.	10	0	3.60	.843

Table 5.18: continued

10	I needed to learn a lot of things before I could get going with this game.	10	0	3.20	.632
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5.17 Summary

This chapter discussed the four quadrants in the proposed guideline, named The *Purpose*, *Design*, *Play* and *Experience* guideline. *Purpose* quadrant represents the first elements need to be considered by the game designer before design the digital game. The need to address of the game type and objectives are dependent on the target group of their user. Therefore, the game goals can be achieved. *Design* quadrant is the guidelines on how to design digital games specifically for older adults. *Play* quadrant represents the platform chosen to play the digital games. *Experience* quadrant represents how players' experience play with digital games. It is important to address the game design and attributes before designing and developing digital games specifically for older adults. The results obtained in this study shows that there are few designs consideration such as selection of font size, colours and level of challenges must be taken into in order to ensure older adults enjoy the process of interaction and experience with digital games.

CHAPTER 6

EVALUATION: FINAL STUDY

6.1 Introduction

This chapter covered the results obtained during Stage 3 (Further Analysis and Discussion). A detailed discussion on the results for final study is discussed. Otak Me! is an application developed based on the results obtained from Chapter 5. It was used in this study as a tool to evaluate the effectiveness of proposed guideline and it was tested with the participants consisted of older adults who participated in the final study. The design for Otak Me! application, rationale of the design and the relationship with the proposed guideline is described in detail. Data obtained from questionnaire is discussed using table and figures.

6.2 Results

All data obtained from the questionnaire were analyse using Microsoft Excel 2019 and IBM SPSS Statistics 22.

6.3 Purpose: Demographic and Technologies Usage

Figure 6.1 shows the location fraction for the participants participated in the final study. The number participants from Sabah and Perak are equally same, with seven participants from each state and two participants from Sarawak. The number of participants in each location is influenced by the sampling technique used in this research, snowball sampling and convenience sampling. Some of the participants were recruited from the pilot study conducted before.

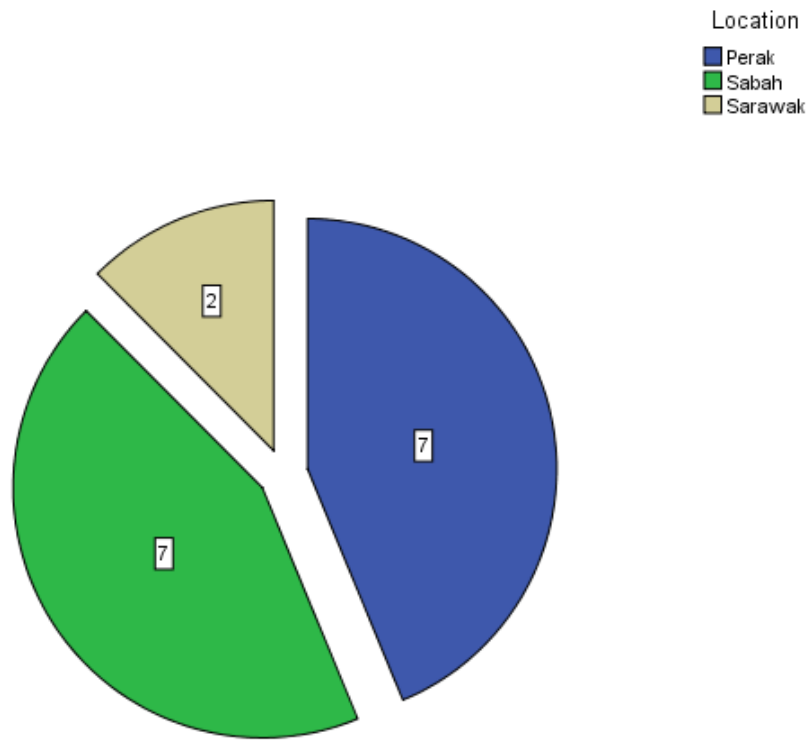


Figure 6.1: Participants' fraction based on location

Female participants are the dominant in this final study, with 11 out of 16 are them. There is various ethnicity of the participants in this study (i.e.: Sabahan, Sarawakian and Malay). These results influence by the location of the participants as they came from different state. In Malaysia, the common age for retirement is 55 years old. Based on the data obtained in this study, six of the participants are pensioner, five are unemployed, four as full-time worker and only one as part time worker.

In regards of participants' computer skills, most of them are novice user where skilled in web surfing and email instead of using various type of software. Twelve out of sixteen participants have no experience with digital games before participated in this study. Two of the experienced participants stated they played digital games every day and another two of them played occasionally and several times a week.

Table 6.1: Demographic data

		Frequency
Gender	Male	5
	Female	11
Ethnicity	Bumiputera Sabah	6
	Bumiputera Sarawak	2
	Malay	8
Employment Status	Pensioner	6
	Part Time Worker	1
	Full Time Worker	4
	Unemployed	5
Computer Skills	Competent- confident to use various software	3
	Novice- web surfing, email	12
	None- never used	1
Experience Playing Games	No	12
	Yes	4
Frequency of Playing Digital Games	Several times a week	1
	Occasionally	1
	Everyday	2
	Never Used	12

6.4 Design: Game Development

The first objective in this study is to identify the challenges related to older adults aged 55 to 75, their interactions and experiences with digital gaming, andragogical perspectives and game design attributes. Based on the results obtained from the Stage 1 and Stage 2 on the design recommendations, and application named Otak Me! application was developed using Unity software. There are three types of games in the application, named trivia, puzzle and paint. Each game is developed for a different purpose.

Each of the digital game listed by the respondents in Stage 2 is vary genres, therefore in the Otak Me! application, there are 3 different type of games embedded in. However, the main genres in the Otak Me! is puzzle, which has the highest number of digital games genre played by the respondents.



Figure 6.2: Otak Me! homepage

Trivia game is a type of game that allow player to trigger their memory to answer questions in the game, by ensuring player grasped the information offer in the game. There are three different categories in the trivia game, *MAKANAN*, *SEJARAH* and *TEMPAT*. Each of category in trivia game has 20 questions related to Malaysian society. Player is allowed to choose category to play. Each of correct answers will be rewarded 50 points and accumulated by the end of the game session. Player only allowed to pick three wrong answers in a row.



Figure 6.3: Trivia homepage

There are nine levels in puzzle game with different level of difficulty. Level 1 is the easiest level and level nine is the hardest level. The purpose of puzzle game is to improve older adults' cognitive function by focussing on their critical thinking. The mechanism of puzzle game is by rotating the pipe to ensure all pipes are connected to each other.

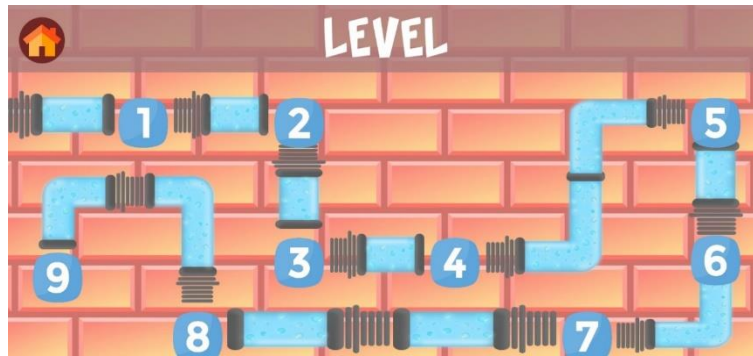


Figure 6.4: Puzzle homepage

Paint game has fifteen different types of shape for the player to draw. The mechanism of paint game is by imitating the object on the screen and draw the shape. When player successfully draw the shape, he or she will be directed to next level with different type of shape. Player is allowed to reset their painting by click the reset button on the screen. The purpose of paint game is to help and older adults' attention and focus during gameplay session by focus on one task at one time.



Figure 6.5: Paint interface

Each of graphics and interface in the Otak Me! application has considered the limitation of older adults to interact with digital technology especially digital game. The interfaces and graphics were designed with simple and easy to navigate.

Every interface in Otak Me! application is designed with simple interface and a smaller number of buttons. It adheres with the guideline given, where the interface must be

design simpler to ensure older adults not confuse with the interface during gameplay session. Otak Me! application does not contain any background music or sound in game to reduce the distraction of older adults during gameplay session. The games in Otak Me! is designed with different level of challenges, which to encourage older adults to feel motivated and continue to interact and play games.

6.5 Design: Proposed Guideline vs Otak Me!

Figure 6.6 shows the proposed guideline in this study. Otak Me! application was designed and developed based on the guidelines in the proposed guideline. There are four quadrants in the proposed guideline were referred during development process.

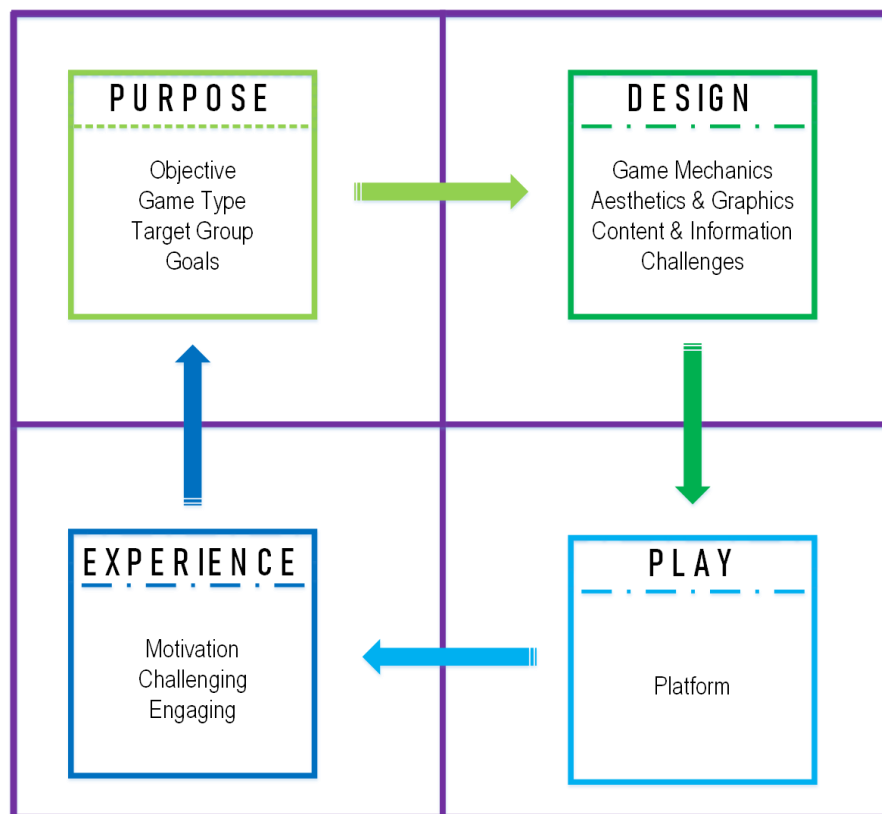


Figure 6.6: The Purpose, Design, Play and Experience guideline

The first quadrant is purpose. The main purpose of Otak Me! application is to become a platform for older adults to interact and experience with digital games that focusing on

their memory, attention, and critical skills. Different games are embedded in one application with different game mechanics, content, and information for the older adults to explore and experience with digital games. The elements in game, challenges, and graphics are designed specifically for older player with by considering their limitation.

6.6 Play: Platform

Otak Me! application is developed specifically for android operating devices. By considering the type of devices owned by participants in the pilot study (Stage 2), and the limitations of older adults, smartphones devices are suitable platform to let older adults interact and experience with digital games (Mohsin et al., 2022).

Based on the results gathered in the final study, the number of participants who owned smartphones devices are higher compared to other devices. Table 6.2 showed the summary of the devices owned by the participants in the final study.

Table 6.2: Devices owned by the participants

Type of devices	Number of participants owned the devices
Desktop	2
Laptop	5
Smartphone	15
MobilePhone	2

The fraction of devices owned by participants in Figure 6.7. The major fraction is on smartphone. To ensure the usage of digital games among older adults is utilised, it is important to ensure they have the knowledge on the devices used to play digital games. This statement is in line with the key principle of andragogy, readiness of learning.

Due to the number of older adults who owned smartphone in this study (Stage 2 and Stage 3), it can be conclude that older adults have the knowledge on how to operate the

devices and they know the devices interface. It can ease the learning process to interact and experience digital games.

