EXPLORING THE MOTIVATIONAL DRIVERS ON FEMALE PUZZLE GAME PLAYERS

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FINAL YEAR PROJECT REPORT

EXPLORING THE MOTIVATIONAL DRIVERS ON FEMALE PUZZLE GAME PLAYERS

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DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at Xiamen University Malaysia or other institutions.

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APPROVAL FOR SUBMISSION

I certify that this project report entitled "**EXPLORING THE MOTIVATIONAL DRIVERS ON FEMALE PUZZLE GAME PLAYERS**" that was prepared by CHEN BEINING has met the required standard for submission in partial fulfillment of the requirements for the award of Bachelor of Engineering in Digital Media Technology (Honours) at Xiamen University Malaysia.

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ABSTRACT

The puzzle games market is crowded and massive, and players makeup spans demographics, and motivations for playing run the gamut. As the mobile puzzle game market continues to evolve, accessing the right insights can help the industry grow its business and target its users. It is preferable to investigate individual incentive motives and player types in puzzle games since they often have simple gameplay. According to the report of Google Play, female is the main players in the puzzle game genre, thus it is significant to figure out female players' motivation and preferred mechanics. However, previous studies presented a gap in female players' motivation drivers and their player types, along with related research in the mobile puzzle game area. This study aimed to explore puzzle game female players' motivational drivers and player types. To achieve the research goal, preliminary research was conducted to classify players. A proposed Match-3 puzzle game with certain game mechanics was developed to evaluate motivations and player experience. The quantitative method was adopted in this study. From 144 responses in preliminary research, Thinker was the top player type among female players followed by Achiever, Thrill Seeker, and Skill Master. A Match-3 puzzle game named *Happy Zoo* was developed in this study and was tested by 45 participants. The final result showed participants are satisfied with the proposed game and they are willing to keep playing the game in the future. Most female players played Match-3 puzzle games for entertainment and skill development, and their favorite game mechanic is Dropping. The findings of this study helped puzzle game designers better understand their target customers, and the proposed game is conducive to other future studies related to Match-3 puzzle games.

Keywords: Motivation, Player Type, Player Experience, Match-3 Puzzle Games

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LIST OF SYMBOLS / ABBREVIATIONS

p	possibility
n	number
M	mean value

SD	standard deviation
UI	User Interface
3D	3-Dimension
MMPGs	Massively Multiplayer Online Games
MMORPGs	Massively-Multiplayer Online Role-Playing Games

CHAPTER 1

INTRODUCTION

1.1 Background

Mobile game is a massive market in the digital era due to smartphone ubiquity. The total downloads of mobile games across IOS, Google Play, and third-party Android were 82.98 billion in 2021 (App Anie, 2022). The mobile game revenues in 2021 were up to $93.2 billion (Newzoo, 2021). From the State of Mobile reported by *App Anie* Intelligence (2021), among global mobile game downloads, the maximum number of downloads is casual games which occupy 78% of the whole mobile game market (see Figure 1.1).

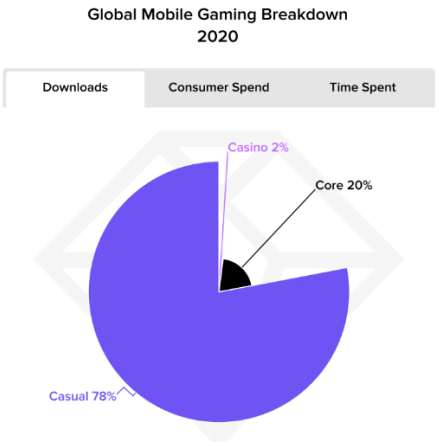


Figure 1.1: Global Mobile Gaming Market (App Anie, 2021)

Casual games are defined by basic rules and straightforward game controls. They typically have brief play sessions and do not demand a high level of player participation (Kuittinen *et al.*, 2007). In the last three years, puzzle games have remained the most popular subgenre of casual games (see Figure 1.2).

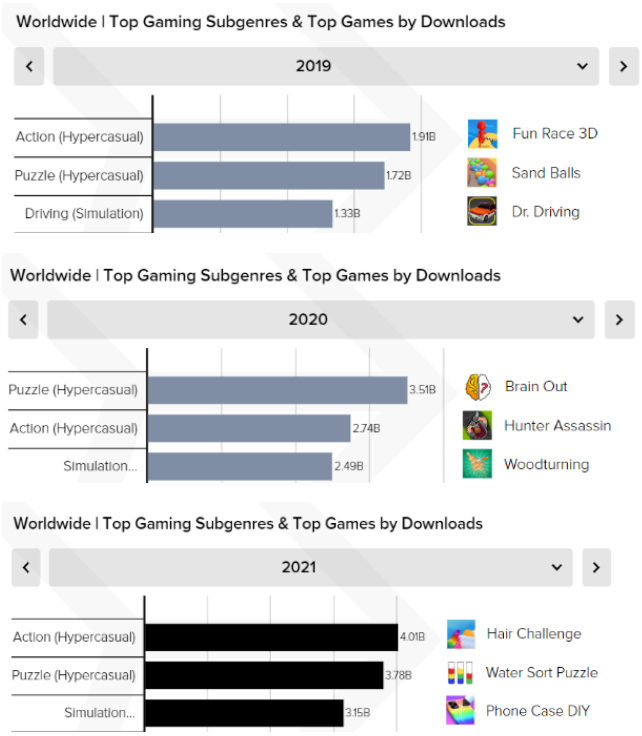


Figure 1.2: Top 3 Gaming Subgenres Downloads in 2019, 2020, and 2021

Researching the main player group of the puzzle game, the fact (Newzoo, 2021; Lopez-Fernandez et al., 2019) shows female players take a leading proportion, although a host of cultural norms both inside and outside of the gaming world have contributed to the impression that male players dominate the game world. As reported by Google Play (2019), woman plays mobile games more than the male whether in number or frequency. In more specific data from Newzoo (2021), puzzle games were mainly made up of female gamers, appealing to 63%, 58%, 52%, and 61% of female players in the United State, United Kingdom, Japan, and Korea respectively (see Figure 1.3). While the number of female players rises, most of them do not regard themselves as gamers. Some research also reveals the low gamer identity among female players (Lotte, Sofie & Jan, 2017).

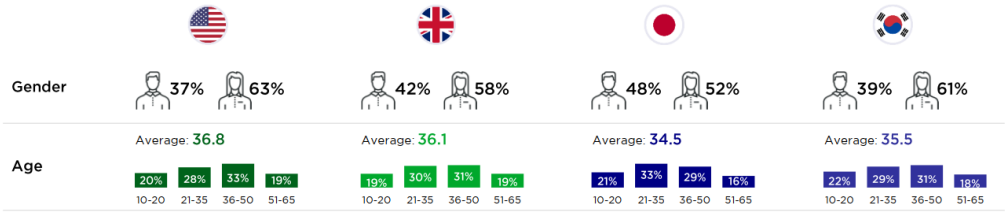


Figure 1.3: Puzzle games are more appealing to female players (Newzoo, 2021)

Categorizing players into types and play styles has been a research topic for years as it helps game designers to understand their target audiences and tailor content to individual players (Tondello et al., 2017). There is a lot of literature (Ahmad et al., 2017; Moll et al., 2020; Toh, 2022) about different research on game experience and player motivation studies, such as interfaces, game mechanics, gameplay, and ideal stories. However, puzzle games are usually equipped with simple gameplay, a simple interface, and a short story. It is more necessary to identify the main personal and psychological elements which motivate and stimulate the players to play. Thus, player motivation and player type are the most suitable methods to explore the attractiveness factors of puzzle games.

Typologies for understanding players' preferences towards gameplay have gained popularity in research. There are different player types and motivation models have been proposed by several authors, such as BrainHex player typology (Nacke et.al, 2014), Bartle's Six Player Type (1996), "4 keys 2 fun" Model (Lazzaro, 2004), and Five Key Motivations put forward by Hamari and Tuunanen. A player satisfaction model called BrainHex is built on knowledge from neurobiological research as well as the outcomes of prior models of demographic game design. BrainHex model put forward seven archetypes of players: Seeker, Survivor, Daredevil, Mastermind, Conqueror, Socialiser, and Achiever. It was been widely used in game player typology and gamification areas. In recent years, a game data analysis company GameRefinery published a report of Player Motivations and Archetypes specifically target to mobile games. It classified twelve Motivational Drivers and eight distinctive Player

Archetypes, and the latter is proposed from the combination of the former by using statistical modeling. In this study, the Brainhex Player Type and up-to-date Player Archetypes published by GameRefinery are combined as the reference of player type classification in the preliminary analysis.

1.2 Problem and Gap

The puzzle games market is crowded and massive, and players makeup spans demographics, and motivations for playing run the gamut. Female players are indicated as the majority groups in the puzzle games. What motivates these players to keep playing such simple but popular games? Do these players have specific player types? What kind of game mechanic triggers them to engage in the games? The problems prompted the study to explore motivation drivers and types of female puzzle game players.

Although many motivational models are providing instructional concepts in game design, their limitations still cannot ignore. For example, the “4 keys 2 fun” Model (2004) proposed by Lazzaro is too broad and general to identify specific player motivations, which leads to limitations in analyzing a specific game genre. Moreover, most studies related to female players’ motivation are based on psychological factors rather than empirical experiments (McLean & Griffiths, 2013). In terms of player archetype classification, researchers often study all players instead of the female players’ type specifically. The female players' data is deficient in the game market. Meanwhile, studies related to player typology often used one game genre such as Massively-Multiplayer Online Role-Playing Games (MMORPGs) as a research target (Marc et.al., 2016). The research on player motivations and types in mobile games areas is lacking.

As the mobile gaming market becomes more competitive, game developers must figure out how to attract players' interest. Despite the huge success of puzzle games,

attractiveness also become one of the biggest challenges. Therefore, it would be important to learn why the majority of players—female gamers, play the puzzle game and what are their habitual playing behaviors. A deeper understanding of female players' characteristics and preferences in puzzle games facilitates the player-oriented design and allows designers to better target customers.

1.3 Research Questions

According to the problem and gap stated above, the following research question was put forward:

Based on predicted player archetypes, what motivational drivers and game mechanics combinations in the puzzle game, can motivate and evoke an interest in female players in engaging and continuing play?

Hypothesis:

H1: The proposed game mechanics and game elements meet female players' expectations.

H2: The predicted types of female players enjoy the planned game, and are motivated to continue playing.

1.4 Aims and Objectives

This research aims to study the impact of motivational drivers and player archetypes on female players' puzzle game experiences. The objectives can be divided into three points:

1. To identify puzzle game female players’ main player archetypes via preliminary analysis.
2. To develop a mobile platform puzzle game by incorporating specific game mechanics and design elements.

3. To evaluate the effectiveness of the proposed game on player experience for different female player archetypes.

1.5 Project Scope

The research purpose is to explore the motivations and player types of female puzzle game players. The sample targets focused on female students at Xiamen University Malaysia who had experience in mobile puzzle games. The study lasted nine months, from April 2022 to December 2022.

Match-3 mobile puzzle game was selected as the game prototype genre because of its applicability and universality among puzzle games. The proposed game with 15 levels was tested on mobile phones with 6.1 to 6.5 inches screen sizes. The physical gameplay test was hosted in Malaysia, and the findings of player motivations, types, and preferences for game mechanics were discussed after the gameplay test.

1.6 Report Structure

The report contains seven chapters. Chapter 1 is an overall introduction to the whole research, summarizing the background and important concepts of the work. Chapter 2 reviews articles and journals related to player typology and motivational drivers in recent ten years. The gap and differences between them are discussed in this section and the inspiration from previous works is demonstrated clearly. Chapter 3 shows the research methodology and framework of the whole research. The game playtests flow, including game setup, experiment context, and participants are stated in Chapter 3 as well. Chapter 4 evaluates and analyses the preliminary research. The complete and comprehensive game prototype development process is declared in Chapter 5. Next, playtest results are discussed and analyzed in Chapter 6. Finally, Chapter 7 concisely concludes this research and discusses future work and recommendations according to the limitations.

1.7 Contribution of This Study

The contributions of this study are listed as follows:

1) A general analysis of puzzle game female players' types

   The preliminary research about female players' player type and their preference toward Match-3 puzzle games is analyzed through the quantitative method. The final result can be used as a reference for future relevant studies on the female player type and puzzle game industry.

2) A developed Match-3 puzzle game with specific game mechanics combination

   The proposed game is a Match-3 puzzle game that combines and arranges difficulty and complexity in each level to explore the players' experience specifically. It can be used as a tool to conduct related Match-3 puzzle game experiments. Also, the design concept of the proposed prototype can be a reference to future similar research on Match-3 puzzle games.

3) Player type and motivation evaluation result

   The result of this research provides the main player type of puzzle game female players, different female players' motivational drivers, and the game mechanics they prefer. The result is meaningful and valuable for the game market and game designers, helping them better understand their target audiences.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

A comprehensive and critical review of previous related research is presented in this chapter. In general, Human-Computer Interaction (HCI) has a long history of customizing interactive systems and services for diverse user groups utilising a variety of parameters, such as personality traits, age, gender, and other fixed characteristics (Dillon & Watson, 1996). Various player-type models have been proposed in game user research (Hamari & Tuunanen, 2014) in the past decades, for classifying players according to their preferences for specific game mechanics. Except for player type classification, players' motivation is another dimension that would be considered as a preliminary step in the game design process.

2.2 Player Motivation

Different motivations will lead to distinct choices, for example, people doing exercise to keep fit tend to do some regular sports such as running, swimming, and riding; while others will seek a professional trainer for body shaping. This kind of difference will occur in game selection as well.

Many academics have attempted to discover the numerous reasons why people adopt different gaming behaviours (Liu, 2018). At first, the discussion started with the fundamental desire for playing behaviour that is not limited to game areas. According to the labor and leisure tradeoffs hypothesis, people's motivation will change to a want-to task after completing a challenging have-to job, such as work (Kool & Botvinick, 2014). Meanwhile, the difficulty of the preceding activity enhances motivation-related brain responses. It can explain why people favour risky games that offer a greater challenge, provocation, and enjoyable feedback. The desired goal can restore the proper balance between work and play rewards (Schmidt et al., 2017).

Furthermore, players' motivations differ by multiple factors. William et al. and Greenberg et al. (2010) found that player motivation is affected by gender. Accordingly, there is evidence that the relationship between gender and players' preference for the game genre is significant (Gustavo & Lennart, 2019). Thus, understanding how players' choices are influenced by gender had better explore player motivations.

Studies about player motivations and preferences are numerous and advanced in recent years. In 1996, Bartle put forward A Players' interest model (see Figure 2.1). Players are divided into four types: Killers, Achievers, Socializers, and Explorers according to their preferences and demands for games. The horizontal dimension describes the players' interest in the world or other players. The vertical dimension reveals the players' interest in acting or interacting.