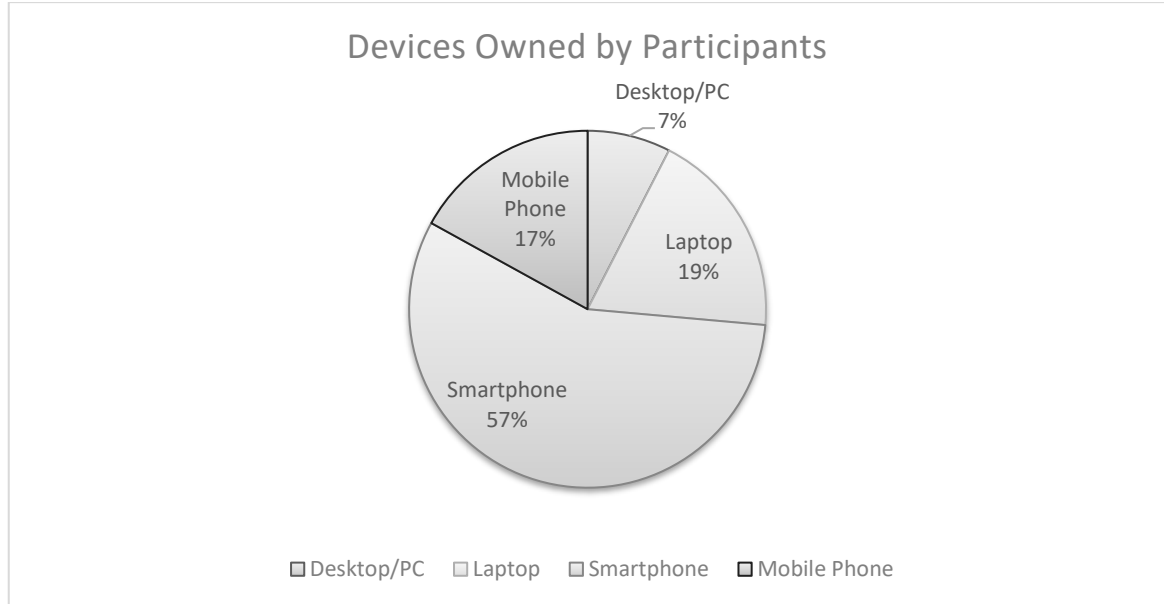


Figure 6.7: Fraction of the devices owned by participants

6.7 Experience: Game Experience Questionnaire (GEQ) and Questionnaire for User Interface Satisfaction (QUIS)

A reliability test was conducted to test the internal consistency of Game Experience Questionnaire (GEQ) and Questionnaire for User Interface Satisfaction (QUIS) used in this study. The value of Cronbach's Alpha is 0.878 for GEQ and 0.962 for QUIS, which are considered acceptable.

6.7.1 Game Experience Questionnaire

There are 33 items in the GEQ with different types of categories, immersion, flow, competence, tension, challenges, positive and negative affect. Table 7.3 summarised the results obtained with mean and standard deviation of each question.

In the first category, immersion, question number 1 "I was interested in the game's storyline" has the highest mean score, 4.00 with 12 of the participants agree with this

statement. It represents the storyline and the content in the game which attract the participants to play. The content and information in each game in Otak Me! application has been designed specifically for older adults. In this study the target group is older adults in Malaysia, therefore the questions in the trivia game are based on Malaysia society.

The second is flow. Question number 10, “I was deeply concentrated in the game” has the highest mean score, 4.00 compared to other questions. This result shows the participants able to understand the game flow and managed to give their attention and concentrated on the game during gameplay sessions. Paint game require older adults to concentrate on the shape given in game to ensure they managed to proceed to the next level.

Question 15 “I felt successful” has the highest mean score for competence category with value 4.00. The trivia and puzzle game were designed with different type of challenges. In trivia game, each of correct questions answered by participants will be reward with 50 points while for puzzle game allow older adults to complete the puzzle to form a complete pipe. When participants able to enjoy the mechanics of these two games, they will be able to feel successful.

Games in Otak Me! application is designed specifically for older adults, therefore the results obtained for tension category is low compared to another category. Most of the participants disagree with the statements for tension category.

With regard to the demographic data collected, only 4 out of 16 participants has experience playing digital game. Question 20, “I thought it was hard” has the highest mean in the challenges category, with mean score 3.13. This result represents the main concern of older adults where they thought the game mechanics might become one of their challenges to interact with it. However, the data in question 24 “I had to put a lot of effort into it”

showed that eight of the participants disagree with this statement. It shows that older adults do not have to put a lot of effort to interact and experience digital games. In addition, the timer which usually appear in trivia games has been omitted to reduce time pressure for older adults.

The main concern in this study is either older adults enjoyed during the gameplay session or not. The enjoyment is the key of the successful of the digital game where one of benefit playing digital game is, it can act as an entertainment tools for older adults (Mohsin et al., 2021). In positive affect category, result showed the mean value for question 27, “I felt happy” is 4.13 where represent the number of participants is agree that playing Otak Me! application gives happiness to them.

The last category is negative affect. The results showed the number of participants disagreed on this statement was high. In question 30, “It gave me a bad mood” has the least number of means, 1.75, which 12 out of 16 participants were disagree on this statement and 4 of them strongly disagree. Table 6.3 summarised the questions in GEQ.

Table 6.3: GEQ questions list

Category	Question	1	2	3	4	5	Mean	s.d
Immersion	Q1 I was interested in the game’s storyline	0	0	2	2	2	4.00	.516
	Q2 It was aesthetically pleasing	0	1	3	10	2	3.81	.750
	Q3 I felt imaginative	2	7	5	2	0	2.44	.892
	Q4 I felt that I could explore things	0	0	4	10	2	3.87	.619
	Q5 I found it impressive	0	0	3	11	2	3.94	.574
	Q6 It felt like a rich experience	1	1	7	6	1	3.31	.946
Flow	Q7 I was fully occupied with the game	0	5	7	4	0	2.94	.772
	Q8 I forgot everything around me	1	8	6	1	0	2.44	.727
	Q9 I lost track of time	2	5	8	1	0	2.50	.816
	Q10 I was deeply concentrated in the game	0	0	3	10	3	4.00	.632
	Q11 I lost connection with the outside world	2	7	6	1	0	2.38	.806

Table 6.4: continued

Competence	Q12	I felt skilful	0	2	1	13	0	3.69	.704
	Q13	I felt competent	1	1	6	7	1	3.38	.957
	Q14	I was good at it	0	2	3	10	1	3.63	.806
	Q15	I felt successful	0	0	2	12	2	4.00	.516
	Q16	I was fast at reaching the game's targets	0	1	5	9	1	3.62	.719
Tension	Q17	I felt annoyed	4	11	1	0	0	1.81	.544
	Q18	I felt irritable	3	12	1	0	0	1.87	.500
	Q19	I felt frustrated	1	13	2	0	0	2.06	.443
Challenge	Q20*	I thought it was hard	1	3	5	7	0	3.13	.957
	Q21	I felt pressured	3	12	1	0	0	1.87	.500
	Q22	I felt challenged	0	7	6	2	1	2.81	.911
	Q23	I felt time pressure	2	9	4	1	0	2.25	.775
	Q24	I had to put a lot of effort into it	0	8	6	2	0	2.63	.719
Positive Affect	Q25	I felt content	0	0	3	11	2	3.94	.574
	Q26	I thought it was fun	0	0	1	13	2	4.06	.443
	Q27	I felt happy	0	0	0	14	2	4.13	.342
	Q28	I felt good	0	0	3	11	2	3.94	.574
	Q29	I enjoyed it	0	0	2	12	2	4.00	.516
Negative Affect	Q30	It gave me a bad mood	4	12	0	0	0	1.75	.447
	Q31	I thought about other things	0	8	6	2	0	2.63	.719
	Q32	I found it tiresome	1	14	0	1	0	2.06	.574
	Q33	I felt bored	1	11	4	0	0	2.19	.544

** 1: strongly disagree, 2: disagree, 3: neutral, 4: agree, 5: strongly agree

Figure 6.8 shows the mean score for each category in the GEQ. Positive affect has the highest mean score, and tension category has the least mean score value. This result shows that playing digital games can give positive affect towards older adults. It prove one of the benefits playing digital games, which is gives enjoyment toward older player (Mohsin et al., 2021). Beside positive affect, mean score for immersion and competence category shows higher value. Both categories are dependent on the game design and mechanics. The questions listed for both category (refer Table 6.3) is related to the storyline, interface, and the mechanics of each game in the application. Based on the result obtained, it can be concluded that games in the Otak Me! application has been well designed specifically for older adults.



Figure 6.8: GEQ category

The mean score for flow category is dependent on how older adults immerse to the games during gameplay session. Although the games in Otak Me! applications has been designed by considering the limitation for older adults such as memory and attention, physical and spatial cognition (Mohsin et al., 2021), the games unable to make older adults to fully immerse themselves into the gameplay session. They are still able to connect with other things while playing digital games.

Tension, challenge, and negative affect category are related to one another. Based on the results obtained, the data shows older adults are disagree on most of the question listed for this category. In question 20 (refer Table 6.3), the data shows 7 out of 16 participants agree on this statement. It shows that older adults have the perception that playing digital games is hard, which require more skills from them. This statement can be related to the key principle of andragogy, where they must understand the rationale of playing and have knowledge and own styles and methods of game-based learning. In this study, the research design has been design aligned with the key principle of andragogy in order to ensure that older adults able to interact and experience with digital games.

6.7.2 Questionnaire for User Interaction Satisfaction

There are five categories in QUIS are analysed, include overall reaction to the game, screen, terminology/information, learning how to use and system performance. Table 6.4 shows the results obtained from the testing (Stage 4).

The first category is participants' overall reaction to the game. Based on the data obtained, question 3, "satisfying" has the highest mean compared to other questions, with value 4.06. These results showed that participants in this study are more likely to satisfied with the overall functions and interface designed in Otak Me! application. Most of the responses gathered in this category is acceptable as only one participant stated disagree on question 5 "stimulating". After crosschecking the data, participants who disagree on this question has experience on playing digital games and currently play real time strategy game. The games in Otak Me! are more of a brain training game, requiring only a small amount of thinking skills in comparison to the current play game.

The second category is screen. There is only a small number of different mean values for all questions in this category. Question 8, "clear organisation" has the highest value, 3.88. This represent the interface in Otak Me! has been designed and organised clearly. It is important to design the interface with easy and clear instructions, especially for older adults, to ensure that there is no confusion in navigating the application while enjoying the gameplay session.

Terminology and information are related to the information entered into the Otak Me! application. Based on the results, the mean value for all questions in this category has only small differences, where question 10 has the highest mean value, 3.94. This result can

be concluded that all information, features, and interface has been designed consistently and the participants are able to understand.

Learning how to use is related to the andragogy principles, where the participants in this study need to learn how to use and interact with Otak Me! application. In this study, we use the demonstration approach, where we explained and demonstrated how the application works before letting the older adults use it. The key principle of andragogy in this method is to ensure that participants have the knowledge and own styles of how to use the Otak Me! application. Based on the results obtained for this category, there is no participants stated disagree on all questions listed in this category. This demonstrated that the approach used is appropriate for approaching adult learners.

The last category is system performance which is related to the game mechanics itself. The mean value for all questions has small difference between each other, where question 20, “reliable system” has the highest mean value, 4.00. It shows the Otak Me! application is reliable for older adults.

Table 6.5: QUIS questions list

Category	Question	1	2	3	4	5	Mean	s.d
Overall reaction to the game	Q1 Wonderful	0	0	3	11	2	3.94	.574
	Q2 Easy	0	0	4	9	3	3.94	.680
	Q3 Satisfying	0	0	1	13	2	4.06	.443
	Q4 Adequate power	0	0	4	10	2	3.88	.619
	Q5 Stimulating	0	1	1	12	2	3.94	.680
	Q6 Flexible	0	0	4	10	2	3.87	.619
Screen	Q7 Easy legible	0	1	3	10	2	3.81	.750
	Q8 Clear organisation	0	0	4	10	2	3.88	.619
	Q9 Clear order	0	1	5	8	2	3.69	.793
Terminology/Information	Q10 Consistent	0	0	3	11	2	3.94	.574
	Q11 Related to work	0	1	6	9	0	3.50	.632

Table 6.6: continued

	Q12	Consistent position of message on the screen	0	0	5	11	0	3.69	.479
	Q13	Provides the information on the current task.	0	0	6	10	0	3.62	.500
	Q14	Useful alert message	0	0	5	9	2	3.81	.655
Learning how to use	Q15	Easy to learn how to use	0	0	1	13	2	4.06	.443
	Q16	Easy to find new function	0	0	6	8	2	3.75	.683
	Q17	Easy to remember how to use	0	0	3	11	2	3.94	.574
	Q18	Easy to operate	0	0	3	11	2	3.94	.574
System performance	Q19	Sufficiently fast system speed	0	0	5	7	4	3.94	.772
	Q20	Reliable system	0	0	2	12	2	4.00	.516
	Q21	Easy to correct error data	0	1	5	8	2	3.69	.793
	Q22	Consider both novice and skilled user	0	0	4	9	3	3.94	.680

Figure 6.9 shows the mean value trends for the category in QUIS. There is only smallest difference between the category, where overall reaction towards the Otak Me! application has the highest mean followed by learning and system performance.

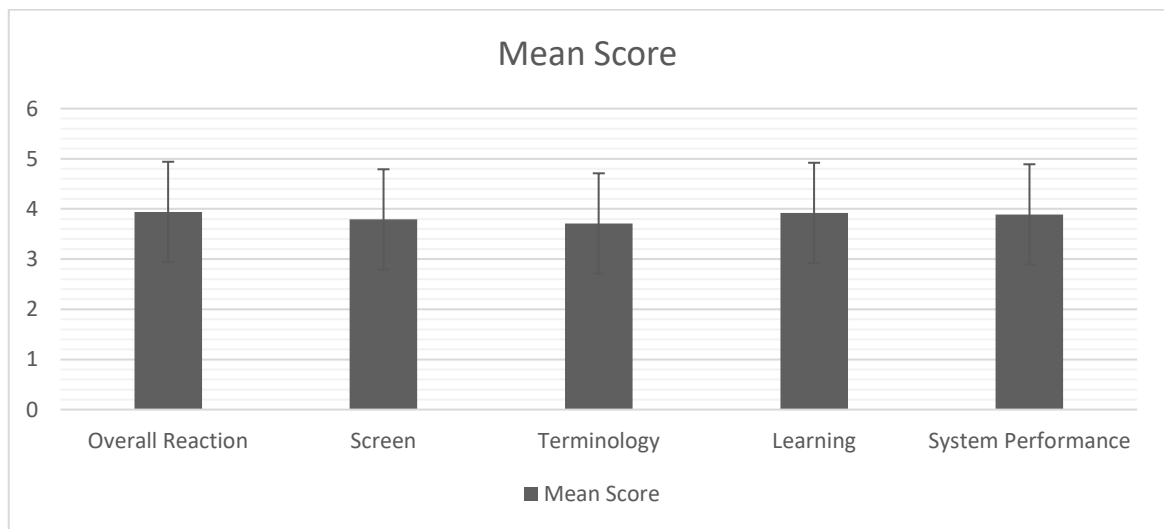


Figure 6.9: QUIS category

Based on the overall mean score in the QUIS category, it shows the Otak Me! application has been well designed to cope with older adults' limitation. The overall reaction category is representing the reaction towards the overall functions in the application.

6.8 Summary

This chapter summarised the overall findings in the final study. A detailed result and analysis obtained were presented and discussed. The evaluation of the effectiveness of the constructed guideline is based on the findings in this chapter. Otak Me! application is a tool to test the effectiveness of the constructed guideline. GEQ and QUIS is used to measure the effectiveness of the constructed guideline. Based on the result obtained, positive affect items in the GEQ have the highest means score compared to other items in GEQ. This can be concluded that participants in this study enjoyed the process of interaction and experience with Otak Me! application. In term of user interface satisfaction, QUIS is used to measure it. The mean score between the items in QUIS only has smaller differences between each other.

CHAPTER 7

CONCLUSION

7.1 Introduction

The aim in this study is to identify user interaction and experience with digital games on mobile platforms focussing on older adults between age of 55 to 75.

The research questions and research design were developed and formulated to achieve the aim for this study. The outcome for this study has contributed to the knowledge through the identification of user interaction and experience with digital games on mobile platforms focussing on older adults between 55 years and above. User interactions are consisting of older adults' interaction with the platform (smartphone and tablet) through digital games and the interaction between players. User experiences are related to the older adults' perception and response occurred from the interaction between players, platform, and gameplay session. The findings of this study can be viewed as a steppingstone toward providing guidelines for designing and developing digital games for older adults. The key elements to achieve this objective, the adoption of key principles of andragogy and challenges of older adults to interact with digital game technology were taken into consideration. It is important to acknowledge the limitations and the design considerations for older adults before design and develop digital games for this population.

This study employs a research design that combines mixed method approaches. A qualitative and quantitative approaches were applied for the data collection process (Stage 2 and Stage 3). This study is significant as it has identified the guideline to design and develop

digital games specifically for older adults with the consideration of the challenges and adopting the andragogical perspectives.

This chapter gives the general summary and the conclusion for all chapters (Chapter 1-7), the contributions and of this study and a brief discussion on the potential of future research.

7.2 Discussion of Results

This study aimed to address research questions as followed:

- i. What are the challenges related to the older adults interact with digital game technology that needs to be considered?

The process to identify the challenges related older adults interact with digital games occurred in Stage 1-4 where the involved qualitative and quantitative approaches. In Stage 1 and Stage 2, a brief discussion of the challenges address in previous study conducted by other researchers and the data obtained in the pilot study are discussed. The challenges are break into four categories: memory and attention, spatial cognition, understanding and physical. Most of the challenges were influenced by their ability, where most of the experienced decline in cognitive and physical abilities. Therefore, the challenges were addressed in this study while constructing the guideline to design and develop digital games specifically for older adults.

- ii. How can their game experiences influence design considerations?

The gaming experience of the older adults were measured in Stage 2 and Stage 3. GEQ and SUS were used as tools to measure the game experience during Stage 2, while in Stage 3, combination and GEQ and QUIS were used. Each of participants in this study have

different level of gaming experience, especially in Stage 2, where they played different type of digital games from one another, whereas in Stage 3, the games played were same as they were asked to play the Otak Me! application. Otak Me! is an application which act as a tool to evaluate the constructed guideline. Based on the results obtained in both stages, the game design influences the game experience for older adults.

- iii. How do player interactions and experiences with digital game technology influence older adult's perceptions toward technology?

In Stage 2 and Stage 3, participants were asked their perception on older adults playing digital games. Most of them stated that playing digital games irrelevant for older adults and waste of time. Therefore, the adoption of principle of andragogy into this study plays the important role to ensure the target group understand the important and the benefits they gained while playing digital game. Data obtained in Stage 3 showed the participants enjoyed the gameplay session despite they did not have experience playing digital games before.

7.3 Study Contributions

Chapter 2 discussed the number of research conducted by the previous researchers on design and develop digital games for older adults. However, most of the research does not adopt the key principles of andragogy in their research. To design and develop digital games specifically for older adults, there are few considerations need to be considered especially on the interaction and experience of older adults. The outcome of this study has found and listed the guideline on how to design and develop digital games based on the constructed guideline. There are four major items in the guideline, game mechanic, aesthetics and graphics, content and information and challenges. Please refer to Table 5.6 in

Chapter 5 for a detailed explanation of the guidelines on how to design and develop digital games for older adults.

7.3.1 Process of Guideline Development

The methods and approaches used in this study can be applied by researchers, academicians, and game designers to design and develop digital games for older adults. A mixed-method approaches were used in this study, with the combination of qualitative and quantitative method for data collection process. The methods used in this study managed to obtain information from different aspects of perspectives and angles. In addition, this study correlates the attributes of the game technology with the consideration of the challenges of older adults to interact and experience with digital games and the andragogical perspectives. Figure 7.1 illustrates the summary of the research design flowchart used in this study.

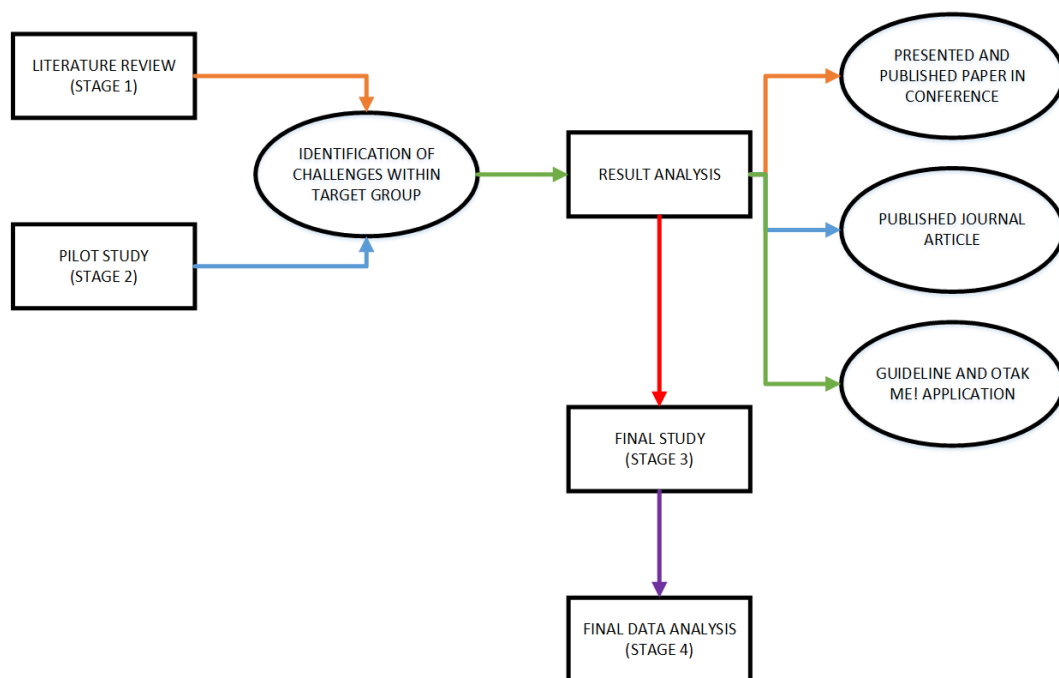


Figure 7.1: Summary of research design flowchart

There are four stages research design in this study. Stage 1 and 2 are the process to identify the challenges for the older adults to interact with digital games which include the

limitations and the design consideration for the target group. Different types of approaches were used during the identification process: qualitative and quantitative methods. In Stage 1, the method used was keyword searched in research databases, where the rationale is to understand the problems and investigate the gap knowledge within the area of study, meanwhile in Stage 2, distribution of questionnaires to the target group by using snowball and convenience sampling techniques and conducted informal interview sessions were used. The data obtained from these two stages were analysed and the data were presented and published in a conference and journal. Apart from that, the data gathered also used to construct the proposed guideline in this study, the guidelines to design and develop digital games for older adults.

Otak Me! application is an application that developed based on the guideline from the constructed guideline, which use as a tool to evaluate the effectiveness of proposed guideline. The evaluation process for the constructed guideline occurred in Stage 3, where the games in the Otak Me! application were tested to the target group in this study. Qualitative and quantitative methods were used in the process to evaluate the constructed guideline, include demonstration, observation, gameplay, informal interview, and questionnaire distribution. Two different types of questionnaires used in the final study, Game Experience Questionnaire (GEQ) and Questionnaire for User Interface (QUIS). The data obtained from this study used in the Stage 4, which the analysis process occurred to verify the effectiveness of the constructed guideline.

7.4 Study Limitations

There are several issues that have been encountered during this study. The issues are as follows:

i. Difficulty in recruiting the target group.

This study started on December 2019 before the pandemic started. Although it initiated before the pandemic, the recruiting process for data collection was started on March 2020, which the pandemic begins in all over the world. With the limitation of movement and restriction order in Malaysia, the recruiting process become difficult. In this study, the target participants were older adults aged between 55 and above, where they are considered as a fragile community to Covid19 virus. Therefore, the process for data collection in Stage 2 and Stage 3 are facing difficulty as the gameplay session were conducted remotely instead of face-to-face session.

The invitation for participation in this study were distributed by using email, social media, and word of mouth. However, only few of the older adults were agreeing to involve in this study. Some of the participants who agreed to participate in this study withdraw themselves from participating due to personal reasons.