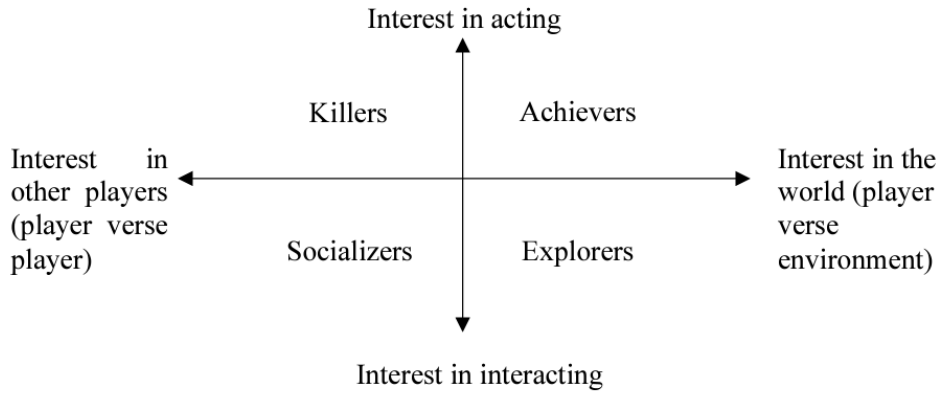


Figure 2.1: The motivation models in Bartle's theory (1996)

A more recently well-known one is Lazzaro's (2004) theory. Lazzaro put forward a concept of "4 keys 2 fun", which stated four elements of what players enjoy in games: Hard Fun (triumph over adversity), Easy Fun (curiosity), Serious Fun (relaxation and excitement), and People Fun (amusement). However, it is too broad to identify player motivation accurately. Thus, a more targeted study collected data from 3000 players on different Massively Multiplayer Online Games (MMPGs) through a factor analytic

approach was put forward by Yee in 2006. Yee classified motivations of play into three main categories, and each category is further divided into several subcategories in more detail (see Figure 2.2). The first group is Achievement, which consists of three components: the desire for advancement, the interest in analyzing and optimizing the game mechanics, and the willingness to compete. The second group is described as Social. It includes the desire to interact with other players, build the relationship and collaborate with others in the virtual world. The third group Yee defined as Immersion, which contains exploring the game world, role-playing, customizing the decorations, and escaping from the real world.

Achievement	Social	Immersion
Advancement Progress, Power, Accumulation, Status	**Socializing** Casual Chat, Helping Others, Making Friends	**Discovery** Exploration, Lore, Finding Hidden Things
Mechanics Numbers, Optimization, Templating, Analysis	**Relationship** Personal, Self-Disclosure, Find and Give Support	**Role-Playing** Story Line, Character History, Roles, Fantasy
Competition Challenging Others, Provocation, Domination	**Teamwork** Collaboration, Groups, Group Achievements	**Customization** Appearances, Accessories, Style, Color Schemes
		Escapism Relax, Escape from RL, Avoid RL Problems

Figure 2.2: Motivations of play in online games (Yee, 2006)

In a meta-analytical review published in 2014, Hamari and Tuunanen summarized Five Key Motivations of play: Achievement, Exploration, Sociability, Domination, and Immersion. More recently, a game analytics consulting company Quantic Foundry (2015) conducted a Gamer Motivation Profile (see Figure 2.3) based on 300,000 participants of all game types. This motivation model was composed of 12 dimensions of player motivation and was clustered into six groups, which are Action (Destruction and Excitement); Social (Competition and Community); Mastery (Challenge and Strategy); Achievement (Competition and Power); Immersion (Fantasy and Story); and Creativity (Design and Discovery).

Figure 2.3: Gamer Motivational Model (Yee, 2016)

New typography of player motivation drivers as shown in Figure 2.4 for mobile games was released by GameRefinery (2020). They put forward a comprehensive and multifaceted player motivational driver model which consists of six groups and each group has diverse gameplay types. It introduces Social (covering Working with Others and Competing Against Others), Mastery (covering Improving Skills and Completing Milestones), Management (covering Strategic Planning and Resource Optimization), Expression (covering Role-playing & Emotions and Customization & Decoration), Exploration (covering Discovering New Worlds and Collecting Treasures) and Escapism (covering Thinking & Solving and Excitement & Thrill).

Figure 2.4: Motivational Driver Model (*GameRefinery*, 2020)

Over 600 variables are used by GameRefinery to map Motivational Driver profiles,

which is done automatically for over 130 000 mobile games. For example, the Match-3 Puzzle game has a high average score in Thinking & Solving and Completing Milestone, whereas PUBG Mobile has a high average score in Competing Against Others, Working with Others, Excitement & Thrill (see Figure 2.5).

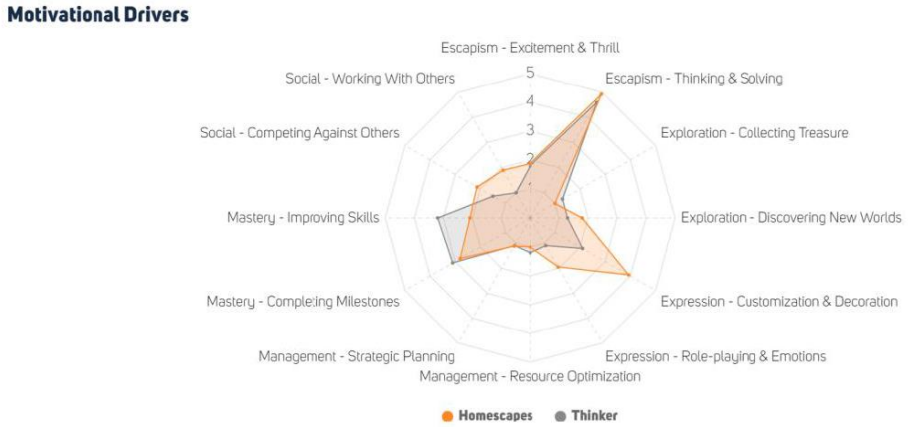


Figure 2.5: Thinker Type Players Motivational Driver Radar Map (*GameRefinery*, 2020)

Table 2.1 concludes the player motivation models mentioned above. The limitations of each motivation model are discussed as well.

Table 2.1: Player motivation model comparison

Name	Year	Description	Limitation
Bartle's 4-dimension theory	1996	Interest in acting; Interest in interacting; Interest in other players; Interest in the world	Four dimensions are limited to describe the players' motivations
Lazzaro's theory	2004	Hard Fun (triumph over adversity); Easy Fun (curiosity); Serious Fun (relaxation and excitement); and People Fun (amusement)	Too broad and general to identify specific player motivation

Online Games motivations (Yee)	2006	Achievement; Social; Immersion	The result is only analyzed from MMOGs
Five Key Motivation (Hamari and Tuunanen)	2014	Achievement, Exploration, Sociability, Domination, and Immersion.	More based on literature reviews rather than an empirical experiment
Gamer Motivation Profile (Quantic Foundry)	2015	Action; Social; Mastery; Achievement; Immersion; and Creativity	A standard assessment tool is still not publicly and readily available
GameRefinery Motivational Driver Model	2020	Social, Mastery, Management, Expression, Exploration, and Escapism	The analysis is only based on mobile games in the current market, the insight may be restrained

2.3 Player Archetypes

Beyond these motivation models, many attempts have been made in player archetypes classification. The motivation factors can act as a criterion to classify the player archetype. For instance, Bartle's 4-dimension theory (1996) divided players into four types which are Killers, Achievers, Socializers, and Explorers (see Figure 2.1). Then Bartle continued to implement the player type into six groups. He identified these six-type players according to their interaction behaviours, with the virtual world or with other players, and whether behaviors are implicit or explicit. The implicit sub-types are Opportunists, Hackers, Friends, and Griefers respectively. The explicit sub-types are respectively Planners, Scientists, Networkers, and Politicians. However, Bartle's Six Player Type model has several shortcomings: Bartle did not experimentally test

the model on the independence of the kinds or psychometric quality criteria but instead argued that each player had some specific overall preference for one of the types (making them mutually exclusive). Meanwhile, it was only studied on Multi-User Dungeons (MUDs) which has some limitations to adapt.

The first Demographic Game Design model (DGD1, Chris & Richard, 2005), which applies the Myers-Briggs type indicator (MBTI, Carlyn, 1977) to games, has a broader view of game kinds. DGD1 proposed four player types: Conqueror, Manager, Wanderer, and Participant. Some case studies provide qualitative evidence for DGD1. Despite offering insightful information on player traits, DGD1 is built on a pre-existing psychometric model (MBTI) that is not game-specific, and the authors noted problems with the methodology and data gathering employed.

BrainHex's seven archetypes were another player-type theory introduced by Nacke et.al in 2014. It was designed with a variety of games and genres in mind, so it is a promising approach. It demonstrates gamer types such as Achiever, Conqueror, Daredevil, Mastermind, Seeker, Socializer, and Survivor. For example, the Mastermind-type players represent those who enjoy solving puzzles, devising strategies, and making the most efficient decisions. Mastermind players feel rewarded for making well-thought decisions. The BrainHex seven archetypes link the player's motivation and corresponding type in more detail and more specific method. It has been adopted in a number of studies (Zeigler-Hill & Monica, 2015; Marc et.al., 2016).

Although the BrainHex player archetypes model was grounded on large demographic data and numerous game genres, it does not address how game mechanics serve different player types. In addition, players' game preferences are influenced by comprehensive motivations rather than a sole incentive. Multiple factors should be taken into consideration in predicting game preference for different games (Gustavo & Lennart, 2019).

In further studies, a mobile game analytics company GameRefinery (2020) created Eight Player Archetypes which were defined by the firm based on interviews with more than 10,000 players and their motives. The Eight Player Archetypes are Expressionist, King of the Hill, Networker, Skill Master, Straight, Thinker, Thrill Seeker, and Treasure Hunter (see Figure 2.6).

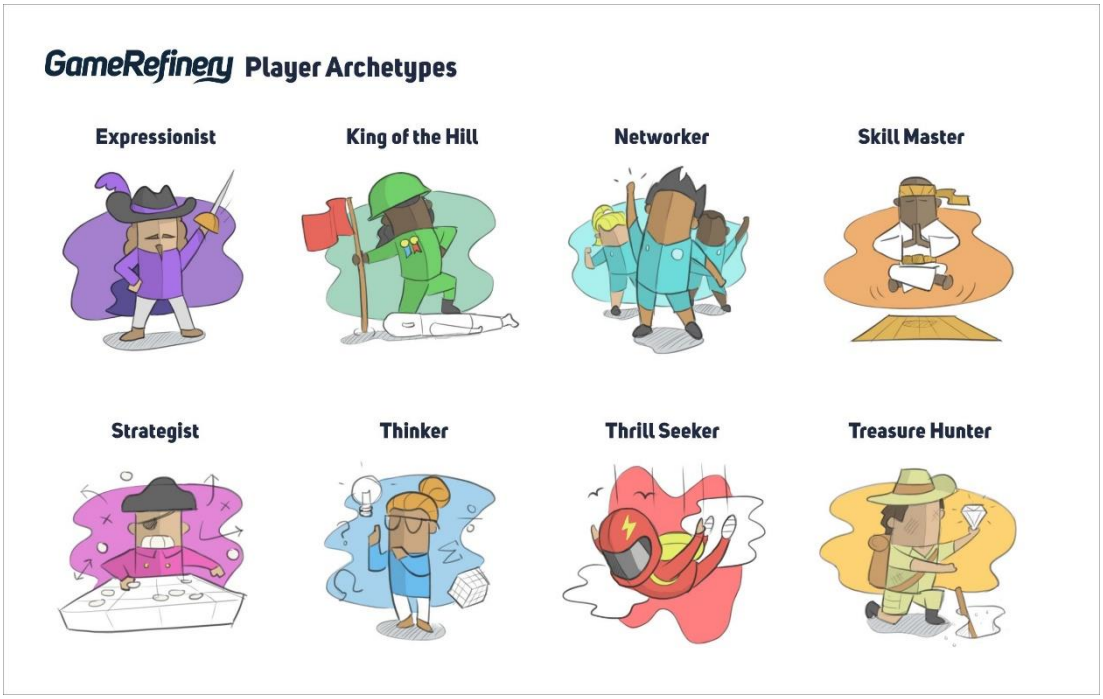


Figure 2.6: Eight Player Archetypes (*GameRefinery*, 2020)

The Thinker represents those players who enjoy playing games with challenges and brain teasers. They will gain a high sense of satisfaction and accomplishment after they are able to solve puzzles. They tend to like puzzle games, and the game features they preferred normally are puzzle-solving mechanics, the average time to play a level, and new game mechanics introduced as the game progresses. Meanwhile, 58% of Thinkers are female according to demographic data. As shown in Figure 2.7, The top 3 player archetypes of puzzle games are Thinker (38%), Skill Master (22%), and Thrill Seeker (12%) (GameRefinery, 2020).

Figure 2.7: Top 3 Player Archetypes of puzzle game (*GameRefinery*, 2020)

The GameRefinery suggests two intertwined basics -- Motivational Drivers and Player Archetypes, to identify player motivations. What's more, they combine players' motivation with different mobile game genres while comparing with the specific game under that genre (see Figure 2.8). GameRefinery provides a new idea that explores game mechanics through player motivations. Figure 2.8 shows that the impact value of social factors in Candy Crush (King, n.d.) is higher than the average Match-3 puzzle game. It indicates that Candy Crush has started to add more competitive game mechanics. It results in higher appeal to competitive players.

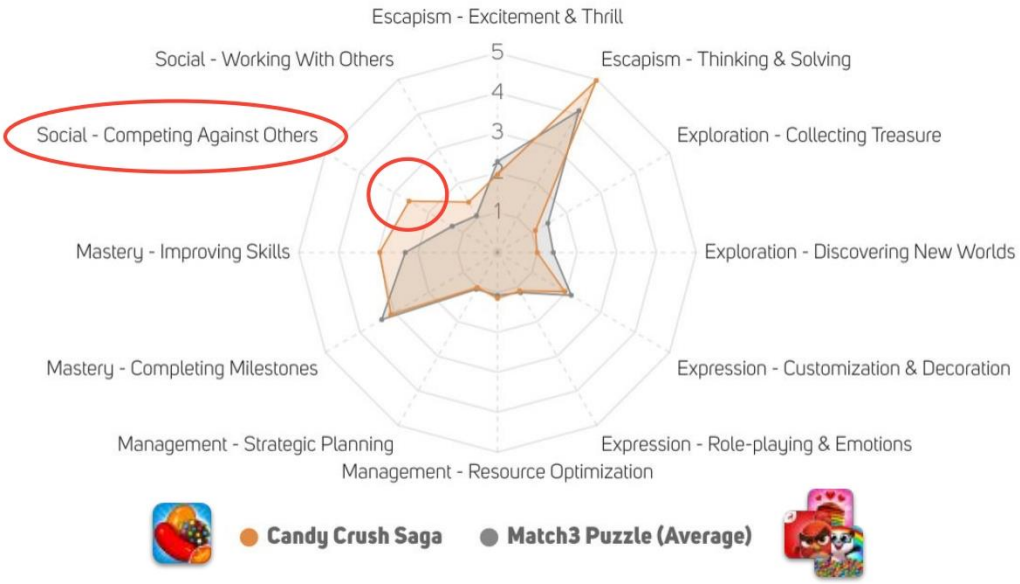


Figure 2.8: Casual player motivations
(Candy Crush Saga vs. an average match-3 game)

This strategy leads to a more in-depth understanding of player motivations. However, these data were derived from people of all genders. It does not directly target female players. There are gaps in research on the inevitable relationship between puzzle game

mechanics and player motivations or archetypes. The table below concludes the player archetypes mentioned above.

Table 2.2: Player archetype comparison

Name	Year	Description	Limitation
Bartles's Six Player Types	1996	The implicit sub-types: Opportunists, Hackers, Friends, and Griefers. The explicit sub-types: Planners, Scientists, Networkers, and Politicians.	Only studies on Multi-User Dungeons (MUDs)
first Demographic Game Design model (DGD1)	2005	Conqueror, Manager, Wanderer, and Participant	built on a pre-existing psychometric model (MBTI) that is not game-specific
BrainHex's seven archetypes (an interim mode)	2014	Achiever, Conqueror, Daredevil, Mastermind, Seeker, Socialiser, and Survivor	Do not address how game mechanics serve different player types
GameRefinery Player archetypes	2020	Expressionist, King of the Hill, Networker, Skill Master, Straight, Thinker, Thrill Seeker, and Treasure Hunter.	Target participants are mobile game players; lack of theory support

2.4 Player Experience

A good game draws the players' attention and keeps players engaged during play. As

the high importance of a game to be engaging, there has been a significant effort from researchers and practitioners in identifying and distilling the essential ingredients for successful and engaging game design. Player experience (PX) is an approach to better understanding engagement. Traditionally, PX assessment has emphasized player motivation or game enjoyment. Nowadays, more and more factors are increased to indicate player experiences, such as playability, flow, immersion, and personal gratifications (Hite, 2010).

A number of methods to measure players' game experience have been produced. The Game Engagement Questionnaire (GEQ) proposed by J. Brockmyer (2009) and her team, is one of the questionnaires to reflect player experience using 19 items. GEQ rates the engagement in four different subscales, which are absorption, presence, flow, and immersion. The reliability and validation of GEQ have been proven in video games (Brockmyer et al., 2009). Another measurement to evaluate player experience is called Player Experience of Needs Satisfaction (PENS, Ryan et al., 2006). The PENS measures player experience from Competence, Autonomy, Relatedness, Presence, and Intuitive Controls aspects.

2.5 Relation Between Four Factors

Figure 2.9 demonstrated the relationship between player motivation, player type, game mechanics, and game experience. The link between player motivation and type classification is distinct from the Player Models and Player Archetypes analysis. Motivations usually serve as a criterion in the player type classification. From BrainHex's seven player types (2014) and GameRefinery's Player Archetypes (2020), the trend to combine player types and game mechanics are being adopted in game design. The proper game mechanics are proven to have positive impacts on player motivation—Wang and Sun (2011) explored reward system can foster players' intrinsic motivation. Meanwhile, Wang and Sun's study also showed that game mechanics (reward systems) are able to create a better gaming experience. Other

empirical studies also support this point in terms of other game mechanics such as health mechanics and choice-enhancing mechanics (Hite, 2010; Daneels et al., 2021). So far, a lack of empirical research is present in proving that player types can significantly predict player experience. A study revealed that the BrainHex player type model is weak in predicting player experience (Marc et.al., 2016). Hence, the game experience cannot be simply measured according to player types. A heuristic method is to take player type as an intermediate parameter, collaborating with motivation and game mechanics (Marc et.al., 2016). First, how the target audience is made up of different player types and base game design choices (such as the selection of game mechanics) on these percentages should be evaluated. Second, the player type models can be used for personalization during the game design.

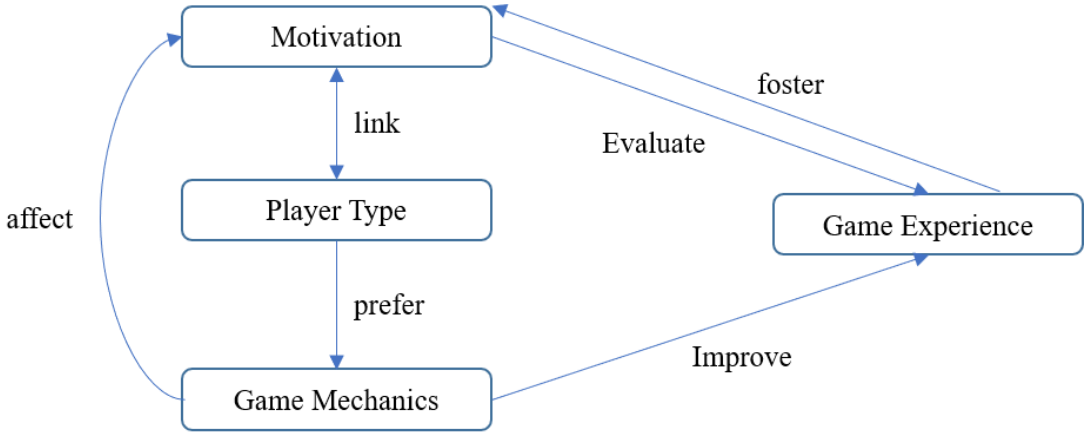


Figure 2.9: Relation between Motivation, Player type, Game mechanics and Game experience

2.6 Match-3 Puzzle Game

Match-3 puzzle game belongs to a subgenre of casual game, and it is popular with its simple gameplay and fun game mechanics. One example of this type of game is Candy Crush which has 273 million active players per month (Smith, 2022). The goal of this kind of game is to combine three or more gems of the same type (Figure 2.10). Players are normally required to destroy the greatest number of gems within a determined time or steps and obtain points.

Figure 2.10: Match-3 Puzzle Game Instructions

The following introduces the fundamental definition and game mechanics in Match-3 puzzle games (Bailey, 2015):

- **Cell:** A container, that can either be empty or filled.
- **Tile:** Tile is an item that fills a cell. More than one tile is not permitted in a cell. Tiles are always either entirely outside the grid or within precisely one cell, except for state transition animations.
- **Grid:** An organized cell arrangement is called a grid. Regular grids, such as square and hexagonal grids, are frequently used in video games.
- **Match:** Match is a set of tiles that meet the matching requirements of the game. Three linked tiles of the same color or type are the most typical match rule. The match shapes are usually presented as a row, a column, T-shape, L-shape (Figure 2.11) in Match-3 puzzle games.

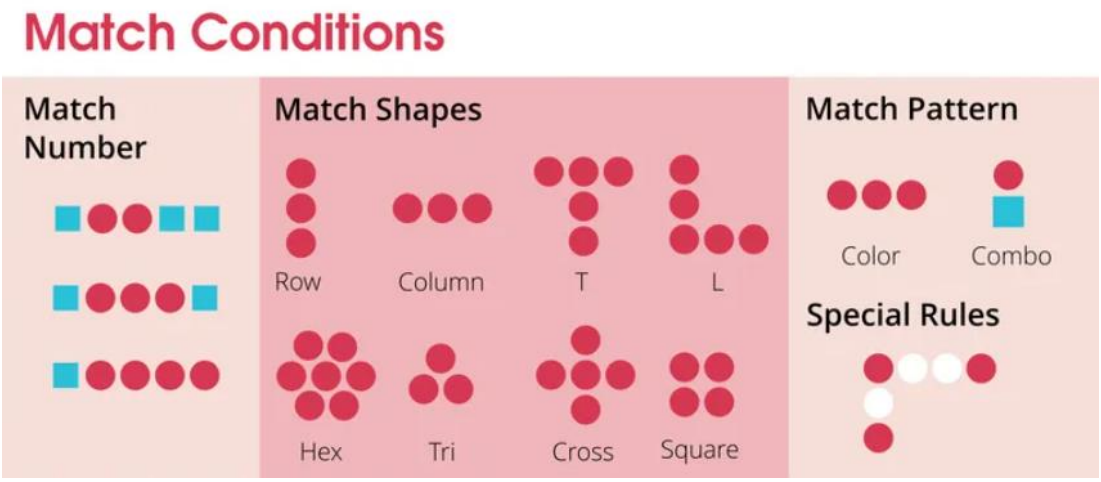


Figure 2.11: Match Conditions

- **Gravity:** A force that moves all tiles in a certain direction.
- **Clear:** When a tile is removed from the game, it gets cleared.
- **Combo:** More than one simultaneous match.
- **Cascades:** Consecutive matches. For instance, a player's input causes an auto-match, and subsequent new or existing tile placements allow another automatic match to happen in empty cells.

According to Juul's research (2007), the desire of casual players to pick up and start playing these games right instantly is one of the difficulties that designers have. There needs to be a degree of comfort without a significant learning curve. Games must also be distinctive enough to stand out from the competitors and, more crucially, to draw players in and keep them engaged. Therefore, some outstanding game designs are presented in the Match-3 puzzle game:

- **Allow short playing sessions:** The majority of casual games may be played in brief sessions since they start quickly and are frequently simple to quit. This does not imply that gamers constantly engage in quick sessions: 66% of players who responded to a survey on the Trymedia website said that their normal play session lasts more than an hour (Macrovision 2006). It's important to note that Match-3

puzzle games provide quick play sessions, which makes it simpler for players to commit to a game.

- **Auto-save:** Most Match-3 puzzle games usually auto-save, even if the player closes the game window, making it simple for a player to pause and pick up where they left off.
- **Very simple rules:** The simple rules decrease the demands on the players.
- **Moderate innovation:** Match-3 puzzle games are usually easy to learn and friendly to play. The simple gameplay, however, means moderate innovations are necessary. Nowadays, more and more Match-3 puzzle games introduce the new game mechanics. For example, the Gardenscape (Let's Play!, n.d.)and Fishdom (Let's Play!, n.d.) combines Match-3 puzzle game mechanics and decoration games.
- **Multiple levels of success:** The player is typically rewarded for completing a subtask in most casual games in more difficult ways. In matching tile games, making combos (several matches at once) and matching more tiles than necessary are frequently rewarded.
- **Much positive feedback:** Match-3 puzzle games tend to be designed to provide players with the experience of success very early on.
- **Little negative feedback:** Compared to other game genres, Match-3 puzzle games are frequently fairly simple and do not penalize the player for making mistakes.
- **Level difficulty design:** Match-3 puzzle games seem to have endless levels. It is important to make the level of difficulty just right. Too simple or too hard of a level will make players frustrated and quit playing. Therefore, a difficulty curve was analyzed (Keith, 2018) from Candy Crush (see Figure 2.12).

There are a variety of simpler and more difficult stages in each Candy Crush level. The number of tries needed to pass a level varies from player to player due to luck and personal talent. It is assumed that harder levels often require more tries than easier

ones. That is, the likelihood of passing a level in a single try decreases as a level's difficulty increases.

$$p_{win} = \frac{\sum wins}{\sum attempts}$$

After computing the difficulty p_{win} separately for each of fifteen levels of Candy Crush, the chart was created as follows Figure 2.12:

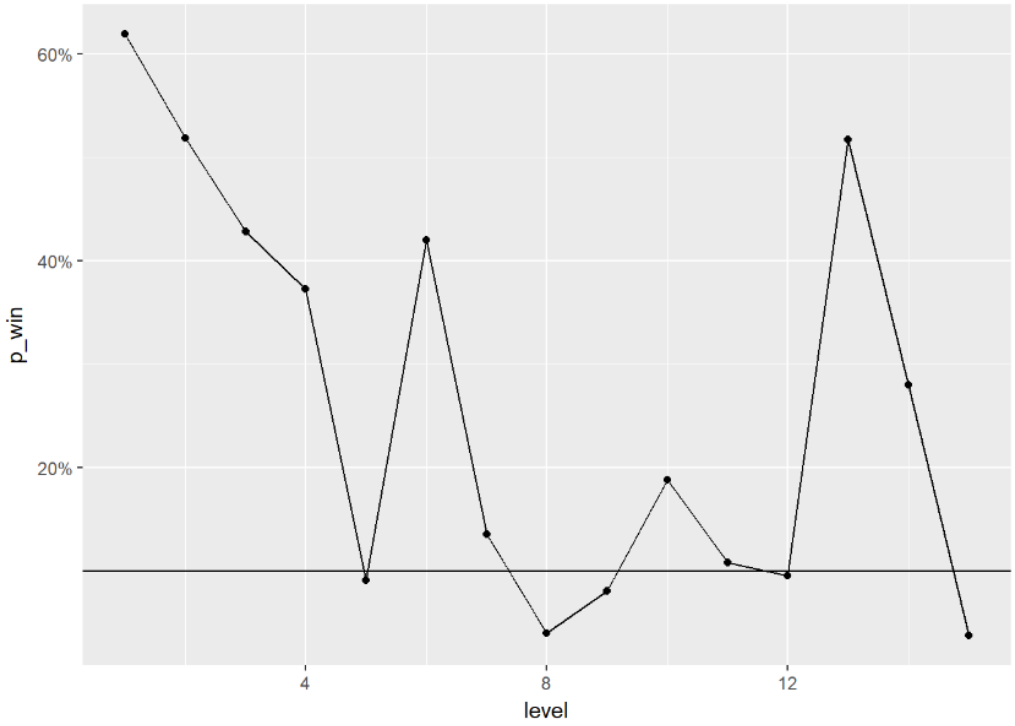


Figure 2.12: Match-3 puzzle game difficulty curve

From the chart, p_{win} < 10% means the level is hard, and the level is relatively easy in a higher value of $p_{win.}$

Why these games which possess simple arts, sounds, game mechanics, and gameplay can attract millions of players? Some conclusions drawn by Duan (2019) declares that social network site is a leading reason. Players are able to share their profiles through social media accounts and display their achievements. It also helps them to establish relationships with players in real life. Second, Match-3 puzzle games with a flexible

concentration requirement and lower entrance bar more easily attract “un-hardcore” players. Players only need to spend several minutes wherever they are at their convenience, then their entertainment quality and convenience are fulfilled. Last but not the least, players are keeping benefiting from continuous gratification –the game bonus mechanic and persistent interactions. A case study (Omori & Felinto, 2012) demonstrated that asynchronous time, publication of the activities, rewarding system, competition, social status, and cooperation are motivational elements of the Match-3 puzzle games. Among them, reward system, competition, and social status were the ones that showed more influence on the number of active players.