Despite the challenges in recruiting the target group in this study, a few older adults were managed recruited during the pandemics. The sampling techniques chosen are able to recruit more participants in this study.

ii. Sample size of target group

The Department of Statistics (2020) has reported that Malaysia has 3.5 million of older adults, however only small number of target group participated in this study. In Stage 2, there were two data collection method were used, quantitative (questionnaire) and qualitative (informal interview). The number of respondents during quantitative is higher than participants in qualitative method. This happens due to the requirements stated in this

study, where only older adults who have experience with digital games are eligible to participate in the informal interview session. The rationale on the requirement is to investigate their challenges they experienced during gaming session and their design consideration for digital games based on their previous gaming experience. Therefore, the number of the participants in the informal interview is relatively small compared to respondents for the questionnaire. The requirement for questionnaire is open for all older adults in Malaysia, aged 55 and above and there is no restriction on gaming experience. The objective of the questionnaire is to investigate the opinions on older adults playing digital games and their perception on the digital games and the design itself.

During the final study, only 16 participants were participated to test the prototype (Otak Me! application). Thus, the data to evaluate the effectiveness of the constructed guideline is not represent the whole population for older adults in Malaysia. In order to back up the data, a mixed method between qualitative and quantitative approaches were applied to enrich the findings in this study.

7.5 Area of Future Research

With the growing number of older adults worldwide, there are potential of the usage digital games to improve their quality of life. Therefore, to improve this study, the study limitations must be taken into consideration. A large number of the participants participate into future study is recommended to get better understanding on older adults and digital games.

Besides that, conducting a face-to-face session instead of remote session can help to reduce the confusion of older adults on how to play digital game, as not all older adults have

the knowledge to use the digital devices. The age range can be broadened into few subgroups in order to understand the comparison of gaming needs and preferences of older adults.

REFERENCES

- Astell, A., Alm, N., Dye, R., Gowans, G., Vaughan, P., & Ellis, M. (2014). Digital video games for older adults with cognitive impairment. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 8547 LNCS(PART 1), 264–271. https://doi.org/10.1007/978-3-319-08596-8_42
- Awad, M., & Craig, C. (2017). Players' Performance in Cross Generational Game Playing. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* (Vol. 10622 LNCS, pp. 170–182). https://doi.org/10.1007/978-3-319-70111-0_16
- Barbara, J. (2014). Measuring user experience in board games. *International Journal of Gaming and Computer-Mediated Simulations*, 6(1), 64–79. <https://doi.org/10.4018/ijgcms.2014010105>
- Barenbrock, A., Herrlich, M., & Malaka, R. (2015). Design lessons from mainstream motion-based games for exergames for older adults. *Conference Proceedings - 2014 IEEE Games, Media, Entertainment Conference, IEEE GEM 2014*, 1–8. <https://doi.org/10.1109/GEM.2014.7048096>
- Blažič, B. J., & Blažič, A. J. (2019). Overcoming the digital divide with a modern approach to learning digital skills for the elderly adults. *Education and Information Technologies*, (Ferrari 2012). <https://doi.org/10.1007/s10639-019-09961-9>
- Boletsis, C., & McCallum, S. (2016). Smartkuber: A Serious Game for Cognitive Health Screening of Elderly Players. *Games for Health Journal*, 5(4), 241–251. <https://doi.org/10.1089/g4h.2015.0107>

- Brown, J. A. (2017). *Human Aspects of IT for the Aged Population. Applications, Services and Contexts*. (J. Zhou & G. Salvendy, Eds.), *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* (Vol. 10298). Cham: Springer International Publishing. <https://doi.org/10.1007/978-3-319-58536-9>
- Chi, H., Agama, E., & Prodanoff, Z. G. (2017). Developing serious games to promote cognitive abilities for the elderly. *2017 IEEE 5th International Conference on Serious Games and Applications for Health, SeGAH 2017*, 1–8. <https://doi.org/10.1109/SeGAH.2017.7939279>
- Chin, J. P., Diehl, V. A., & Norman, K. L. (1988). Development of an instrument measuring user satisfaction of the human-computer interface. *Conference on Human Factors in Computing Systems - Proceedings, Part F1302*, 213–218. <https://doi.org/10.1145/57167.57203>
- Chin, Y. J., Lim, W. N., & Lee, C. S. (2017). Mobile game for the elderly: Bundled bingo game. *IEEE Region 10 Annual International Conference, Proceedings/TENCON, 2017-Decem*, 2262–2267. <https://doi.org/10.1109/TENCON.2017.8228238>
- Codreanu, I. A., & Florea, A. M. (2015). A Proposed Serious Game Architecture to Self-Management HealthCare for Older Adults. In *2015 17th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing (SYNASC)* (pp. 437–440). IEEE. <https://doi.org/10.1109/SYNASC.2015.71>
- Cota, T. T., Ishitani, L., & Vieira, N. (2015). Mobile game design for the elderly: A study with focus on the motivation to play. *Computers in Human Behavior*, 51(PA), 96–105. <https://doi.org/10.1016/j.chb.2015.04.026>
- Creswell, J. W. (2003). *Research Design: Qualitative, Quantitative, and Mixed Method*

Approaches (2nd ed.). Sage Publication, Inc.

- Cruz, M., Kugel, J. D., Hewitt, L., & Salamat, A. (2018). Perceptions of Older Adults on the Use of an Interactive Video Game in Promoting Health and Well-Being. *The Open Journal of Occupational Therapy*, 6(3). <https://doi.org/10.15453/2168-6408.1490>
- De Oliveira Santos, L. H., Okamoto, K., Funghetto, S. S., Cavalli, A. S., Hiragi, S., Yamamoto, G., ... Kuroda, T. (2019). Effects of social interaction mechanics in pervasive games on the physical activity levels of older adults: Quasi-experimental study. *Journal of Medical Internet Research*, 21(7). <https://doi.org/10.2196/13962>
- Department of Statistics. (2020). *Current Population Estimates. Department of Statistics Malaysia*. Putrajaya, Malaysia: Department of Statistics, Malaysia. Retrieved from https://www.dosm.gov.my/v1/index.php?r=column/cthemByCat&cat=155&bul_id=aWJZRkJ4UEdKcUZpT2tVT090Snpydz09&menu_id=L0pheU43NWJwRWVVSZklWdzQ4TlhUUT09
- Dias, J., Veloso, A. I., & Ribeiro, T. (2019). “A Priest in the Air.” In *2019 14th Iberian Conference on Information Systems and Technologies (CISTI)* (Vol. 2019-June, pp. 1–7). IEEE. <https://doi.org/10.23919/CISTI.2019.8760748>
- Dupl  a, E., Kaufman, D., Sauv  , L., Renaud, L., & Ireland, A. (2017). Can Mobile Digital Games Benefit Older Adults’ Health? (pp. 115–146). https://doi.org/10.1007/978-3-319-60672-9_6
- Garcia, J. A. (2018). Assessing the validity of in-game stepping performance data from a kinect-based fall prevention exergame. *2018 IEEE 6th International Conference on Serious Games and Applications for Health, SeGAH 2018*, 1–7. <https://doi.org/10.1109/SeGAH.2018.8401317>
- Garcia, J. A., Raffae, W. L., & Navarro, K. F. (2018a). Assessing user engagement with a fall

- prevention game as an unsupervised exercise program for older people. In *Proceedings of the Australasian Computer Science Week Multiconference* (p. 8). New York, NY, USA: Association for Computing Machinery. <https://doi.org/10.1145/3167918.3167943>
- Garcia, J. A., Raffaele, W. L., & Navarro, K. F. (2018b). Assessing user engagement with a fall prevention game as an unsupervised exercise program for older people. *ACM International Conference Proceeding Series*. <https://doi.org/10.1145/3167918.3167943>
- Gerling, Kathrin M., Livingston, I. J., Nacke, L. E., & Mandryk, R. L. (2012). Full-body motion-based game interaction for older adults. In *Conference on Human Factors in Computing Systems - Proceedings* (pp. 1873–1882). New York, NY, USA: Association for Computing Machinery. <https://doi.org/10.1145/2207676.2208324>
- Gerling, Kathrin M., Schulte, F. P., Smeddinck, J., & Masuch, M. (2012). Game Design for Older Adults: Effects of Age-Related Changes on Structural Elements of Digital Games. Herrlich M., Malaka R., Masuch M. (Eds) *Entertainment Computing - ICEC 2012. ICEC 2012. Lecture Notes in Computer Science*, 7522(August 2018), 349–362. <https://doi.org/10.1007/978-3-642-33542-6>
- Guimarães, V., Pereira, A., Oliveira, E., Carvalho, A., & Peixoto, R. (2018). Design and evaluation of an exergame for motor-cognitive training and fall prevention in older adults. *ACM International Conference Proceeding Series*, 202–207. <https://doi.org/10.1145/3284869.3284918>
- Hall, A. K., & Marston, H. R. (2014). Gaming and Older Adults in the Digital Age of Healthcare. Van Hoof J., Demiris G., Wouters E. (Eds) *Handbook of Smart Homes, Health Care and Well-Being*, (January 2014), 1–9. <https://doi.org/10.1007/978-3-319->

- Hamid, T. A. (2019). Ageing in Malaysia, (February).
- Hausknecht, S., Schell, R., Zhang, F., & Kaufman, D. (2015). Building Seniors' Social Connections and Reducing Loneliness Through a Digital Game. In *Proceedings of the 1st International Conference on Information and Communication Technologies for Ageing Well and e-Health* (pp. 276–284). SCITEPRESS - Science and Technology Publications. <https://doi.org/10.5220/0005526802760284>
- Hersh, M., & Leporini, B. (2019). *Serious Games for the Rehabilitation of Disabled People: Results of a Multilingual Survey* (Vol. 1002). Springer International Publishing. <https://doi.org/10.1007/978-3-030-16785-1>
- Hongmei Chi, Agama, E., & Prodanoff, Z. G. (2017). Developing serious games to promote cognitive abilities for the elderly. In *2017 IEEE 5th International Conference on Serious Games and Applications for Health (SeGAH)* (pp. 1–8). IEEE. <https://doi.org/10.1109/SeGAH.2017.7939279>
- Ibrahim, W. M. S. W., Ashi, S. H. M., Othman, N. H., Zukri, S. F. M., Anwar, R., Miskiman, N., ... Shukor, F. A. A. (2017). Population and Demographics: Ageing, pp. 1–2.
- IJsselsteijn, W. A., de Kort, Y. A. W., & Poels, K. (2013). *The Game Experience Questionnaire*. Eindhoven: Technische Universiteit Eindhoven. Retrieved from https://pure.tue.nl/ws/files/21666907/Game_Experience_Questionnaire_English.pdf
- IJsselsteijn, W., Hoogen, W. Van Den, Klimmt, C., Kort, Y. De, Lindley, C., Mathiak, K., ... Vorderer, P. (2008). Measuring the Experience of Digital Game Enjoyment. *Journal of Personality*, 2008(June 2014), 7–8.
- IJsselsteijn, W., Nap, H. H., De Kort, Y., & Poels, K. (2007). Digital game design for elderly users. *Proceedings of the 2007 Conference on Future Play, Future Play '07*, 17–22.