2.7 Summary

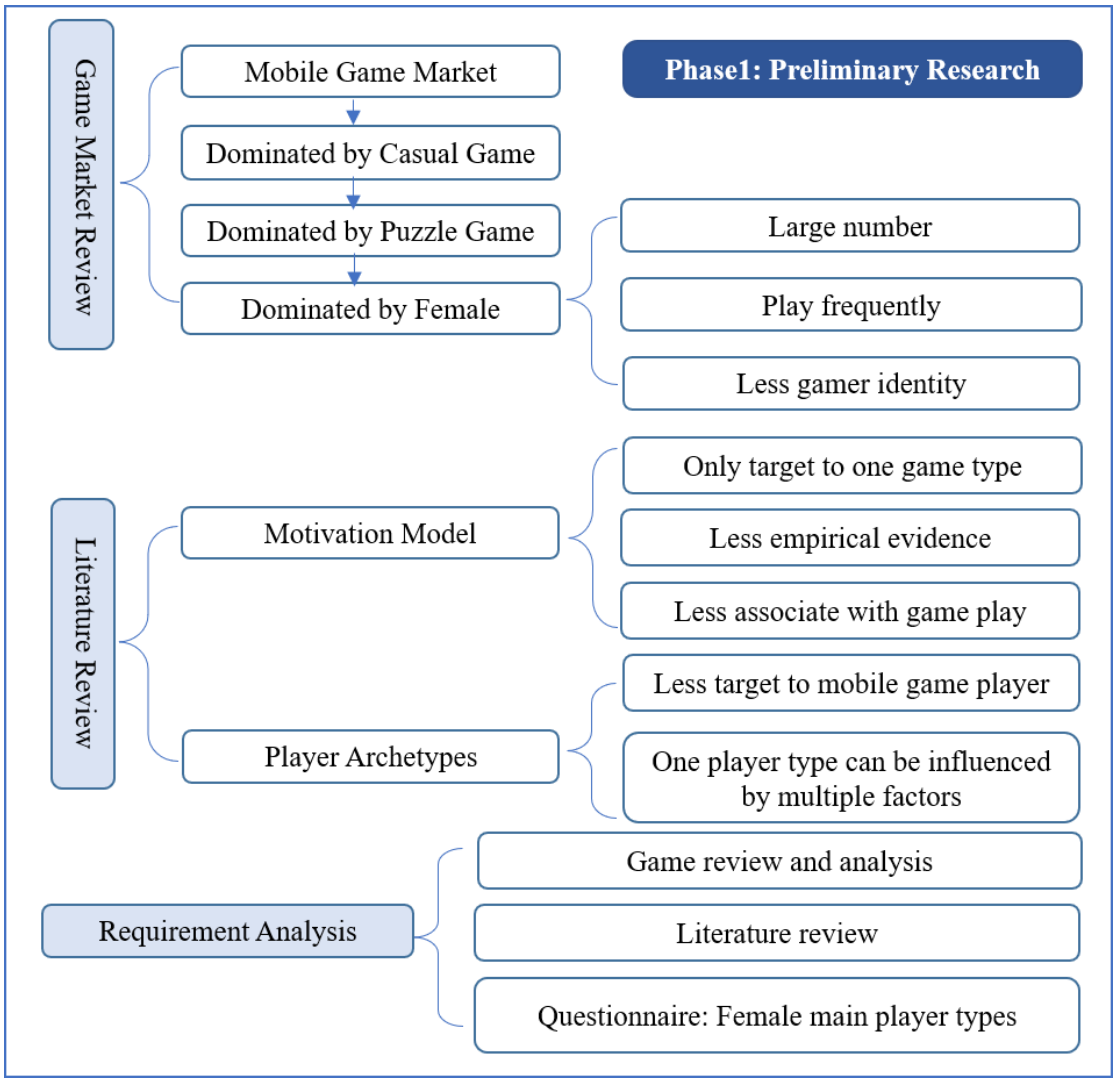
From the literature review, the suitable player motivations model and player types classification method are chosen to apply to this study. The PENS was adopted as the method to access players’ experience of the proposed game. The Match-3 puzzle game was selected as the target game. Because the main audience of the Match-3 puzzle game is female players, and it is equipped with simple gameplay.

CHAPTER 3

RESEARCH METHODLOGY

3.1 Overview

The research was divided into three phases to achieve its objective (see Figure 3.1). The first phase was the preliminary research on female players' player type and their attitudes toward Match-3 puzzle game mechanics. The second phase was game prototype implementation. The third phase was the gameplay test and result analysis. The data collection in the first and third phases adopted the quantitative method. The more detailed process of game prototype development can be found in Chapter 5.



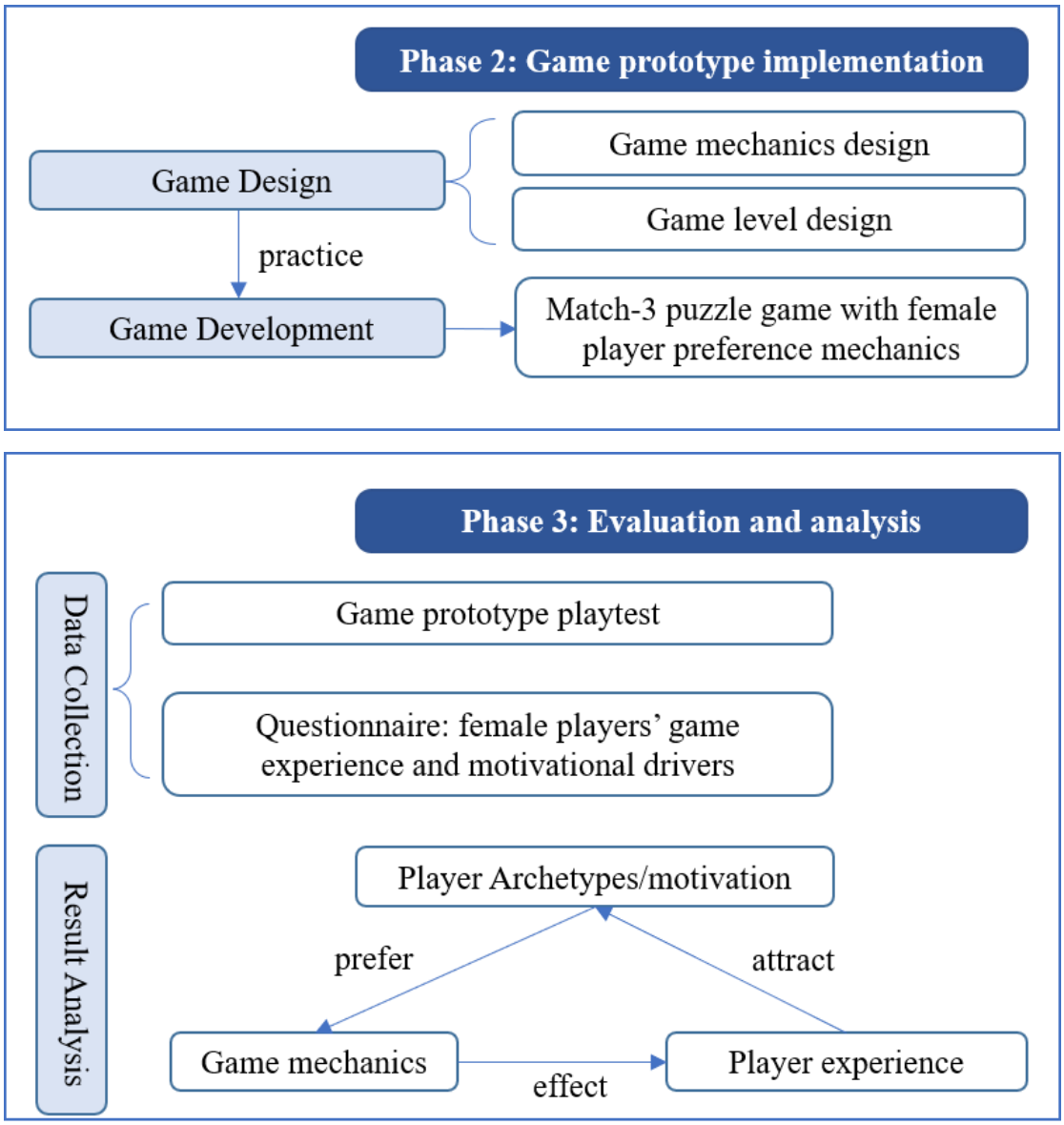


Figure 3.1: Research Framework

Phase 1: Preliminary Research

The objective of preliminary research is to identify the main player archetypes among female players and their preferred game mechanics in Match-3 puzzle games. The preliminary research was carried out from the current market review, related report and literature review, and a questionnaire.

3.2.1 Research Method and Instrument

- Game review

Reviewed popular or top 10 puzzle games in the current market, compared and analyzed differences and similarities in terms of game mechanics, and game elements, and concluded gameplay as a reference. This method is authoritative and indicative of current puzzle game players' preferences.

- Literature review

Reviewed 10-15 published reports and articles related to puzzle game player motivation and traits in recent 10 years. Identified player motivation and archetype of puzzle game female players. The data from published reports and articles are accessible and reliable.

- Questionnaire

Quantitative research is the most efficient method for numerical representation and statistical inference (Balnaves & Caputi, 2011). Therefore, the study adopted the quantitative research method so that participants' feedback could be collected and analysed intuitively and accurately. Participant's player type can be calculated and reflected from their marks for each item. The main instrument of this quantitative method was questionnaires, which have been proven to be an efficient and economical way to collect data (Patten, 2014). The questionnaire was designed by Microsoft Forms and was published online to collect answers.

3.2.2 Sampling Method

The simple random sampling method was adopted in the preliminary research since it is the most time-saving and unbiased method in data collection (Sharma, 2017). Simple random sampling can help to get more accurate results through plenty of samples. There is no limitation in participants' gender and age in the preliminary research, therefore, simple random sampling was the most suitable method in the first phase. The broad scope of data collection facilitates analyzing data and making comparisons.

3.2.3 Questionnaire Design

The questionnaire is divided into three sections (see Table 3.1). Section A asks about participants' demographic information and their gaming habits. The participants's name or the contact information is ignored because the higher level of privacy leads to higher accuracy answers (Murdoch et al., 2014). The complete questionnaire is in Appendix A.

Table 3.1: Categorization of preliminary questionnaire design

Section	Section topic	Research Objectives	Number of Questions
A	General Demographic information and gaming habits	Data validation and participants' gaming habits in Match-3 puzzle game	6
B	Game experience of puzzle games	Identify participants' player archetypes	16
C	Match-3 puzzle game mechanics	Explore participants' attitudes toward different Match-3 puzzle game	8
Total			30

Section B requires participants to rate statements according to their previous game experience. There are 16 statements, each four items match one player type (see Table 3.2). According to the literature review (BrainHex, 2014 & GameRefinery, 2022), Thinker, Achiever, Skill Master and Thrill seeker are the top four player types among puzzle game players. So participants are classified into these four types.

Table 3.2: Player types and statements

Player type	No.	Statement
Thinker	7	"I enjoy working out how to crack a challenging puzzle."
	12	"I prefer working out on my own"
	18	"I enjoy the moment when the solution to a difficult puzzle clicks in my mind."
	20	"I play the puzzle game time a time again because of the sense of accomplishment."
Achiever	8	"I enjoy the moment of completeness that I have strove for."
	14	"I will be motivated if I need to collect the items in the game."
	16	"I love getting 100% (completing everything in a game)."
	19	"I enjoy finding what I need to complete a collection."
Thrill Seeker	9	"I like risk-taking and high-speed action."
	11	"I will be motivated by a nervous and exciting game environment."
	15	"The excitement and suspense attract me more than slow-paced gameplay requiring lots of strategic planning and thinking."
	21	"I seek excitement as a positive experience and a reward enhancer."
Skill Master	10	"I enjoy devising a promising strategy on the next try."
	13	"I always look for ways to become better and better in a game."
	17	"I gain satisfaction when others acknowledge my high level of skill."
	20	"I am passionate about improving and honing all aspects of gameplay."

Questions took the BrainHex questionnaire (International Hobo - BrainHex - Intro, n.d.) as a reference in the statement description and evaluation, but with some

modifications. Because the original BrainHex questionnaire used two different assessment methods for every four items: the first three items have to be rated on a 5-point Likert scale, while the fourth item has to be ranked. The different scoring approaches resulted in the reliability scores of the BrainHex scales being higher without the fourth item (Busch et al., 2016). It is not fair and difficult to calculate an overall score for items with different response formats. Furthermore, the actual response to one item should not be influenced by the response to another item—which is not valid for ranked items. For gaining a more accurate and actual score, the four items are all designed on a 5-point scale. Participants scored them from "Strongly Disagree" to "Strongly Agree" (see Table 3.3).

Table 3.3: Likert scale representation of agreement

Likert scale	Description
1	Strongly Agree
2	Disagree
3	Neutral
4	Agree
5	Strongly Agree

The third part listed 8 different Match-3 puzzle game mechanic, participants scored their preference toward these game mechanics. To better present Match-3 puzzle game mechanics, a current market review (Figure 3.2) was accomplished to integrate representative features in the Match-3 puzzle game. Most Match-3 puzzle games contain tile matching, power-ups, maps, and puzzle solving. Some other characteristics such as artistry will be applied according to specific game requirements.

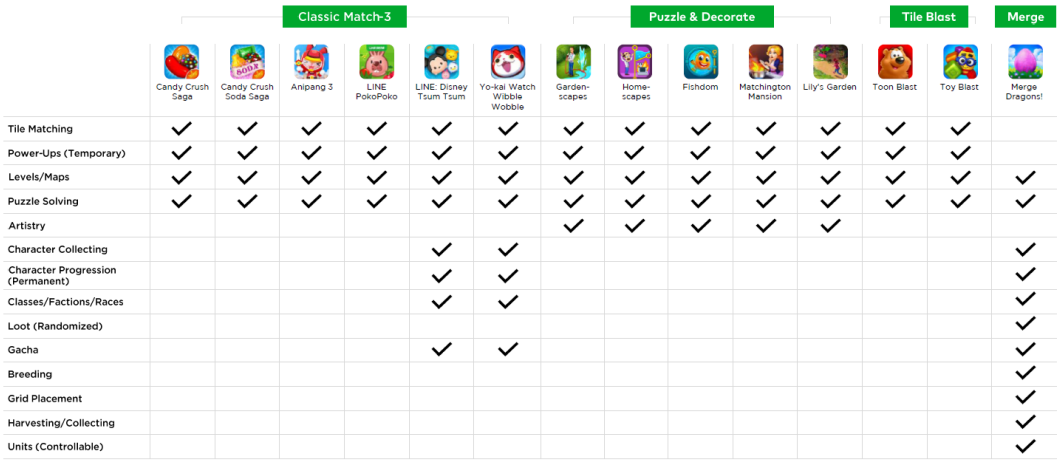


Figure 3.2: Similar Game Mechanics in Top Puzzle Games (Newzoo, 2021)

After studying the most popular and frequently used game mechanics in the Match-3 puzzle game (2018), 8 Match-3 puzzle game mechanics are selected as the main research targets.

Table 3.4: Game Mechanics Selected for Game Prototype

Game Mechanic	Description	Sample
Immovable Obstacle	An element that cannot be matched with any other stays immovable on the grid. Making a match next to immovable obstacles removes them from the grid.	
Layer	To erase a layer, players need to make a match in its cell one or several times.	

Dropping	Items need to be moved down by making matches and freeing up the place underneath them.	
Blocked Element	An element that cannot be moved until it is unblocked. In order to unblock it, players need to make a match with it. There is also multilevel element blocking, which requires several matches.	
Turn-based	Players are limited to moving certain steps in each level.	
Timer	A countdown in each level, players should complete the level in the given time.	
Reach Score	The goal of this level is to reach a certain score.	
Collect Items	The goal of this level is to collect a certain number of items.	

Five-point preference scale was designed to measure the partocopants' preference for different game mechanics. 1 point indicates the participant has no preference toward this game mechanic, while the 5 points indicate the participant prefers this game mechanic strongly.

3.2.4 Data Validation

The data validation process is to filter the eligible samples from all data, which is significant for the result's accuracy and reliability. The questionnaire was designed to only allow user fills out the form once for each Microsoft ID. In order to verify the data more precisely, the following shows the circumstance of invalid data which should be removed before data analysis:

- The answer duration is less than 90 seconds
- The repetitive email address
- Same rating throughout the whole questionnaire
- Two responses with totally the same answer submit within 10 minutes (remove the second one only)

3.2.5 Data Analysis

In the part 2 question design, each player type can be measured from four items based on a 5-point Likert scale. The mean value of each four items is calculated after participants finish the questionnaire. Comparing the mean values of four player types, the highest mark means the participant belongs to that kind of player type. A participant’s player type may be a mix of multiple types rather than an exclusive type, as they might get the same mean value in two or three player types. The detailed result of the preliminary research is stated in Chapter 4.

3.3 Phase 2: Game Prototype Implementation

The Droppler Interactive Game Development Life Cycle (Figure 3.3) proposed by Romadan and Widyani (2013) is adopted in this study.

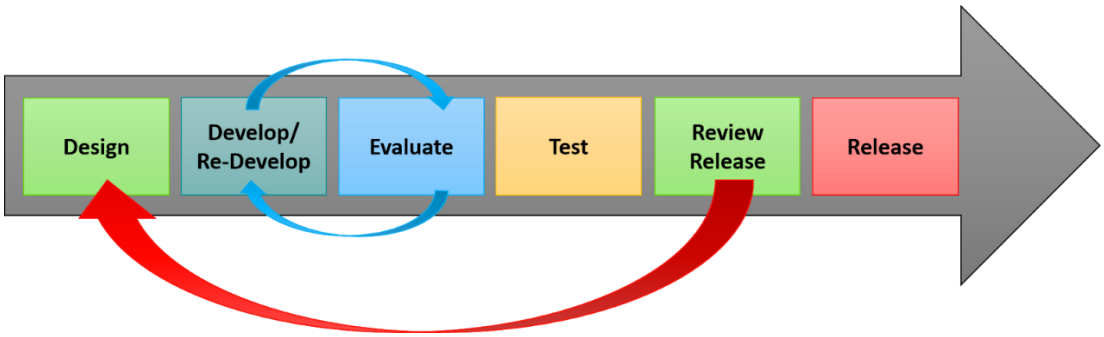


Figure 3.3 Droppler Interactive Game Development Life Cycle (GDLC)

It is an interactive approach to developing a game. The design phase includes game concept design and game level design. After the game mechanic and rule design are ready, start to develop the game. During the development, the game is tested in the evaluate phase. If the result is not satisfying or existing bugs, back to the re-develop phase to modify the game. The development and evaluation step are a circulation process. The internal test is conducted in the test phase to do modification and bug fixing. Then pass to the third party in review release. Repeat the whole process from design to review release until the game is ready to launch in the release phase.

For the evaluation, Match-3 puzzle game was chosen as they equipped with simpler gameplay and game mechanics, which does not need broad analysis related to the characteristics of the game itself. It allows focusing research more on the player's personal experience and self-motivation of the game which is also the objective of this study. Meanwhile, the simple game mechanics of the Match-3 puzzle game help to obtain more precise analysis and get the result faster. The detailed of the development process is further explained in Chapter 5.

3.4 Phase 3: Evaluation and Analysis

A playtest was conducted to evaluate participants' game experience. The quantitative method was used on collecting participants' feedback. Therefore, participants were required to answer a questionnaire about their play experience after playing the proposed game. The objective of the phase 3 research is to figure out the motivational

drivers and specific game mechanics between different player types.

3.4.1 Sampling Method

The Stratified Sample method was used in the phase 3 research. The Stratified Sample method divide population according to demographic factor (e.g. gender, age, religion), then select and draw a random sample from different subgroups (Gravetter & Forzano, 2012). As this research object is female players, so the population is divided into two groups based on gender. Samples are randomly selected from the female group.

3.4.2 Tools for Data Collection

The proposed game was published as a mobile application for Android phones. Three Android phones with similar screen sizes acted as testing devices during the playtest experiment. The phone type and API level are listed in Table 3.5.

Table 3.5: Devices used for playtest

Number	Phone Type	API Level
1	Vivo X20A	Android 8.1
2	Vivo X27	Android 10
3	Oppo Reno5 Pro	Android 11

The questionnaire was designed using Microsoft Forms for data collection. Microsoft Forms was selected due to its flexibility and ease of use. This platform is free of charge and provides clear and intuitive visualization. The data and feedback collected from the participants were automatically formatted into charts and tables, making data collection and analysis trouble-free.

3.4.3 Questionnaire Design

The questionnaire was divided into four parts (see Table 3.6). The whole questionnaire can be accessed from Appendix B.

Table 3.6: Categorization of final questionnaire design

Section	Section topic	Research Objectives	Number of Questions
A	General Demographic information	Data validation and participants' gaming habits in Match-3 puzzle game	4
B	Game experience of the proposed game	Evaluate participants' experience need satisfaction	21
C	Motivation factors	Explore participants' motivational drivers of playing Match-3 puzzle games	15
D	The difficulty and quality game mechanics in the proposed game	Figure out the participants' in different type prefer what kinds of game mechanics	7
Total			47

Section A of the questionnaire is demographic information including four questions. Participants were required to answer their age, Match-3 game experience, and their player types in this section.

Section B is to study participants' game experience. Questions refer to Player Experience of Needs Satisfaction (PENS - Ryan et al., 2006). PENS is a 21-item scale designed to measure player experience across five dimensions: Competence, Autonomy, Relatedness, Presence/Immersion, and Intuitive Controls. Some sub-scales are not suitable for measuring Happy Zoo such as Relatedness, since Happy Zoo is a single-player game. The personal gratification, audio and visual aesthetics evaluation are supplementary to measure player experience from Game User Experience Satisfaction Scale (GUESS; Phan et al., 2016). Therefore, the questions asked about

participants' experience from Competence, Autonomy, Intuitive Controls, Personal Gratification, Audio Aesthetic, and Visual Aesthetic six dimensions. Questions were clustered into six groups, presented to participants as statements about their game experience. Each statement is rated on a 5-point Likert agreement scale, from "Strongly Disagree" to "Strongly Agree" (see Table 3.2). The definition of each subscale in PENS questionnaire are stated below:

- **Competence:** Competence is evaluated with three items that indicate different aspects of how capable the participants felt.
- **Autonomy:** Autonomy is evaluated with three items which show how much freedom and control they had when they are playing the game.
- **Intuitive Controls**: Intuitive Controls is evaluated with three items which show how well participants felt they could convert their decisions into in-game actions.
- **Personal Gratification**: Personal gratification is evaluated with five items which show how participants satisfied when they are playing the game.
- **Audio Aesthetics:** Audio aesthetics is evaluated with four items which show how well participants enjoy the background music and music effects in the game.
- **Visual Aesthetics:** Visual aesthetics is evaluated with three items which show the how much participants like the game graphics and visual design.

Section C researched on participants' gaming motivation. Motives Online Gaming Questionnaire (MOGQ) is taken as a reference for this part. There were 15 items in total (see Table 3.7), measuring motives from Escape (escaping from reality, 4 items), Coping (coping with stress and distress, 4 items), Skill Development (such as attention and coordination, 4 items), and Recreation (entertainment and enjoyment, 3 items) four dimensions. 15 items were in a random sequence, also measured on a 5-point Likert agreement scale.

Table 3.7 Motives Online Gaming Questionnaire

Motives	No.	Statement
Escape	11	"This game helps me to forget about daily hassles."
	17	"This game makes me forget real life."
	21	"This game helps me escape reality."
	24	"This game helps me to forget about unpleasant things or offences."
Coping	12	"This game helps me get into a better mood."
	16	"This game helps me get rid of stress."
	18	"This game helps me channel my aggression."
	23	"This game reduces my tension."
Skill Development	13	"This game sharpens my senses."
	22	"This game improves my skills."
	19	"This game improves my concentration."
	15	"This game improves my coordination skills."
Recreation	14	"I enjoy playing this game."
	20	"I think this game is entertaining."
	25	"I will play this game for recreation."

The last section D of the questionnaire listed Match-3 puzzle game mechanics in the proposed game, including Timer, Turn-based, Dropping, Ice Layer, Immovable Obstacle, Reach the Score, and Collect item. The description of each game mechanic can be found in Table 3.3.

Four repetitive questions are stated for each game mechanic: "I felt challenged" and "I had to put a lot of effort into it" reflect the difficulty. "I thought it was fun" and "I enjoyed it" reflect affection. Participants scored the degree of difficulty and affection on a 5-point scale (Table 3.6) for seven game mechanics.

Table 3.8 Likert scale representation of the degree

Score	Description
1	Not at all
2	Slightly
3	Moderately
4	Fairly
5	Extremely

3.4.4 Playtest Setup

A physical playtest took place at Xiamen University Malaysia (see Figure 3.5 and Figure 3.6) in three days (30 Nov. 2022 – 2. Dec. 2022). Participants are 45 female students of Xiamen University Malaysia who have experience in the Match-3 puzzle game before. The participants are both Chinese and Malaysian female students, aged 18-23 years old.

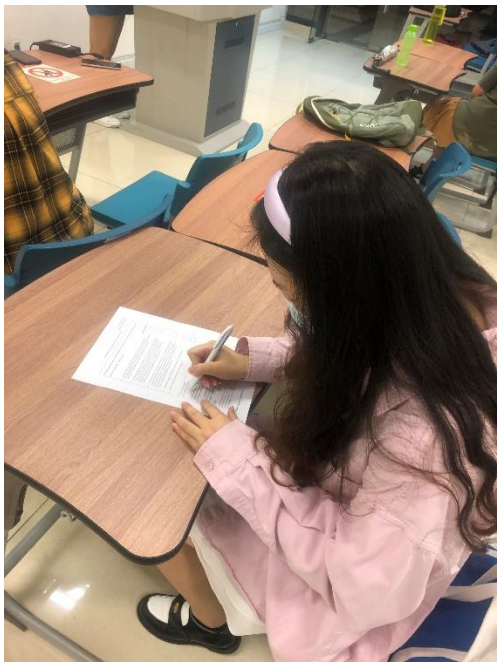


Figure 3.5 Participants Sign the Consent Form

Figure 3.6 Physical Gameplay Test

The flow of the physical playtest was indicated in Figure 3.7. There are five steps in total. The first step was to explain the research objective and the proposed game to participants, then they are required to sign a participant consent form (Appendix C). Next, participants were asked whether have answered the preliminary research before, as the preliminary research analyzed their player type which is required in this phase's research. If participants have not done the preliminary research questionnaire yet, they should answer first, then started playing the proposed game. After playing 15 levels, the questionnaire related to game experience and motivation was sent to participants as the last step of the whole playtest.

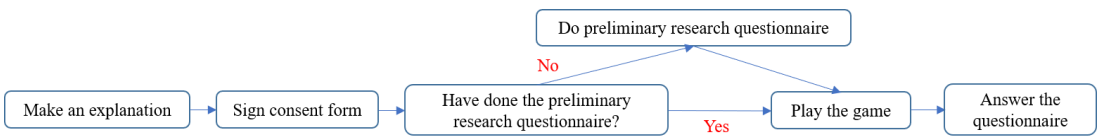


Figure 3.7 Playtest Flow

3.4.5 Data Validation

The questionnaire was sent to the participants directly after they finish the game playtest, so the data collected in phase 3 is more reliable than sending the questionnaire link in public. However, some measures are still carried out to prevent invalid data. For example, participants should use their campus id to identify themselves. The respondent time less than 90 seconds, or rated the same score throughout all questions were removed before data analysis.

3.4.6 Data Interpretation and Analysis

After data validation, all valid data are imported into Google Sheets to further analysis. The data includes categorical data (section A demographic questions) and numerical data (Section B, C, D). The distance between each score on the Likert scale is not measurable, one cannot assume that the difference between responses is equidistant even though the numbers assigned to those responses are (Sullivan & Artino, 2013). Thus, mean value calculated from Likert Scale used Liker Scale Interval to interpret collected data. This qualitative analysis of the Likert Scale average classifies the average values into several categories, which will be used to assess if a given subject produces the desired results (Pimentel, 2010). More detailed classification are showed in Table 3.9 as below:

Table 3.9: Qualitative Interpretation of 5-Point Likert Scale Measurements

Liker Scale Description	Liker Scale	Likert Scale Interval
Strongly Disagree / Not at all	1	1.00 - 1.79
Disagree / Slightly	2	1.80 - 2.59
Neutral / Moderately	3	2.60 - 3.39
Agree / Fairly	4	3.40 - 4.19
Strongly Agree / Extremely	5	4.20 -5.00

The data is interpreted as the frequency and proportion of responses in bar charts or

pie charts as well. The evaluation and discussion can be checked in Chapter 6. To explore the relation between player experience and preference game mechanics. The regression analysis and one-way ANOVA method are adopted in data analysis.

3.5 Summary

The research consists of three phases: 1) preliminary research; 2) game design and implementation; 3) result analysis and evaluation. The quantitative method is mainly adopted in the study. In preliminary research, a questionnaire related to puzzle game players' type was published online to collect data. In evaluation phase, the physical gameplay test was conducted and participants filled out the questionnaire on the spot. The data collected from preliminary research and evaluation phase are anaylzed and discussed in Chapter 4 and Chapter 6 respectively.