<https://doi.org/10.1145/1328202.1328206>

- Jali, S. K., & Arnab, S. (2016). The andragogical perspectives of older people's interaction with digital game technologies: Gameplay on gesture and touch-based platforms. *Proceedings of the European Conference on Games-Based Learning, 2016-Janua*, 319–326.
- Jali, S. K., & Arnab, S. (2017a). The Perspectives of Older People on Digital Gaming : Interactions with Console The Perspectives of Older People on Digital Gaming : Interactions with Console and Tablet-based Games. Vaz de Carvalho C., Escudeiro P., Coelho A. (Eds) *Serious Games, Interaction and Simulation. SGAMES 2016. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering*, 176(December). <https://doi.org/10.1007/978-3-319-51055-2>
- Jali, S. K., & Arnab, S. (2017b). The Perspectives of Older People on Digital Gaming: Interactions with Console and Tablet-Based Games. In *Lecture Notes of the Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering, LNICST* (Vol. 176 LNICST, pp. 82–90). https://doi.org/10.1007/978-3-319-51055-2_11
- Kaufman, D., & Sauve, L. (2019). Digital Gaming by Older Adults: Can It Enhance Social Connectedness? In Zhou J., Salvendy G. (eds) *Human Aspects of IT for the Aged Population. Social Media, Games and Assistive Environments. HCII 2019. Lecture Notes in Computer Science* (Vol. 11593, pp. 167–176). Springer International Publishing. https://doi.org/10.1007/978-3-030-22015-0_13
- Kaufman, D., Sauvé, L., Renaud, L., Sixsmith, A., & Mortenson, B. (2016). Older Adults' Digital Gameplay: Patterns, Benefits, and Challenges. *Simulation and Gaming*, 47(4),

465–489. <https://doi.org/10.1177/1046878116645736>

Kaufman, D., & Zhang, F. (2015). Can Playing Massive Multiplayer Online Role Playing Games (MMORPGs) Help Older Adults? In *Proceedings of the 1st International Conference on Information and Communication Technologies for Ageing Well and e-Health* (Vol. 1, pp. 527–535). SCITEPRESS - Science and Technology Publications. <https://doi.org/10.5220/0005551405270535>

Khalili-Mahani, N., De Schutter, B., Mirgholami, M., Holowka, E. M., Goodine, R., DeJong, S., ... Sawchuk, K. (2020). For Whom the Games Toll: A Qualitative and Intergenerational Evaluation of What is Serious in Games for Older Adults. *The Computer Games Journal*, 9(2), 221–244. <https://doi.org/10.1007/s40869-020-00103-7>

Khalili-Mahani, N., de Schutter, B., & Sawchuk, K. (2020). *The Relationship Between the Seniors' Appraisal of Cognitive-Training Games and Game-Related Stress Is Complex: A Mixed-Methods Study. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* (Vol. 12426 LNCS). Springer International Publishing. https://doi.org/10.1007/978-3-030-60149-2_45

Kowal, P. (2014). Definition of an older person. Proposed working definition of an older person in Africa for the MDS Projaect., (January 2001). <https://doi.org/10.13140/2.1.5188.9286>

Ku, C.-H., Huang, S.-L., & Li, T.-Y. (2016). *Serious Games, Interaction, and Simulation*. (C. Vaz de Carvalho, P. Escudeiro, & A. Coelho, Eds.), *Lecture Notes of the Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering, LNICST* (Vol. 161). Cham: Springer International Publishing.

<https://doi.org/10.1007/978-3-319-29060-7>

- Law, E. L. C., & Sun, X. (2012). Evaluating user experience of adaptive digital educational games with Activity Theory. *International Journal of Human Computer Studies*, 70(7), 478–497. <https://doi.org/10.1016/j.ijhcs.2012.01.007>
- Leporini, B., & Hersh, M. (2016). Games for the rehabilitation of disabled people. In *Proceedings of the 4th Workshop on ICTs for Improving Patients Rehabilitation Research Techniques* (pp. 109–112). New York, NY, USA: Association for Computing Machinery. <https://doi.org/10.1145/3051488.3051496>
- Lewis, J. R., & Sauro, J. (2018). Item Benchmarks for the System Usability Scale. *Journal of Usability Studies*, 13(3), 158–167.
- Lin, C. T., & Chuang, S. S. (2019). A Study of Digital Learning for Older Adults. *Journal of Adult Development*, 26(2), 149–160. <https://doi.org/10.1007/s10804-018-9314-0>
- Lin, H., Hou, J., Yu, H., Shen, Z., & Miao, C. (2016). An agent-based game platform for exercising people's prospective memory. *Proceedings - 2015 IEEE/WIC/ACM International Joint Conference on Web Intelligence and Intelligent Agent Technology, WI-IAT 2015*, 3, 235–236. <https://doi.org/10.1109/WI-IAT.2015.42>
- Lin, Y.-H., Mao, H.-F., Tsai, Y.-C., & Chou, J.-J. (2018). Developing a serious game for the elderly to do physical and cognitive hybrid activities. In *2018 IEEE 6th International Conference on Serious Games and Applications for Health (SeGAH)* (pp. 1–8). IEEE. <https://doi.org/10.1109/SeGAH.2018.8401314>
- Loeng, S. (2018). Various ways of understanding the concept of andragogy. *Cogent Education*, 5(1), 1–15. <https://doi.org/10.1080/2331186X.2018.1496643>
- Loos, E., & Zonneveld, A. (2016). *Human Aspects of IT for the Aged Population. Healthy and Active Aging*. (J. Zhou & G. Salvendy, Eds.), *ACM/IEEE International Conference*

- on *Human-Robot Interaction* (Vol. 9755). Cham: Springer International Publishing.
<https://doi.org/10.1007/978-3-319-39949-2>
- Malliarakis, C., Tomos, F., Shabalina, O., & Mozelius, P. (2018). Andragogy and e.M.o.t.i.o.n.: 7 key factors of successful serious games. In *Proceedings of the 12th European Conference on Games Based Learning (ECGBL 2018)* : (Vol. 12, pp. 371–378).
- Mansor, N. S., Chow, C. M., & Halaki, M. (2020). Cognitive effects of video games in older adults and their moderators: a systematic review with meta-analysis and meta-regression. *Aging and Mental Health*. Routledge. <https://doi.org/10.1080/13607863.2019.1574710>
- Merilampi, S., Chen, J., Koivisto, A., Sirkka, A., Raunonen, P., Virkki, J., ... Chujun, X. (2017). The cognitive mobile games for older adults - a Chinese user experience study. In *2017 IEEE 5th International Conference on Serious Games and Applications for Health (SeGAH)* (pp. 1–6). IEEE. <https://doi.org/10.1109/SeGAH.2017.7939280>
- Merilampi, S., Koivisto, A., & Virkki, J. (2018). Activation game for older adults - Development and initial user experiences. *2018 IEEE 6th International Conference on Serious Games and Applications for Health, SeGAH 2018*, 1–5. <https://doi.org/10.1109/SeGAH.2018.8401351>
- Merriman, N. A., Roudaia, E., Romagnoli, M., Orvieto, I., & Newell, F. N. (2018). Acceptability of a custom-designed game, CityQuest, aimed at improving balance confidence and spatial cognition in fall-prone and healthy older adults. *Behaviour and Information Technology*, 37(6), 538–557. <https://doi.org/10.1080/0144929X.2018.1462402>
- Mihajlov, M., Law, E. L.-C., & Springett, M. (2016). The Effect of Dyadic Interactions on

- Learning Rotate Gesture for Technology-Naïve Older Adults. In *Proceedings of the International Symposium on Interactive Technology and Ageing Populations - ITAP '16* (pp. 99–108). New York, New York, USA: ACM Press.
<https://doi.org/10.1145/2996267.2996277>
- Mitgutsch, K., & Alvarado, N. (2012). Purposeful by design?: A serious game design assessment framework. *Foundations of Digital Games 2012, FDG 2012 - Conference Program*, 121–128. <https://doi.org/10.1145/2282338.2282364>
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Medicine*, 6(7), e1000097. <https://doi.org/10.1371/journal.pmed.1000097>
- Mohsin, N. F., Jali, S. K., Arnab, S., Bandan, M. I., & Ma, M. (2022). The Adoption of Digital Games Among Older Adults. *International Journal of Advanced Computer Science and Applications (IJACSA)*, 13(2), 39–45. <https://doi.org/10.14569/IJACSA.2022.0130205>
- Mohsin, N. F., Jali, S. K., Bandan, M. I., Jali, N., & Jupit, A. J. R. (2021). Older Adults and Digital Game Trends , Challenges and Benefits. In *2021 IEEE Asia-Pacific Conference on Computer Science and Data Engineering (CSDE)* (pp. 1–6). Brisbane, Australia: IEEE. <https://doi.org/10.1109/CSDE53843.2021.9718445>
- Motti, L. G., Vigouroux, N., & Gorce, P. (2015). Improving Accessibility of Tactile Interaction for Older Users: Lowering Accuracy Requirements to Support Drag-and-Drop Interaction. *Procedia Computer Science*, 67(Dsai), 366–375. <https://doi.org/10.1016/j.procs.2015.09.281>
- Muhamad, M., Razak, F. H. A., & Haron, H. (2018). A Conceptual Framework for Co-design Approach to Support Elderly Employability Website. In *5th International*

- Conference, i-USER 2018* (pp. 114–124). https://doi.org/https://doi.org/10.1007/978-981-13-1628-9_11
- Nagalingam, V., & Ibrahim, R. (2015). User Experience of Educational Games: A Review of the Elements. *Procedia Computer Science*, 72, 423–433. <https://doi.org/10.1016/j.procs.2015.12.123>
- Nap, H. H., Diaz-Orueta, U., González, M. F., Lozar-Manfreda, K., Facal, D., Dolničar, V., ... de Schutter, B. (2015). Older people's perceptions and experiences of a digital learning game. *Gerontechnology*, 13(3), 322–331. <https://doi.org/10.4017/gt.2015.13.3.002.00>
- Neto, H. C. S., Cerejeira, J., & Roque, L. (2017). *Serious Games for Cognitive Assessment with Older Adults: A Preliminary Study Helio*. (N. Munekata, I. Kunita, & J. Hoshino, Eds.), *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* (Vol. 10507). Cham: Springer International Publishing. <https://doi.org/10.1007/978-3-319-66715-7>
- Neto, H. C. S., Neto, D. P. C., Leite, J. B., Cerejeira, J., & Roque, L. (2016). Cow Milking Game. In *Proceedings of the International Symposium on Interactive Technology and Ageing Populations - ITAP '16* (pp. 44–53). New York, New York, USA: ACM Press. <https://doi.org/10.1145/2996267.2996272>
- Niksadat, N., Rakhshanderou, S., Negarandeh, R., Ramezankhani, A., Vasheghani Farahani, A., & Ghaffari, M. (2019). Development and Psychometric Evaluation of Andragogy-based Patient Education Questionnaire (APEQ). *American Journal of Health Education*, 50(6), 390–397. <https://doi.org/10.1080/19325037.2019.1662860>
- Nuswantari, A., Wu, Y.-T., & Surjono, H. D. (2020). System Usability Scale Measurement on Synhchronous Online Argumentation Learning System. In *Proceedings of the*

- International Conference on Online and Blended Learning 2019 (ICOBL 2019)* (pp. 142–146). Paris, France: Atlantis Press. <https://doi.org/10.2991/assehr.k.200521.031>
- Oppl, S., & Sary, C. (2018). Game-playing as an effective learning resource for elderly people: encouraging experiential adoption of touchscreen technologies. *Universal Access in the Information Society* 19, 295–310. <https://doi.org/10.1007/s10209-018-0638-0>
- Orimo, H., Ito, H., Suzuki, T., Araki, A., & Hosoi, T. (2006). Reviewing the definition of “elderly ,” 149–158. <https://doi.org/10.1111/j.1447-0594.2006.00341.x>
- Pappas, M. A., Demertzi, E., Papagerasimou, Y., Koukianakis, L., Voukelatos, N., & Drigas, A. (2019). Cognitive-based E-learning design for older adults. *Social Sciences*, 8(6). <https://doi.org/10.3390/socsci8010006>
- Peres, S. C., Pham, T., & Phillips, R. (2013). Validation of the system usability scale (sus): Sus in the wild. *Proceedings of the Human Factors and Ergonomics Society*, (September 2013), 192–196. <https://doi.org/10.1177/1541931213571043>
- Poels, K., De Kort, Y., & IJsselsteijn, W. (2007). “It is always a lot of fun!” Exploring dimensions of digital game experience using focus group methodology. *Proceedings of the 2007 Conference on Future Play, Future Play '07*, 83–89. <https://doi.org/10.1145/1328202.1328218>
- Pyae, A. (2017). The potential of digital games in promoting older people ’ s active ageing in developing countries : the case of Myanmar. *International Journal of Education and Ageing*, 4(1), 19–34.
- Radhakrishnan, K., Toprac, P., O’Hair, M., Bias, R., Kim, M. T., Bradley, P., & Mackert, M. (2016). Interactive Digital e-Health Game for Heart Failure Self-Management: A Feasibility Study. *Games for Health Journal*, 5(6), 366–374.