CHAPTER 4

PRELIMINARY RESEARCH RESULT

4.1 Overview

The preliminary research lasted two weeks. All data collected from the questionnaire which was published online. There are 149 responses are collected in total, and 144 of those responses are valid. Among the valid answers, 111 participants are female, and 33 participants are male. In the female participants group, 2 persons are below 18 years old; 94 persons are 18-23 years old; six persons are aged from 23 to 28; 9 persons are above 28 years old. In the male participant group, only one person is below 18 years old; 25 persons are from 18 to 23 years old; 7 persons are older than 28 years old; no one belongs to the 23-28 age group (Table 4.1).

Table 4.1: Age and gender of Participants

	Below 18	18-23	23-28	Above 28	Total
Female	2	94	6	9	111
Male	1	25	0	7	33
Total	3	119	6	16	145

4.2 Preliminary Analysis: Demographic Information

- **Play Frequency**

The play frequency is clustered into three groups from five options. Players play puzzle games every day or every week representing they play puzzle games frequently. Players play puzzle games every month or occasionally representing they play puzzle games occasionally.

From Figure 4.1, 30.6% of females play puzzle games frequently. This proportion is slightly higher in male players which shows as 36.4% (Figure 4.2). While male players

who rarely play puzzle games take up 21.2% of all male samples. Only 16.2% of female players declare they rarely play puzzle games. In conclusion, more female players play puzzle games more frequently than male players.

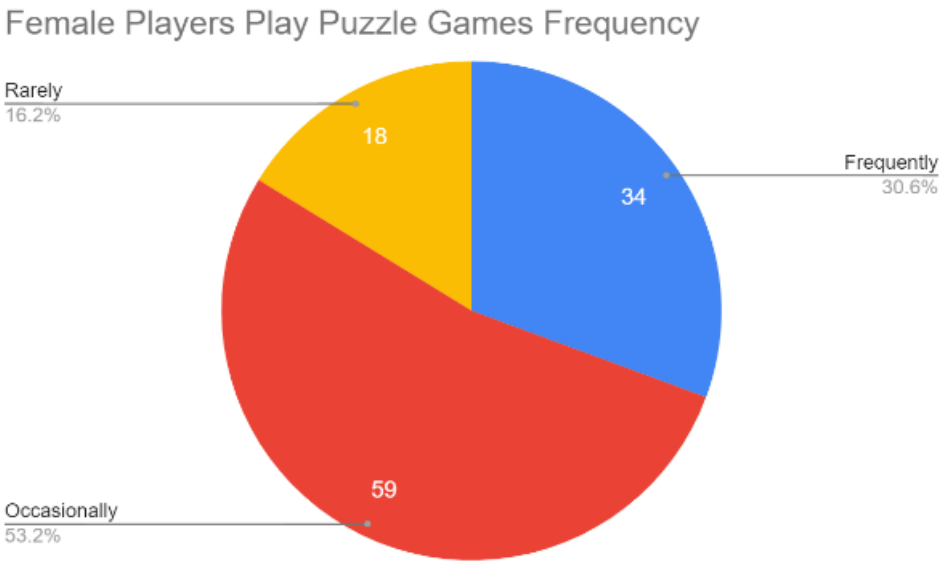


Figure 4.1: The frequency of female play puzzle game

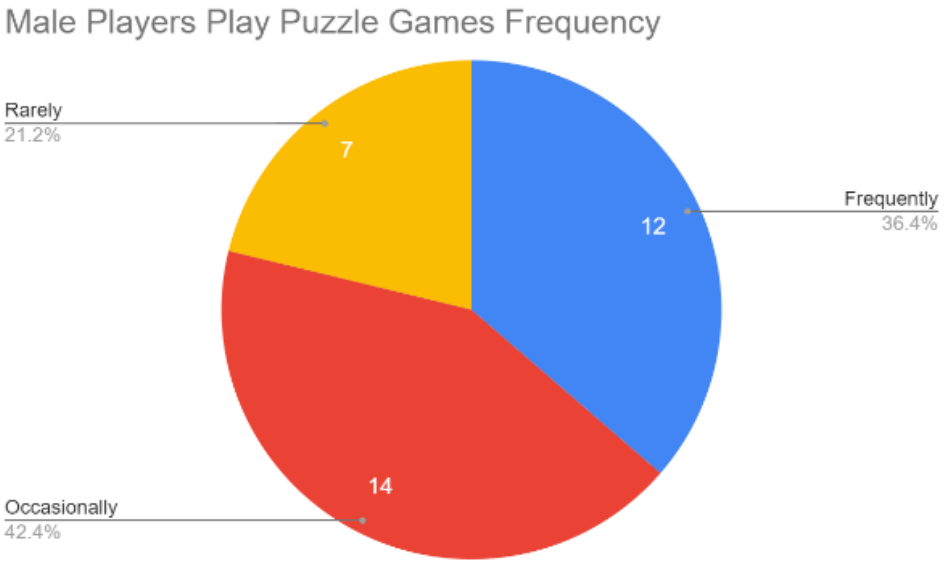


Figure 4.2: The frequency of male play puzzle game

- **Play Experience**

Players are classified into three groups, which are kid players (play puzzle games for 1 year), progressive players (play puzzle games for 2-5 years), and senior players (play puzzle games over five years). From Figure 4.3, there is 22.5% of senior female players while only 3% of male players have deep experience in puzzle games. Meanwhile, more percentage of male players only have played puzzle games for one year (see Figure 4.4). It is obvious from the two charts that female players are more experienced in puzzle games than male players.

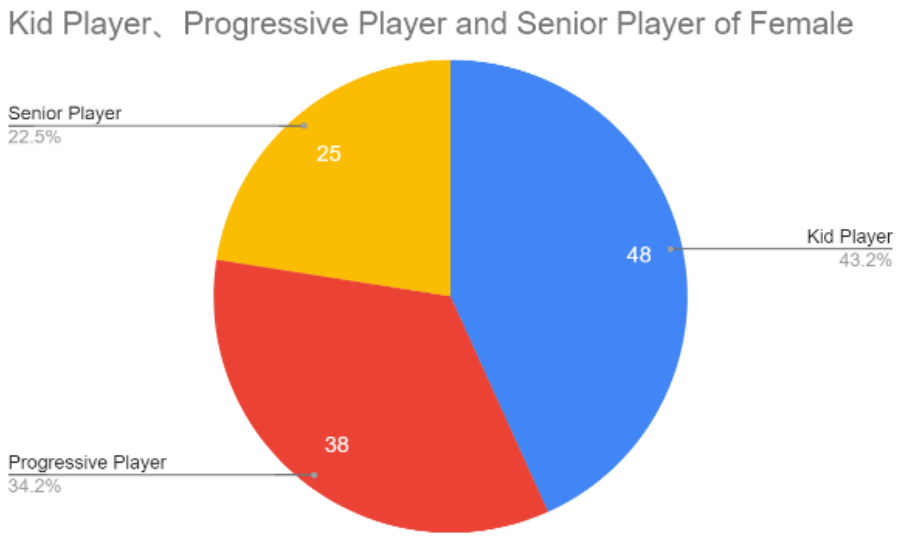


Figure 4.3: The puzzle game experience of female players

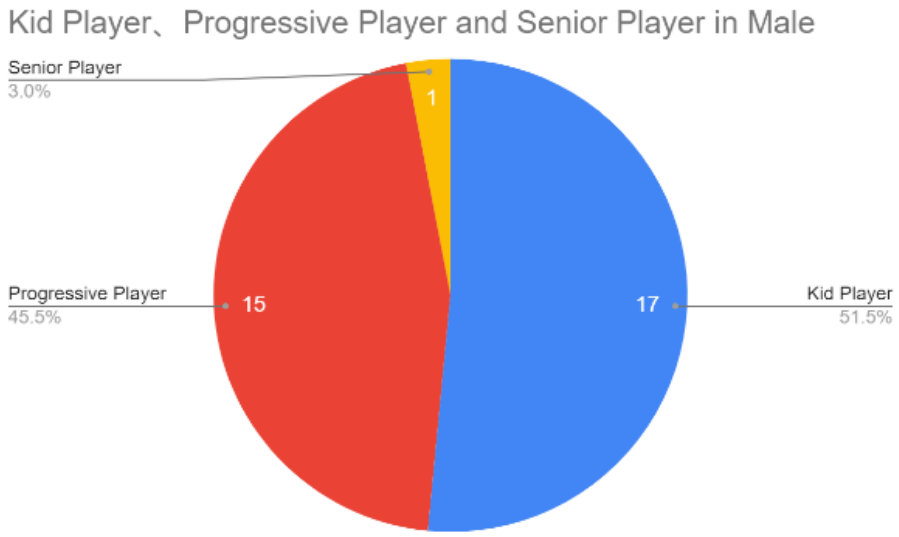


Figure 4.4: The puzzle game experience of male players

- **Top puzzle game**

According to the Chinese and Malaysian game market review, 11 puzzle games (especially the Match-3 puzzle games) are listed in the questionnaire. Participants choose their favorite games up to three. Figure 4.5 stated 11 games and the number of male and female players who voted for them as their top 3 games. From the histogram, Sheep A Sheep (Sheep a Sheep - Apps on Google Play, n.d.) and Anipop (Happy Elements, n.d.) have high popularity. Craz3 Match (Craz3 Match, n.d.), Gardenscapes (Let's Play!, n.d.), and Candy Crush (King, n.d.) are also the main popular games in the current market.

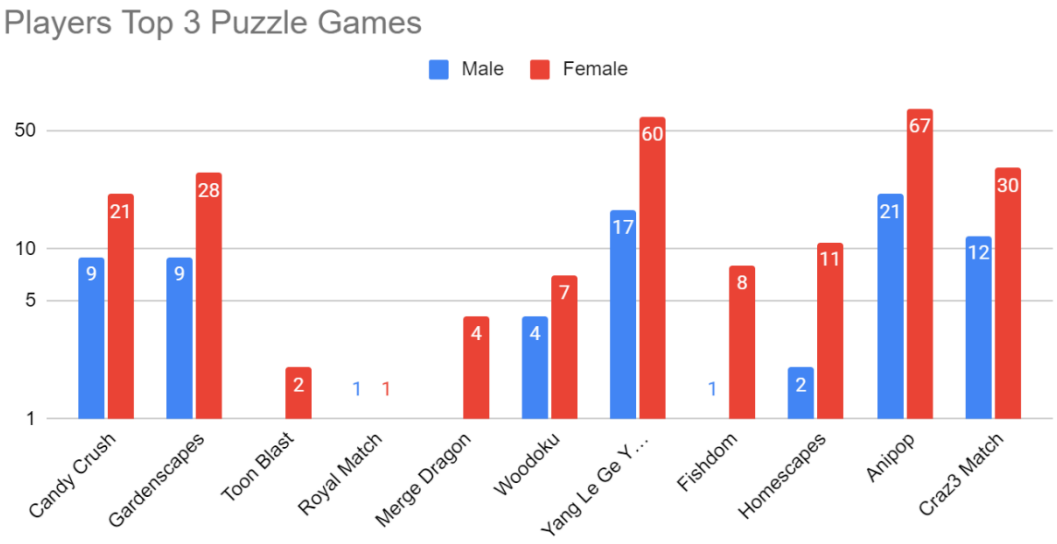


Figure 4.5: Female and male players' Top 3 Puzzle games

4.3 Player Archetypes

Players' type is calculated from the mean values of each four items. After calculating the participants' four player types score in Google Sheets, the highest one indicates the main player type of participants. Among female players (see Figure 4.6), therefore, the majority is Thinker (50.5%), the following are Achiever (30.6%), Thrill Seeker (13.5%), and Skill Master (5.4%). The proportion of the four types is different in male players (Figure 4.7). 54.4% Thinker is the largest group, next is Achiever taking 24.2

percent among all samples. Skill Master ranks third place with 12.1%, and a few Thrill Seeker player type (9.1%) exists in male players.

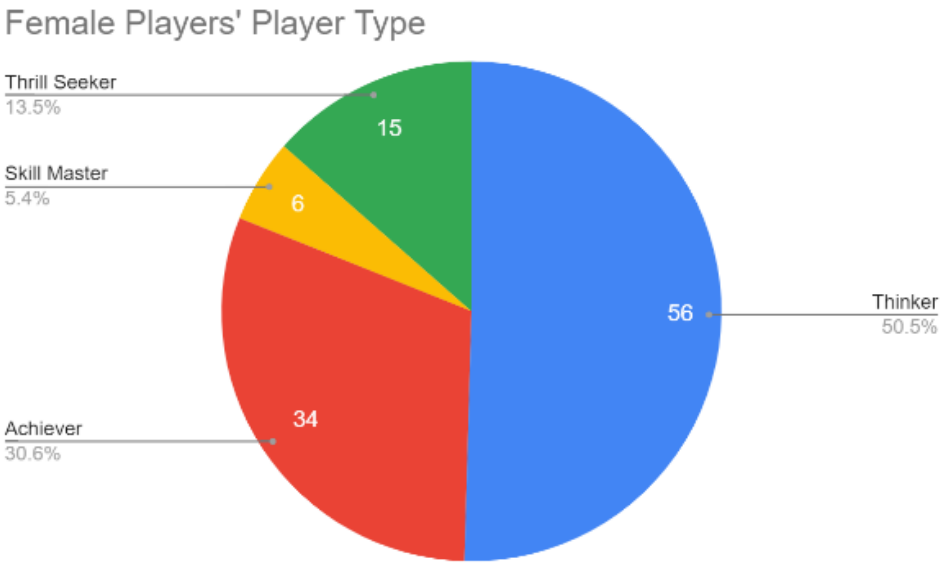


Figure 4.6: Female players' types

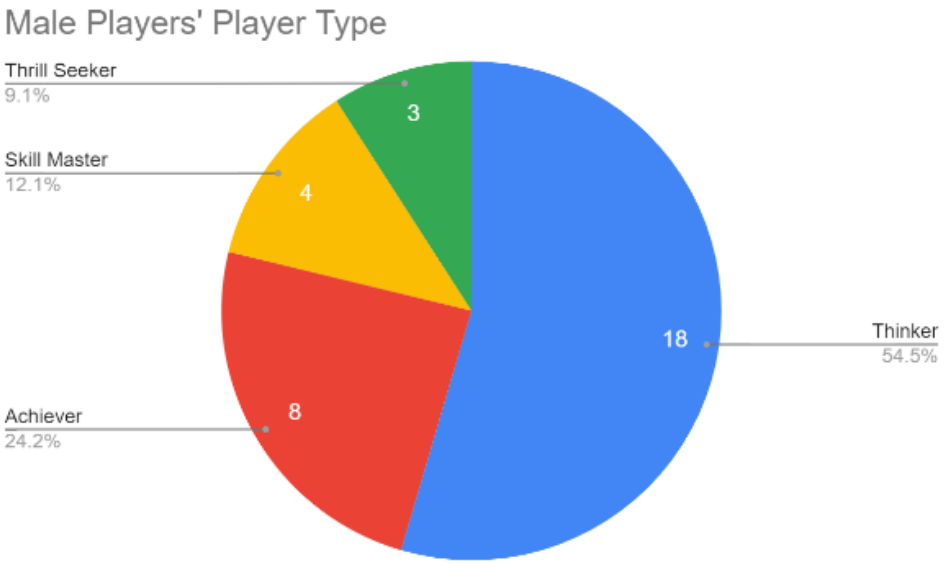


Figure 4.7: Male Players' types

Below are the descriptions of four player types (*GameRefinery*, 2021; Nacke et.al, 2014):

- **Thinker:** The occasional brain teaser or other cognitive challenge is why thinkers love playing games to divert their attention from other things. Thinkers are highly motivated and continually drawn to the game industry by their ability to successfully solve challenges.

- **Achiever:** The Achiever is more overtly focused on their goals and driven by long-term success. As a result, achievers like games that can be finished all the way. None of the "grinds" are too difficult for players that match the Achiever archetype; they will gather and accomplish whatever they can. Achiever-style games should be viewed as ultimately compulsive in their pursuit of the satisfaction of a completed task.

- **Skill Master:** Skill Masters are constantly looking for methods to improve in each game they take up. They view tough challenges and steep learning curves as desirable traits rather than deterrents. It makes them happy when other players acknowledge their high level of talent since Skill Masters are enthusiastic about perfecting and refining every area of their gameplays.

- **Thrill Seeker:** High-speed activity, risk-taking, and an adrenaline rush are qualities. Optimal gaming experience has always been something thrill seekers value. They don't want to spend their time playing slow-moving games that require a lot of strategic preparation and thought; they want to feel adrenaline and suspense.

In conclusion, the proportion of female players is Thinker>Achiever>Thrill Seeker>Skill Master, whereas this ranking in male players is Thinker>Achiever>Skill Master>Thrill Seeker.

4.4 Game Mechanics Preference

The following Table 4.2 and Table 4.3 list the top 3 game mechanics in the Match-3 puzzle games that different player types preferred. For example, female thinker prefers reach the score, layer, and dropping or collect items. From the horizontal and vertical comparison, different player types from one gender are fond of different game mechanics. Female thrill seeker like dropping most while female skill master like layer extremely. The same player type also has different choices between two gender groups. For example, the female achiever considers reaching score as the top 1 preferred game mechanic. Whereas male achiever regards reach score as the third favourite game mechanic, they like layer most.

Table 4.2: Female Player Types Top 3 Puzzle Game Mechanics

Player Type	Top 1		Top 2		Top 3	
	Game Mechanic	Score	Game Mechanic	Score	Game Mechanic	Score
Thinker	Reach Score	3.875	Layer	3.661	Dropping/ Collect Items	3.536
Achiever	Reach Score	3.765	Collect Items	3.735	Layer	3.412
Skill Master	Layer	3.5	Reach Score	3.333	Blocked Element	3.333
Thrill Seeker	Dropping	3.6	Collect Items	3.533	Layer	3.467

Table 4.3: Male Player Types Top 3 Puzzle Game Mechanics

Player Type	Top 1		Top 2		Top 3	
	Game Mechanic	Score	Game Mechanic	Score	Game Mechanic	Score
Thinker	Reach Score	3.611	Collect Items	3.278	Layer	3.222
Achiever	Layer	4	Collect Items	3.875	Reach Score	3.625
Skill Master	Reach Score	4.5	Layer/ Blocked Element	4	Immovable Obstacle	4
Thrill Seeker	Blocked Element	4	Timer	4	Dropping	4

***Score** is the mean value calculated from each group's data. A higher score indicates players prefer this mechanic more.

Classifying groups according to age and gender can summarize another result (Table 4.4). In terms of turn-based and timer mechanics, male players who are under 18 years old and female players aged 18-23 prefer timer. Other group players either enjoy turn-based mechanics or have no bias between two mechanics. Except for the group that players aged older than 28, other ages female players rated higher scores in Dropping than male players do. Meanwhile, Table 4.2 shows that Thrill Seeker usually prefers the Dropping mechanic. An inference may draw as: the reason why female players are more fond of the Dropping mechanic is that the Thrill Seeker player type takes more percentage in female players.

Table 4.4: Different Ages of Player's Preference towards Puzzle Game Mechanics

	Age Below 18		Age 18-23		Age 23-28		Age Above 28	
Score*	Female	Male	Female	Male	Female	Male	Female	Male
Immovable obstacles	3	2	2.8	3	2.5	/	2.3	4
Blocked element	3.5	2	3.4	3.3	2.5	/	2.4	3.9
Turn-based	3.5	1	3	3.2	2	/	2.2	4
Timer	2.5	2	2.8	2.6	2.5	/	2.2	3.7
Dropping	4	3	3.5	3.1	3.3	/	2.9	3.9
Collect Items	4	3	3.7	3.3	2.3	/	2.9	4.3
Reach Score	4.5	4	3.8	3.6	3.3	/	3.1	4.1
Layer	2.5	3	3.7	3.4	3.3	/	2.8	4

***Score** is the mean value calculated from each group's data. The higher score indicates players prefer this mechanic more.

4.5 Summary

The preliminary research mainly analyzed data from participants' demographic information, player archetype, and preference for Match-3 game mechanics. The result shows that female players play Match-3 puzzle games more frequently and longer. The top player types among female participants are Thinker, Achiever, Thrill Seeker, and Skill Master in sequence. The result also indicates that different types of players are fond of distinct game mechanics from one gender. Even if players are from the same player type, their preference for game mechanics differs from gender.According to the preliminary research feedback, Immovable obstacle, players, dropping, reach the score, and collect items are selected as the main target mechanics in the proposed game. The turn-based mechanic and timer appeared in the proposed game as two versions on the same level.

CHAPTER 5

CONCLUSION

5.1 Overview

This chapter mainly explains the design and implementation process of the proposed game *Happy Zoo.* It is a Match-3 puzzle game developed by Unity (2021.3.11f1c2) and was published by the Android platform. The Droppler Interactive Game Development Life Cycle was adopted as a development methodology (See Chapter 3). The game contains 15 levels in total, featuring different Match-3 puzzle game mechanics.

5.2 Game Design

5.2.1 Game Introduction

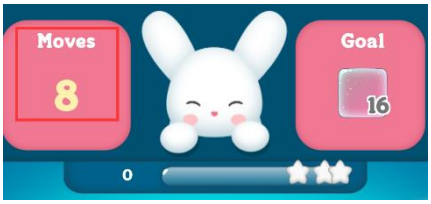
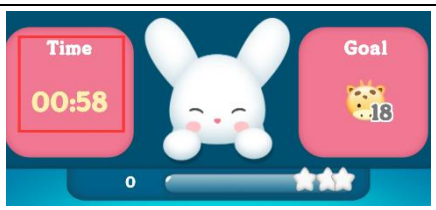
The name of the proposed game is *Happy Zoo*. Cute animals such as rabbits, foxes, frogs, and bees act as the tiles of this Match-3 puzzle game. The proposed game includes a home page, a level page, and game pages. The game's visual aesthetic design is consistent and cartoon-styled since the target audience is female players. Players can view their progress and score at each level.

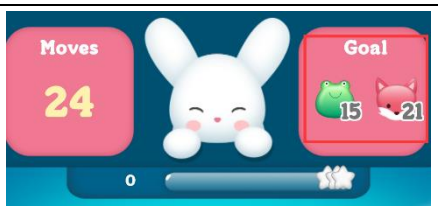
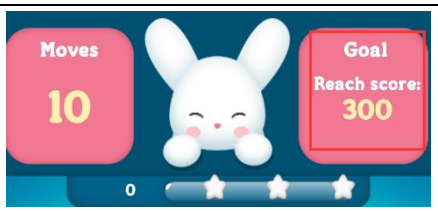
5.2.2 Game Rule Design

The game rule is the same as the traditional Match-3 puzzle games. The goal of the game is to exchange adjacent tiles (animals) to form lines, chains, or groups of three or more of the same tiles (animals). When the match happens, the same tiles will be eliminated from cells. Then new tiles will drop down in the empty cell to replace the disappeared tiles. Each level has a goal (eliminate the specific number of tiles or reach the score), and players can move to the next level only when they complete the goals within limited steps or time.

Immovable obstacles, Turn-based, Timer, Dropping, Collect Items, Reach Score, and Layer are selected as game mechanics (see Table 5.1), as they tend to be popular among players in the preliminary research. The description of each game mechanic can be found in Chapter 3 (see Table 3.3).

Table 5.1: Game mechanics in Happy Zoo

Game mechanic	Sample
Immovable obstacles	
Layer	
Dropping	
Turn-based	
Timer	

Collect Items	
Reach Score	

5.2.3 Game Level Design

The proposed game is divided into 15 levels according to difficulty and complexity. Each level is the permutation and combination of different difficulties and complexities (see Table 5.2). The difficulty of the game is defined by the number of animal types. The more kinds of animals appear in the game the lower possibility of matching, so the difficulty includes three dimensions: low difficulty with 4 types of animals, medium difficulty with 5 types of animals, and high difficulty with 6 types of animals. The complexity is indicated by the game mechanics combination. Among game mechanics, Reach Score and Collect Item are the basic game mechanics used as the goal in each level alternately. The Timer and Turn-based are the fundamental game mechanics to limit players' interaction during gameplay. A level that does not have any other game mechanics is noted as no complexity. The low complexity level includes the Immovable Obstacles based on no complexity level. The medium complexity level includes both Immovable Obstacles and Layer based on no complexity level.

Table 5.2: Difficulty and Complexity Dimension

Low Difficulty	4 types of animals
Medium Difficulty	5 types of animals
High Difficulty	6 types of animals
No Complexity	Basic game mechanics
Low Complexity	Basic game mechanics + Immovable Obstacles

Medium Complexity	Basic game mechanics + Immovable Obstacles + Layer

There is a lack of published Match-3 puzzle game score calculation methods and related formulation. Therefore, a detailed game review of various Match-3 puzzle games in the current market is carried out, recording the goals of each level and the corresponding required score. Here takes an example (Table 5.3) of the game Candy Crush:

Table 5.3: Candy Crush Level Design

level	Goal	Mechanism (Turn-based)	Remark
1	Blue Candy x 15	15	
2	Clean Mess x 28	22	
3	Stripe candy x 6	21	Appear stripe candy
4	Clean Mess x 29	15	
5	Mess 25 Candy 3	16	Appear Wrapped Candy
6	Mess 35 Candy 5	27	
7	Candy 40	25	Appear Bomb
8	Remove Jelly 21	12	Appear Jelly
9	Remove Jelly 67	30	
10	Remove Jelly 64	22	Difficult!
11	Blue Candy 60	18	Appear Bubble layer
12	Orange Candy 65	22	Bubble layer+ block
13	Remove Jelly 59	18	(4 colors)
14	Remove Jelly 50	21	(5 colors)
15	Clean Mess 50	30	
16	Clean Mess 87	21	Difficult!
17	Dropping 3	20	Appear Dropping
18	Dropping 3	22	Dropping + Block
19	Dropping 5	20	

20	Clean Mess 41	19	

Inspired by games in the current market, the calculation method between steps, goals, and scores is confirmed. Players should complete the goals within the steps or time and move to the next level. The score of the level is presented with three stars, which demonstrates how well the player finish this level. The calculation can be clustered into two groups, one method is for the Reach Goal mechanic (see Table 5.4), and another is for the Collect Item mechanic (see Table 5.5).

Table 5.4: Calculation method of Reach Goal mechanic

Turn-based steps = Reach Goal / 30 Match3 = 30 marks (Each tile 10 marks) Match4 = 40 marks + Bomb Match5 = 50 marks +Bomb Star Collected = reach goal marks + remaining 1 star = (Level Turn-based steps × 30) + 0 steps left 2 stars = (Level Turn-based steps × 30) + (1 step) left 3stars = (Level Turn-based steps × 30) + (> 2 steps) left		
Reach Goal: 300	Turn-based steps: 10	300 = 1 star 340 = 2 stars 380 = 3 stars
Reach Goal: 360	Turn-based steps: 12	360 = 1 star 400 = 2 stars 440 = 3 stars

Table 5.5: Calculation method of Collect Item mechanic

Turn-based steps = (Collect item/3×3)-1 **OR** (Collect item/3 × 2)-1 **OR** (Collect item/3 × 2) Match3 = 30 marks (Each tile 10 marks) Match4 = 40marks + Bomb Match5 = 50 marks +Bomb Star Collected = reach goal marks + remaining 1 star = (Level Turn-based steps × 30) + 0 steps left 2 stars = (Level Turn-based steps × 30) + (1 step) left 3stars = (Level Turn-based steps × 30) + (> 2 steps) left		
Collect 9 animals	Turn-based steps: (3 × 3)-1=8 steps	240 = 1 star 350 = 2 stars 380 = 3 stars
Collect 60 animals	Turn-based steps: (13 × 20)-1=25 steps	750 = 1 star 800 = 2 stars 830 = 3 stars

According to the game score system design and game rule design, the proposed game can be divided into 15 levels as the following table:

Table 5.6: Goal, Game mechanics, and Score Design

Level Code	Game Mechanics	Collectible	Turn-based	Reach Goal	Star Collected
A	Low difficulty No Complexity	/	10	300	300 = 1 star 350 = 2 stars 380 = 3 stars
B	Medium difficulty	18 Orange	6*2=12	360	360 = 1 star

	No Complexity	Giraffe			410 = 2 stars 440 = 3 stars
C	High difficulty No Complexity	15 Green Frogs 21 Red Foxes	12*2=24	800	800 = 1 star 850 = 2 stars 880 = 3 stars
B*	Medium difficulty No Complexity	18 Orange Giraffe	**Timer 60s**	360	360 = 1 star 410 = 2 stars 440 = 3 stars
D	Low difficulty Low complexity	40 purple cats	13*2-1=25	750	750 = 1 star 800 = 2 stars 830 = 3 stars
E	Medium difficulty Low complexity	20 Green Frogs 20 Orange Giraffes	14*2-1=27	810	810 = 1 star 860 = 2 stars 890 = 3 stars
F	High difficulty Low complexity	15 white Bees 15 Green Frogs 15 Orange Giraffes 15 Purple	20*2-1=39	1170	1170 = 1 star 1220 = 2 stars 1250 = 3 stars
E*	Medium difficulty Low complexity	30 Green Frogs 30 Orange	**Timer 90s**	1170	1170 = 1 star 1220 = 2 stars 1250 = 3 stars
G	Low difficulty Medium complexity	16 Ice	3*3-1=8	240	240 = 1 star 290 = 2 stars 420 = 3 stars
H	Medium difficulty	18 Ice	7*3-	600	600 = 1 star

	Medium complexity		1=20		650 = 2 stars 680 = 3 stars
I	High difficulty Medium complexity	24 Ice	31	930	930 = 1 star 980 = 2 stars 1100 = 3 stars
H*	Medium difficulty Low complexity	18 Ice	**Timer 120s**	600	600 = 1 star 650 = 2 stars 680 = 3 stars
X	Low difficulty No Complexity Dropping	2 Cherry	20	600	600 = 1 star 650 = 2 stars 680 = 3 stars
Y	Medium difficulty Low complexity Dropping	1 Cherry 1 Watermelon	32	960	960 = 1 star 1100 = 2 stars 1140 = 3 stars
Z	High difficulty Medium complexity Dropping item	1 Cherry 1 Watermelon 10 Ice	39	1170	1170 = 1 star 1220 = 2 stars 1250 = 3 stars

Level A, B, C are levels with no complexity but the difficulty increases gradually. The D, E, F levels have low complexity mechanics while levels G, H, I have medium complexity mechanics. The Turn-based mechanic was changed to Timer mechanic in B*, E*, H* levels, other conditions are consistent with levels B, E, H respectively. The Dropping mechanic is added based on difficulty and complexity in levels X, Y, Z.