<https://doi.org/10.1089/g4h.2016.0038>

- Razak, F. H. A., Azhar, N. H. C., Adnan, W. A. W., & Nasruddin, Z. A. (2017). Exploring Malay older user motivation to play mobile games. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 10645 LNCS(October), 478–488. https://doi.org/10.1007/978-3-319-70010-6_44
- Razak, F. H. A., Razak, N. A., Wan Adnan, W. A., & Ahmad, N. A. (2013). How simple is simple: Our experience with older adult users. *ACM International Conference Proceeding Series*, 379–387. <https://doi.org/10.1145/2525194.2525307>
- Santos, L. H., Okamoto, K., Hiragi, S., Yamamoto, G., Sugiyama, O., Aoyama, T., & Kuroda, T. (2019). Pervasive game design to evaluate social interaction effects on levels of physical activity among older adults. *Journal of Rehabilitation and Assistive Technologies Engineering*, 6(June), 205566831984444. <https://doi.org/10.1177/2055668319844443>
- Sayago, S., Rosales, A., Righi, V., Ferreira, S. M., Coleman, G. W., & Blat, J. (2019). *Digital Games and Older People from a Theoretical and Conceptual Perspective : A Critical Literature Review*. Springer Singapore. <https://doi.org/10.1007/978-981-13-3693-5>
- Schell, R., Hausknecht, S., & Kaufman, D. (2015). Barriers and Adaptations of a Digital Game for Older Adults. In *Proceedings of the 1st International Conference on Information and Communication Technologies for Ageing Well and e-Health* (pp. 269–275). SCITEPRESS - Science and Technology Publications. <https://doi.org/10.5220/0005524002690275>
- Schell, R., & Kaufman, D. (2017). Community Building among Older Adults in a Digital Game Environment. In *Proceedings of the 9th International Conference on Computer*

- Supported Education* (Vol. 2, pp. 233–239). SCITEPRESS - Science and Technology Publications. <https://doi.org/10.5220/0006253202330239>
- Shi, Y. R., & Shih, J. L. (2015). Game Factors and Game-Based Learning Design Model. *International Journal of Computer Games Technology*, 2015(August). <https://doi.org/10.1155/2015/549684>
- Taherdoost, H., & Group, H. (2017). Sampling Methods in Research Methodology ; How to Choose a Sampling Sampling Methods in Research Methodology ; How to Choose a Sampling Technique for, (January 2016). <https://doi.org/10.2139/ssrn.3205035>
- Tobi, S. U. M., Fathi, M. S., & Amaratunga, D. (2017). Ageing in place, an overview for the elderly in Malaysia. *AIP Conference Proceedings*, 1891(October). <https://doi.org/10.1063/1.5005434>
- Tran, M. K. P., Bremond, F., & Robert, P. (2016). *Assistance for Older Adults in Serious Game Using an Interactive System*. (A. De Gloria & R. Veltkamp, Eds.), *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* (Vol. 9599). Cham: Springer International Publishing. <https://doi.org/10.1007/978-3-319-40216-1>
- van der Spek, E. D., Sidorenkova, T., Porskamp, P., & Rauterberg, M. (2014). The Effect of Familiar and Fantasy Aesthetics on Learning and Experience of Serious Games. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* (Vol. 8770, pp. 133–138). https://doi.org/10.1007/978-3-662-45212-7_17
- Wang, J. Y. (2016). Designing Brain Training Games and Evaluating the Usability between Young and Elderly. *Proceedings - 2016 3rd International Conference on Information Science and Control Engineering, ICISCE 2016*, 308–312.

<https://doi.org/10.1109/ICISCE.2016.75>

- Wang, X., Yao, X., & Gu, J. (2019). Attraction and Addiction Factors of Online Games on Older Adults: A Qualitative Study. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 11593 LNCS, 256–266. https://doi.org/10.1007/978-3-030-22015-0_20
- Wiemeyer, J., & Kliem, A. (2012). Serious games in prevention and rehabilitation-a new panacea for elderly people? *European Review of Aging and Physical Activity*, 9(1), 41–50. <https://doi.org/10.1007/s11556-011-0093-x>
- Winn, B. (2009). The Design, Play, and Experience Framework (Chapter LVIII). In *Ferdig, R. E. (Eds.), Handbook of Research on Effective Electronic Gaming in Education* (Vol. II, pp. 1010–1024). IGI Global. <https://doi.org/10.4018/978-1-59904-808-6.ch058>
- Yeh, T., Pai, F., & Jeng, M. (2019). The Factors Affecting Older Adults ' Intention toward Ongoing Participation in Virtual Reality Leisure Activities. *International Journal of Environmental Research and Public Health Article*, 16(3). <https://doi.org/10.3390/ijerph16030333>
- Yunus, N. M., Abd Manaf, N. H., Omar, A., Juhdi, N., Omar, M. A., & Salleh, M. (2017). Determinants of healthcare utilisation among the elderly in Malaysia. *Institutions and Economies*, 9(3), 117–142.
- Zadeh, H. G., Veloso, A. I., & Pereira, A. (2019). Mr Dustman: A multitasking digital game for older adults who suffer from Mild Cognitive Impairment and Urinary Incontinence, (June), 19–22.
- Zainal, A., Ahmad, N. A., & Razak, F. H. A. (2013). Older people and the use of mobile phones: An interview study. *Proceedings - 2013 International Conference on Advanced Computer Science Applications and Technologies, ACSAT 2013*, (December), 390–

395. <https://doi.org/10.1109/ACSAT.2013.83>

Zhang, F., Hausknecht, S., Schell, R., & Kaufman, D. (2017). Factors Affecting the Gaming Experience of Older Adults in Community and Senior Centres. In *Communications in Computer and Information Science* (Vol. 739, pp. 464–475). https://doi.org/10.1007/978-3-319-63184-4_24

Zhang, F., & Kaufman, D. (2016). Physical and Cognitive Impacts of Digital Games on Older Adults: A Meta-Analytic Review. *Journal of Applied Gerontology*, 35(11), 1189–1210. <https://doi.org/10.1177/0733464814566678>

Zhang, F., Kaufman, D., Schell, R., Salgado, G., Seah, E. T. W., & Jeremic, J. (2017). Situated learning through intergenerational play between older adults and undergraduates. *International Journal of Educational Technology in Higher Education*, 14(1), 16. <https://doi.org/10.1186/s41239-017-0055-0>

APPENDICES

Appendix A: Publication

1. **Mohsin, N. F.**, Jali, S. K., Bandan, M. I., Jali, N., & Jupit, A. J. R. (2021). Older Adults and Digital Game Trends, Challenges and Benefits. In *2021 IEEE Asia-Pacific Conference on Computer Science and Data Engineering (CSDE)* (pp. 1–6). Brisbane, Australia: IEEE.
2. **Mohsin, N. F.**, Jali, S. K., Arnab, S., Bandan, M. I., & Ma, M. (2022). The Adoption of Digital Games Among Older Adults. *International Journal of Advanced Computer Science and Applications (IJACSA)*, 13(2), 39–45.

Appendix B: : Participant Information Sheet

Participant Information Sheet

Study Title:

Digital Game for Older Adults

What is the purpose of the study?

This study is being carried out by Nurul Farinah Binti Mohsin, a master's degree research student at Faculty of Computer Science and Information Technology, Universiti Malaysia Sarawak. The proposed of this work is to provide a serious game framework for older adults, which in turn will become the guidelines or an effective design approach that can be used when developing an innovative game-based environment that correlates the technologies and andragogy (adult learning) perspectives. It will analyse the feature or element in serious game facilities andragogical perspectives, while maintaining good gameplay for older adults. The focus will be on empirically demonstrating what features of serious game framework are crucial for motivation and learning among older adult users.

Why have I been approached?

To be of value the study requires the assistance of many participants, for statistical purposes, since owing to random elements and other variables, only a sufficiently large sample can be relied upon to give results to the necessary degree of confidence.

Do I have to take part?

No. Participation is entirely voluntary. If you change your mind about taking part in the study, you can withdraw at any point during the sessions. This can be spoken request during any period of the study itself or by contacting me via email [19020202@siswa.unimas.my] or WhatsApp [013536790] quoting your participant reference number. If you decide to withdraw, all of your data will be destroyed and will not be used in the study. There are no consequences to deciding that you no longer wish to participate in the study, and this is seen as a normal right within such research.

The activities you will be involved in will not be outside the scope of activities you would normally be asked to participate in, in a module of this nature.

What will happen to me if I take part?

The study requires you (the participant) to complete a series of questionnaires surrounding your views of game-based learning (adult learning (andragogical) perspectives), ICT (Information Communication Technology) and your overall technical experience. You will then be asked to join the games demonstration or play through a series of digital Serious Game that focus on ageing population. Each play through will be monitored by the researcher, Nurul Farinah Binti Mohsin, and at the start of each session an informed briefing will be given. After this exercise, you will then be asked to fill out a second set of questionnaires which contain your views on the content of the game/s that you have played through.

If you consent to the audio and/or visual recorded interview, then you will be asked a series of questions to aid in the development of a new older people game. These questions might ask about your experiences and/or suggestions surrounding ICT and older adult acceptance.

What are the possible disadvantages and risks of taking part?

Some of the tasks you will be asked to perform may be challenging or repetitive and cause some emotional reactions within the normal range of reactions. This is a necessary part of the trial. It is not expected to cause any excessive distress and may be a pleasant experience. You may withdraw from the exercise at any time and the researchers may end the trial if undue distress does occur to either yourself or the other participant.

The interview stage intends to, in part, inquire about your experiences. If you feel uncomfortable or unsure how to answer, please note there is no right or wrong answer, and you can always refuse to give an answer if you wish. The interview will be audio or/and visual recorded, and you will be assigned a participant number that will be cross-referenced to the consent form for confidentiality.

If any aspect of the research causes you distress or you wish to remove yourself from the study, then you can contact the researcher directly.

What are the possible benefits of taking part?

The results of this study are intended to contribute to, and aid in, the design of further tools for game-based learning support (Serious Games) in the subject area of ageing society. By concentrating research efforts into practitioner centred design, developers can optimise techniques in ICT delivery by considering the acceptance by ageing society.

What if something goes wrong?

If there are any problems or you have any questions concerning the study at any time, please contact the researcher directly. If at any point a session needs to be postponed or cancelled, then the researcher will attempt to contact you as soon as possible using the method indicated by you on the consent form.

If you change your mind about taking part in the study, you can withdraw at any point during the sessions and at any time in the two months following that session by contacting the researcher using the email address or telephone number stated below.

If you decide to withdraw, all your data will be destroyed and will not be used in the study.

Will my taking part in this study be kept confidential?

Yes. Only researcher will have access to the raw data or the Director of Studies if she is unable to discharge her duties. All the consent forms will be stored in a separate, secure (locked) location from the raw data itself. Only your participant number will identify you. This will be cross-referenced to permission forms.

All participants are asked to agree to respect the privacy of other participants and not disclose such information outside of the research project.

What will happen to the results of the research study?

The results will be written up and presented as part of the researcher's Master thesis. Results may also be presented at academic conferences and/or written up for publication in academic journals.

Who is organising and funding the research?

The research is organised by Nurul Farinah Binti Mohsin, a Master Degree student at the Faculty of Computer Science and Information Technology, Universiti Malaysia Sarawak. This project is not externally funded.

Making a complaint

If you take part and are unhappy with any aspect of this research then you should contact the Principal Investigator in the first instance. If you still have concerns and wish to make a formal complaint about the research then you should write to:

Associate Professor Dr Kartinah Bt Zen,
Dean,
Faculty of Computer Science and Information Technology,
Universiti Malaysia Sarawak,
94300, Kota Samarahan,
Sarawak,
Malaysia

In your letter, please provide as much detail about the research as possible, the name of the researcher and indicate in detail the nature of your complaint.

Contact for Further Information**Principal Researcher**

Nurul Farinah Binti Mohsin
Email: 19020202@siswa.unimas.my
Tel: +60135536790

Main Supervisor

Dr Suriati Khartini Binti Jali
Email: jskhartini@unimas.my
Tel: +6082-592647

Appendix C: The Consent Statement

The Consent Statement

Please sign both the Research Team and Participant Sections

Research Team Copy

Please answer the following questions by circling your response.		
Have you read the information provided about this study?	Yes	No
Have you able to ask questions about this study?	Yes	No
Have you been given enough information regarding this study?	Yes	No
Have you received answers to all your questions?	Yes	No
Do you understand that you have the right to withdraw from this study without needing to provide a reason?	Yes	No
Are you happy to deliver the session with research staff on-hand?	Yes	No
Would you like to provide feedback in one-to-one discussion with a researcher afterwards?	Yes	No
Do you consent to audio or/and visual recording of the interview sessions?	Yes	No
Are you happy to participate in all aspects of the study?	Yes	No
Your signature will certify that you agree to take part in the study that you have been given information about. It will also show that you have had adequate opportunity to discuss the study with an investigator, and that all your questions have been answered to your satisfaction. Please note that this consent form will be kept by the researcher and will be stored in a locked filing cabinet away from other study data and information. Other information you provide will in no way be connected to this consent form. I have read and understood the attached participant information sheet. By signing below I consent to participate in this study. I understand that the interview will be audio recorded and transcribed afterwards. I understand that I have the right to withdraw from the study without giving a reason at any time during the study itself. I understand that I also have the right to change my mind about participating in the study until the data has been published, at least up to 2 months after the sessions have ended. I agree to respect the privacy of other participants and not disclose any private issues that may arise outside of the research project.		
Participants Signature	Print Name	Date
_____	_____	_____
Participants email or phone:		

Researchers Signature	Print Name	Date
_____	_____	_____

Appendix D: Questionnaire (Pilot Study)

Section 1: Demographic Data

1. Your current location (State): _____
2. Gender: ☐ Male
☐ Female
3. Age: _____
4. Marital Status:
☐ Single- never married
☐ Married
☐ Divorced
☐ Widowed
5. Employment Status:
☐ Full time worker
☐ Part time worker
☐ Retired
☐ Unemployed
6. Ethnicity
☐ Malay
☐ Chinese
☐ India
☐ Bumiputera Sabah
☐ Bumiputera Sarawak
☐ Other : _____

Section 2: Technologies Usage

1. How would you describe your computer skills better?
☐ Expert- can perform various task on the computer
☐ Competent- confident to use various software
☐ Novice- web surfing, email
☐ None- never used
2. What kind of devices you own?
☐ Desktop PC
☐ Laptop
☐ iPad
☐ Smartphone
☐ Tablet
☐ Mobile Phone
☐ None
☐ Other : _____
3. Please indicate the name of your current played digital game(s).

4. To what extent do you use a computer in your daily activities?
☐ Everyday
☐ Several times a week
☐ Occassionally
☐ Never used
5. Do you play digital game?
☐ Yes
☐ No

*Please skip to SECTION 6 if you did not have experience play digital game

Section 3: Game Experience

Please circle the number indicate your previous experience using digital game(s).
(1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly agree)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I felt content	1	2	3	4	5
I felt skilful	1	2	3	4	5
I was interested in the game's storyline	1	2	3	4	5
I thought it was fun	1	2	3	4	5
I was fully occupied with the game	1	2	3	4	5
I felt happy	1	2	3	4	5
It gave me a bad mood	1	2	3	4	5
I thought about other things	1	2	3	4	5
I found it tiresome	1	2	3	4	5
I felt competent	1	2	3	4	5
I thought it was hard	1	2	3	4	5
It was aesthetically pleasing	1	2	3	4	5
I forgot everything around me	1	2	3	4	5
I felt good	1	2	3	4	5
I was good at it	1	2	3	4	5
I felt bored	1	2	3	4	5
I felt successful	1	2	3	4	5
I felt imaginative	1	2	3	4	5
I felt that I could explore things	1	2	3	4	5
I enjoyed it	1	2	3	4	5
I was fast at reaching the game's targets	1	2	3	4	5
I felt annoyed	1	2	3	4	5
I felt pressured	1	2	3	4	5

I felt irritable	1	2	3	4	5
I lost track of time	1	2	3	4	5
I felt challenged	1	2	3	4	5
I found it impressive	1	2	3	4	5
I was deeply concentrated in the game	1	2	3	4	5
I felt frustrated	1	2	3	4	5
It felt like a rich experience	1	2	3	4	5
I lost connection with the outside world	1	2	3	4	5
I felt time pressure	1	2	3	4	5
I had to put a lot of effort into it	1	2	3	4	5

Section 4: Game Usability

Please circle the number indicate your previous experience using digital game(s).
(1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly agree)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I think that I would like to use this game frequently.	1	2	3	4	5
I found this game unnecessarily complex.	1	2	3	4	5
I thought this game was easy to use.	1	2	3	4	5
I think that I would need assistance to be able to use this game.	1	2	3	4	5
I found the various functions in this game were well integrated.	1	2	3	4	5
I thought there was too much inconsistency in this game.	1	2	3	4	5
I would imagine that most people would learn to use this game very quickly.	1	2	3	4	5

I found this game very cumbersome/awkward to use.	1	2	3	4	5
I felt very confident using this game.	1	2	3	4	5
I needed to learn a lot of things before I could get going with this game.	1	2	3	4	5

Section 5: Challenges and Game Recommendation

1. What are the challenges you faced during gameplay session?
(e.g: small screen, small font, too fast)

2. Do you think the game is relevant to your daily routine?

3. Any recommendation to improve the game design to captive your specification?

Section 6: Recommendation

1. Do you play any traditional games? (Scribble, Saidina, UnoCard, Jigsaw Puzzle, Mahjong, etc...)

☐ Yes

☐ No

2. What is your opinion regarding the usage of digital game among older adults?

3. Do you want to try play digital game?

☐ Yes

☐ No

Contact Information

1. Do you want to participate for further investigation for this research?

☐ Yes

☐ No

2. Email/Contact Number

Appendix E: Interview Questions (Preliminary Study)

Interview Questions.

1. Did you play any digital game? If yes, what is the game's name? Why do you prefer/choose that game?
2. How did you feel when you played a game?
3. What do you like or dislike about the game? (Interface/music/colour) Explain more.
4. Did you learn/gain something from playing the game? If Yes, please explain more.
5. Where and when did you usually play game?
6. Are you prefer playing game alone or with someone else? What the reason?
7. What is your opinion regarding older adults playing game?
8. What features would you like to see in the game that you played or going to play? What is/are the reason(s)?
9. What feature(s) may put you off from playing game? Can you probably explain why it is so?
10. Do you think playing games would benefit older people? Based on your opinion, what kind of benefits that you think it would be? i.e. Social Interaction, Motivation.... You can include your framework finding here.

Appendix F: Questionnaire (Final Study)

Section 1: Demographic Data

1. Your current location (State): _____
2. Gender: ☐ Male
☐ Female
3. Age: _____
4. Marital Status:
☐ Single- never married
☐ Married
☐ Divorced
☐ Widowed
5. Employment Status:
☐ Full time worker
☐ Part time worker
☐ Retired
☐ Unemployed
6. Ethnicity
☐ Malay
☐ Chinese
☐ India
☐ Bumiputera Sabah
☐ Bumiputera Sarawak
☐ Other : _____

Section 2: Technologies Usage

1. How would you describe your computer skills better?
☐ Expert- can perform various task on the computer
☐ Competent- confident to use various software
☐ Novice- web surfing, email
☐ None- never used
2. What kind of devices you own?
☐ Desktop PC
☐ Laptop
☐ iPad
☐ Smartphone
☐ Tablet
☐ Mobile Phone
☐ None
☐ Other : _____
3. Please indicate the name of your current played digital game(s).

4. To what extent do you use a computer in your daily activities?
☐ Everyday
☐ Several times a week
☐ Occasionally
☐ Never used
5. Do you play digital game?
☐ Yes
☐ No

*Please skip to SECTION 6 if you did not have experience play digital game

Section 3: Game Experience

Please circle the number indicate your previous experience using digital game(s).
(1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly agree)

Section 3.1: Immersion	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I was interested in the game's storyline	1	2	3	4	5
It was aesthetically pleasing	1	2	3	4	5
I felt imaginative	1	2	3	4	5
I felt that I could explore things	1	2	3	4	5
I found it impressive	1	2	3	4	5
It felt like a rich experience	1	2	3	4	5

Section 3.2: Flow	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I was fully occupied with the game	1	2	3	4	5
I forgot everything around me	1	2	3	4	5
I lost track of time	1	2	3	4	5
I was deeply concentrated in the game	1	2	3	4	5
I lost connection with the outside world	1	2	3	4	5

Section 3.3: Competence	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I felt skilful	1	2	3	4	5
I felt competent	1	2	3	4	5
I was good at it	1	2	3	4	5
I felt successful	1	2	3	4	5
I was fast at reaching the game's targets	1	2	3	4	5

Section 3.4: Tension	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I felt annoyed	1	2	3	4	5
I felt irritable	1	2	3	4	5

I felt frustrated	1	2	3	4	5
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Section 3.5: Challenge

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I thought it was hard	1	2	3	4	5
I felt pressured	1	2	3	4	5
I felt challenged	1	2	3	4	5
I felt time pressure	1	2	3	4	5
I had to put a lot of effort into it	1	2	3	4	5

Section 3.6: Positive Affect

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I felt content	1	2	3	4	5
I thought it was fun	1	2	3	4	5
I felt happy	1	2	3	4	5
I felt good	1	2	3	4	5
I enjoyed it	1	2	3	4	5

Section 3.7: Negative Affect

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
It gave me a bad mood	1	2	3	4	5
I thought about other things	1	2	3	4	5
I found it tiresome	1	2	3	4	5
I felt bored	1	2	3	4	5

Section 4: Game Interface Satisfaction

Please circle the number indicate your previous experience using digital game(s).
(1= Strongly disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly agree)

Overall reaction to the game	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Wonderful	1	2	3	4	5
Easy	1	2	3	4	5
Satisfying	1	2	3	4	5
Adequate power	1	2	3	4	5

Stimulating		1	2	3	4	5
Flexible		1	2	3	4	5
Screen		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Easy legible		1	2	3	4	5
Clear organisation		1	2	3	4	5
Clear order		1	2	3	4	5
Terminology Information	and	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Consistent		1	2	3	4	5
Related to work		1	2	3	4	5
Consistent position of message on the screen		1	2	3	4	5
Provides the information on the current task.		1	2	3	4	5
Useful alert message		1	2	3	4	5
Learning how to use		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Easy to learn how to use		1	2	3	4	5
Easy to find new function		1	2	3	4	5
Easy to remember how to use		1	2	3	4	5
Easy to operate		1	2	3	4	5
System performance		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Sufficiently fast system speed		1	2	3	4	5
Reliable system		1	2	3	4	5
Easy to correct error data		1	2	3	4	5
Consider both novice and skilled user		1	2	3	4	5

Section 5: Challenges and Game Recommendation

1. What are the challenges you faced during gameplay session?
(e.g: small screen, small font, too fast)

2. Do you think the game is relevant to your daily routine?

3. Any recommendation to improve the game design to captive your specification?

Section 6: Recommendation

1. Do you play any traditional games? (Scribble, Saidina, UnoCard, Jigsaw Puzzle, Mahjong, etc...)

☐ Yes

☐ No

2. What is your opinion regarding the usage of digital game among older adults?

3. Do you want to try play digital game?

☐ Yes

☐ No

Contact Information

1. Do you want to participate for further investigation for this research?

☐ Yes

☐ No

2. Email/Contact Number

Appendix G: Interview Question (Final Study)

Interview Question (Post Gameplay Session)

1. How do you feel during the gameplay session?
2. Do you like the game? Why?
3. What is your first impression when you see the game?
4. What do you like the most in the game?
5. Do you think the games are well arranged?
6. Do you find any difficulty during the gameplay session?
7. Do you think the game is suitable for older adults?
8. Are there any features in the game you want to put off? Why?

Soalan Temuduga (Sesi Pasca Permainan)

1. Apakah perasaan anda semasa sesi permainan?
2. Adakah anda suka permainan itu? kenapa?
3. Apakah pendapat pertama anda apabila anda melihat permainan itu?
4. Apakah yang paling anda sukai dalam permainan ini?
5. Adakah anda fikir permainan ini disusun dengan baik?
6. Adakah anda menemui sebarang kesukaran semasa sesi permainan?
7. Adakah anda fikir permainan ini sesuai untuk orang dewasa yang lebih tua?
8. Adakah terdapat sebarang ciri dalam permainan yang anda ingin buang? kenapa?

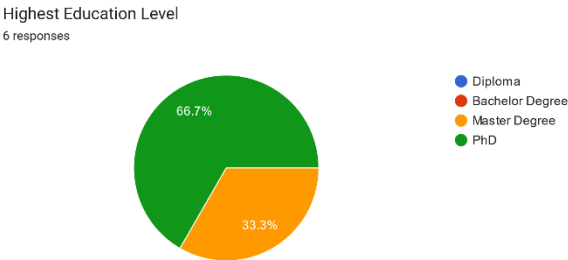
Appendix H: Expert Review Result

Number of expertise: 6 Experts

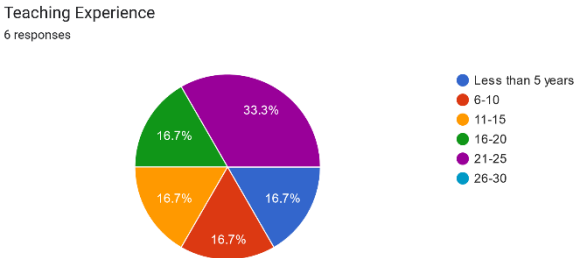
Area of expertise: Expert 1: Multimedia Design
Expert 2: Serious Games and Augmented Reality
Expert 3: Education
Expert 4: Serious Games, Gamification, Playful Learning
Expert 5: Human Computer Interface
Expert 6: Serious Game

Year of Experience: Expert 1: 20
Expert 2: 5
Expert 3: 23
Expert 4: 13
Expert 5: 12
Expert 6: 6

Highest Education Level

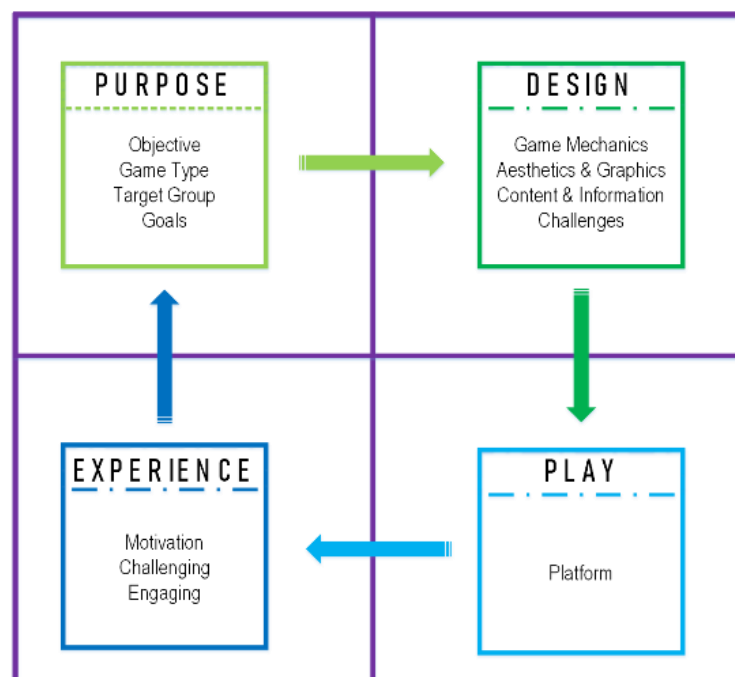


Teaching Experience



The Purpose, Design, Play and Experience Framework

The Purpose, Design, Play and Experience (PDPE) framework is a guideline to design and develop digital games specifically for older adults. There are four quadrants in PDPE framework. The first quadrant "purpose" consists of objectives, game type, goals and target group. It involves the planning stage before designing and developing the digital game. The second quadrant is "design", which the design guideline to develop digital games specifically for older adults is mentioned, consisted of the game mechanics, aesthetics and graphics, content and information, and challenges. The third quadrant is "play", which refers to the platform chosen to experience digital games. In this framework, smartphone and tablet are suggested due to the nature of the devices which are easy to handle, and the interface is simpler compared to other digital devices. The last quadrant is an "experience" which is related to the player's experience during the gameplay session. All quadrant is framed together, and the process is in the iterative cycle, starting from purpose to experience.



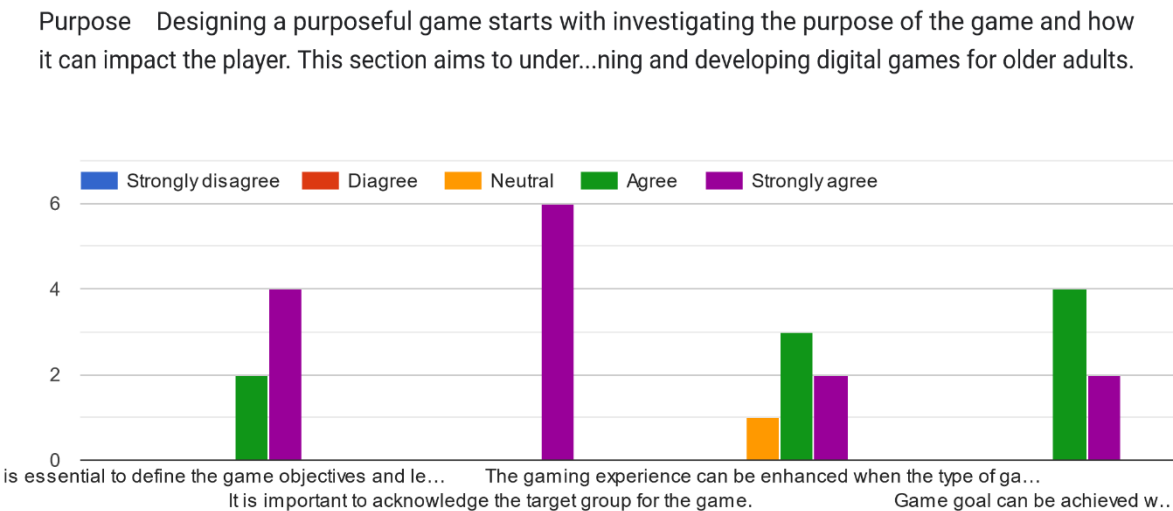
Question 1 (Purpose): Designing a **purposeful** game starts with investigating the purpose of the game and how it can impact the player. This section aims to understand the purpose before designing and developing digital games for older adults.

Item 1: It is essential to define the game objectives and learning outcome before design and develop digital games.

Item2: It is essential to define the game objectives and learning outcome before design and develop digital games.

Item 3: The gaming experience can be enhanced when the type of game able to deal with negative ageing impact.

Item 4: Game goal can be achieved when the objectives and type of games are aligned with the capability of the target groups.



Question 2 (Framing): Design is an essential process in creating a blueprint or plan for a game, and good design is what enables developers to create games that are enjoyable, engaging, and intuitive for players. This section aims to understand the appropriate design considerations that should be taken into account before beginning the development process.

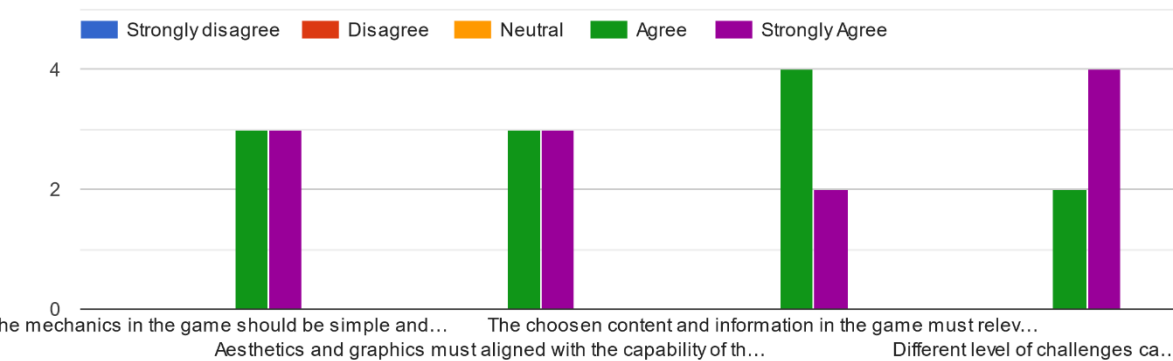
Item 1: The mechanics in the game should be simple and straight forward.

Item2: Aesthetics and graphics must aligned with the capability of the target group.

Item 3: The choosen content and information in the game must relevant with the target group.

Item 4: Different level of challenges can ensure player engage and focus on the game and develop interest to play games.

Design Design is an essential process in creating a blueprint or plan for a game, and good design is what enables developers to create games that a...ccount before beginning the development process.

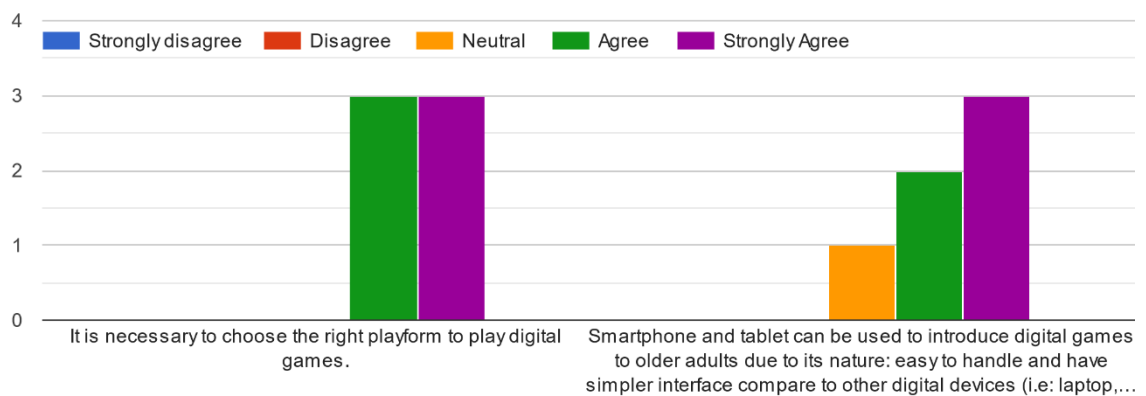


Question 3 (Play): This section attempts to clarify why the platform chosen for **playing** digital games is crucial when designing and developing games for older adults.

Item 1: It is necessary to choose the right playform to play digital games.

Item2: Smartphone and tablet can be used to introduce digital games to older adults due to its nature: easy to handle and have simpler interface compare to other digital devices (i.e: laptop, desktop).

Play This section attempts to clarify why the platform chosen for playing digital games is crucial when designing and developing games for older adults.



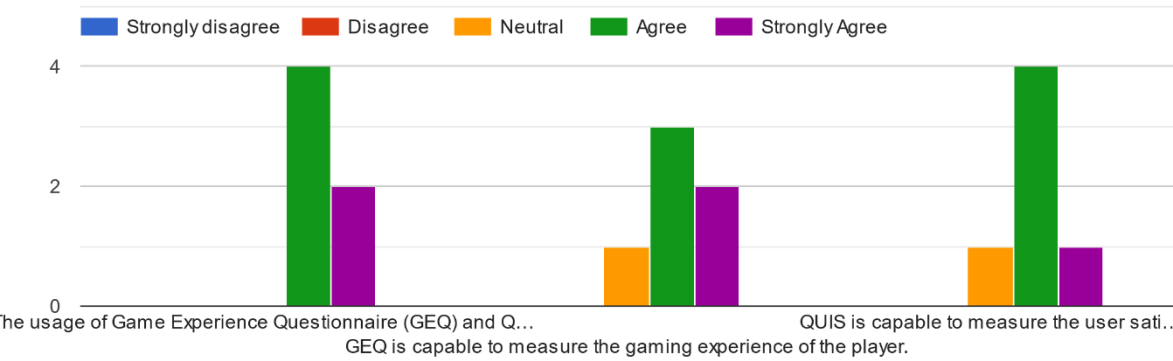
Question 4 (Experience): By allowing the target group to **experience** the game during gameplay, designers can gain valuable feedback to make improvements to the game. This section aims to understand the experience element before designing and developing digital games for older adults.

Item 1: The usage of Game Experience Questionnaire (GEQ) and Questionnaire for User Interface Satisfaction (QUIS) are necessary to measure the effectiveness of the gaming experience.

Item2: GEQ is capable to measure the gaming experience of the player.

Item 3: QUIS is capable to measure the user satisfaction on the interface design in the game.

Experience By allowing the target group to experience the game during gameplay, designers can gain valuable feedback to make improvements to th...ng and developing digital games for older adults.



Question 5 (Framing): All of the elements in the PDPE framework are framed by one another. The rationale for framing all elements in the proposed framework is to assure the framework's success and effectiveness.

Item 1: The process to design and develop digital games is start from defining the purpose to measuring the user experience and must be in iterative cycle.

Item2: If one element in the framework is not taken into consideration, the success and effectiveness of the digital games unable to be defined.

Framing All of the elements in the PDPE framework are framed by one another. The rationale for framing all elements in the proposed framework is...assure the framework's success and effectiveness.