The level arrangement takes the Match-3 puzzle game difficulty curve as a reference. In order to rank the general difficulty of each level, a two-dimension table was created in Table 5.7.

Table 5.7: Level difficulty in two dimensions

	4 ANIMALS	**5 ANIMALS**	**6 ANIMALS**
NO COMPLEXITY	A	B	C
BLOCK	D	E	F
BLOCK + ICE LAYER	G	H	I

From Table 5.7, the game levels can be clustered into three groups:

- Easy levels (low difficulty OR no complexity): A, B, C, D, G
- Medium level (medium difficulty OR low complexity): B, E, H, D, F
- Difficult level (high difficulty OR Medium complexity): C, F, I, G, H

After comparing each group and integrating them into one sequence, the conclusion can be drawn as follow:
Conclusion (difficulty from low to high): A<B<D<C<E<G<F<H<I

Meanwhile, levels which have the Dropping mechanics are more difficult than high difficulty and high complexity levels according to empirical evidence and playtests. Therefore, the Dropping levels are considered harder than I, and the order among them is X < Y< Z. The B*, E*, H* levels are accessed by Timer mechanics differing from all other levels, so these three levels are arranged at the end. The difficulty curve represents the order in which the levels are difficult, and the p_{win} value in vertical coordinates represents the possibility of winning condition. The higher p_{win} value means the levels are easier. The final game level design is shown in Figure 5.1.

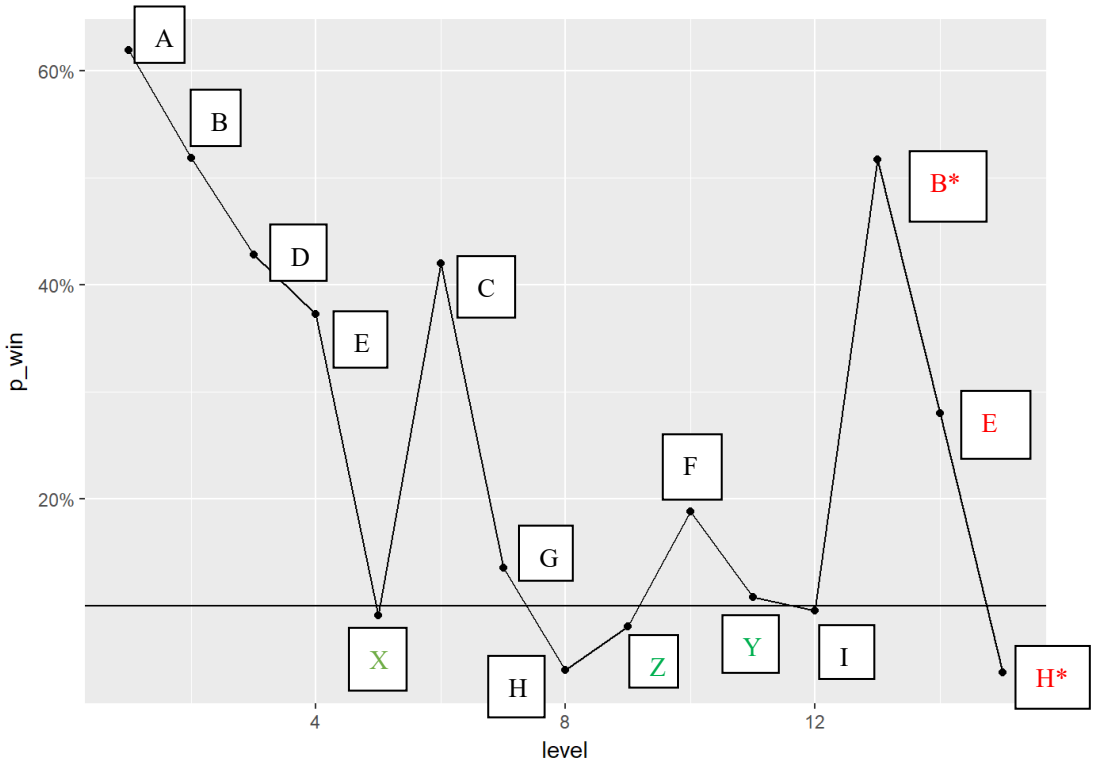


Figure 5.1: Final game level design

5.3 Game Development

The Game mainly contains three scenes: the Home Scene, the Level Scene, and the Game Scene. The game implementation process will be introduced as this sequence in the following part.

5.3.1 Home Scene

The home page is equipped with a music control button, a music effect control button, and a setting button to turn on or turn off the sound (Figure 5.2). The name of the proposed game and characters are popping up when the player opens the game.

```
/// <summary>
/// Called when the settings button is pressed.
0 个引用
public void OnSettingsButtonPressed()
{
    OpenPopup<SettingsPopup>("Popups/SettingsPopup");
}

/// <summary>
/// Called when the sound button is pressed.
0 个引用
public void OnSoundButtonPressed()
{
    SoundManager.instance.ToggleSound();
}

/// <summary>
/// Called when the music button is pressed.
0 个引用
public void OnMusicButtonPressed()
{
    SoundManager.instance.ToggleMusic();
}
```

Figure 5.2: Button control functions in Home Scene

The background music and all sound effects are stored in Home Scene as a list through the *SoundManager* script. Then the sound effects will be called in different popup functions by names.

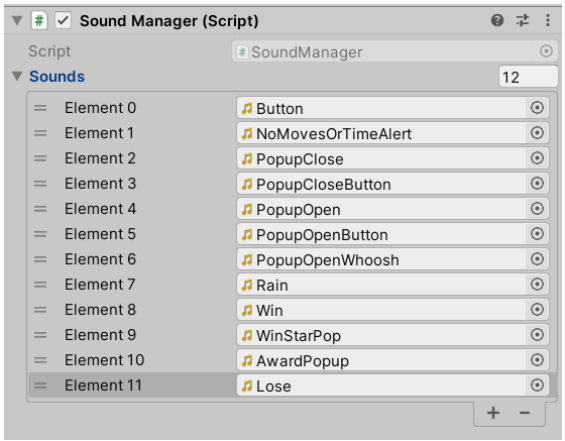


Figure 5.3: Sound effects list

5.3.2 Level Scene

The Level Scene contains all levels button in the game. Players can select the levels one by one to enter the game here. First of all, a Scroll View (Figure 5.4) was used in the canvas to make users can browse all levels by swiping the screen down.

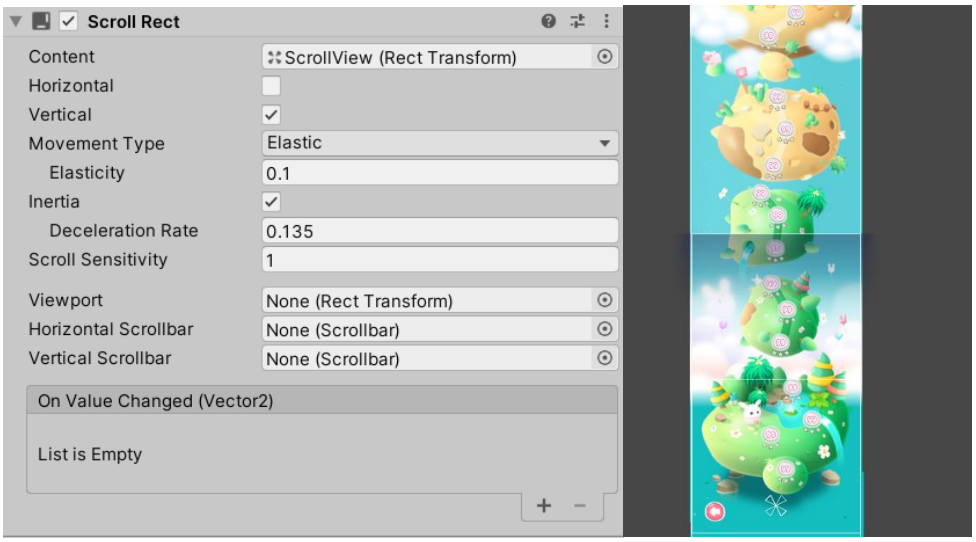


Figure 5.4: Scroll View

The level buttons are stored as prefabs so that each data can be easily modified in the Level Scene. The attributes in the level button include: level number, three colors in different status, text colors, and stars represented rewards (Figure 5.5).

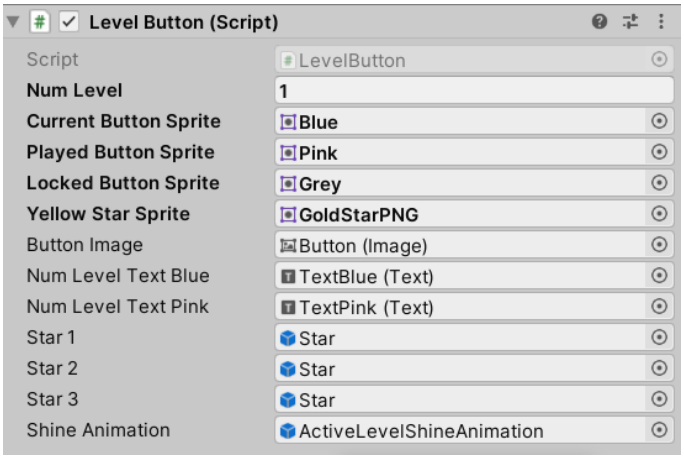


Figure 5.5: Level button attributes

Figure 5.6 shows the functions to control the level buttons' status. The level buttons have three statuses: 1) Current level; 2) Played level with stars status; 3) Locked button that cannot be played. When players press the button, the game will jump to the corresponding level according to the Level number id.

```
private void Start()
{
    numLevel1TextBlue.text = numLevel1.ToString();
    numLevel1TextPink.text = numLevel1.ToString();
    var nextLevel1 = PlayerPrefs.GetInt("next_level1");
    if (nextLevel1 == 0)
    {
        nextLevel1 = 1;
    }

    if (numLevel1 == nextLevel1)
    {
        buttonImage.sprite = currentButtonSprite;
        star1.SetActive(false);
        star2.SetActive(false);
        star3.SetActive(false);
        shineAnimation.SetActive(true);
        numLevel1TextPink.gameObject.SetActive(false);
    }
    else if (numLevel1 < nextLevel1)
    {
        buttonImage.sprite = playedButtonSprite;
        numLevel1TextBlue.gameObject.SetActive(false);
        var stars = PlayerPrefs.GetInt("level_stars_" + numLevel1);
        switch (stars)
        {
            case 1:
                star1.GetComponent<Image>().sprite = yellowStarSprite;
                break;

            case 2:
                star1.GetComponent<Image>().sprite = yellowStarSprite;
                star2.GetComponent<Image>().sprite = yellowStarSprite;
                break;

            case 3:
                star1.GetComponent<Image>().sprite = yellowStarSprite;
                star2.GetComponent<Image>().sprite = yellowStarSprite;
                star3.GetComponent<Image>().sprite = yellowStarSprite;
```

```
        else
        {
            buttonImage.sprite = lockedButtonSprite;
            numLevel1TextPink.gameObject.SetActive(false);
            star1.SetActive(false);
            star2.SetActive(false);
            star3.SetActive(false);
        }
    }
```

Figure 5.6: Level button attribute functions

5.3.3 Game Scene

The Game Scene is the main scene for generating grids, cells, and tiles of the Match-3 puzzle game. Figure 5.7 shows all animals appearing in the game as tiles. The same type of animals can be eliminated if the matching occurs.

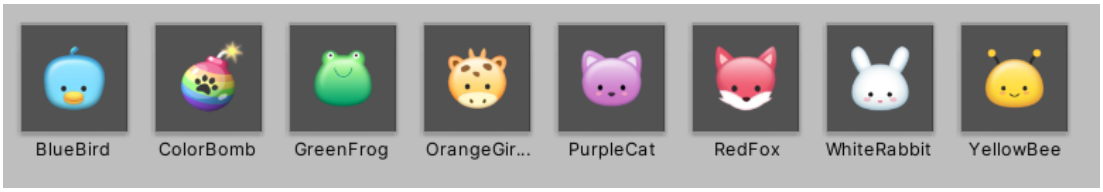


Figure 5.7: Animals in Happy Zoo

These animals are stored as prefabs and linked to the tile pool (Figure 5.8). The tile pool has been serialized first, then tiles are initialized every time when restart the level.

Figure 5.8: Tile pool of Game Scene

The tiles will be randomly generated by using *Random* functions (Figure 5.9). The type of animals can be set first, and then only the eligible tiles will be generated randomly at each certain level. The tiles are fetched from the tile pool.

```
private GameObject CreateTile(int x, int y, bool runtime)
{
    var eligibleTiles = new List<CandyColor>();
    eligibleTiles.AddRange(level.availableColors);

    var leftTile1 = GetTile(x - 1, y);
    var leftTile2 = GetTile(x - 2, y);
    if (leftTile1 != null && leftTile2 != null &&
        leftTile1.GetComponent<Candy>() != null && leftTile2.GetComponent<Candy>() != null &&
        leftTile1.GetComponent<Candy>().color == leftTile2.GetComponent<Candy>().color)
    {
        var tileToRemove = eligibleTiles.Find(t =>
            t == leftTile1.GetComponent<Candy>().color);
        eligibleTiles.Remove(tileToRemove);
    }

    var topTile1 = GetTile(x, y - 1);
    var topTile2 = GetTile(x, y - 2);
    if (topTile1 != null && topTile2 != null &&
        topTile1.GetComponent<Candy>() != null && topTile2.GetComponent<Candy>() != null &&
        topTile1.GetComponent<Candy>().color == topTile2.GetComponent<Candy>().color)
    {
        var tileToRemove = eligibleTiles.Find(t =>
            t == topTile1.GetComponent<Candy>().color);
        eligibleTiles.Remove(tileToRemove);
    }
```

```
    GameObject tile;
    if (runtime && eligibleCollectables.Count > 0)
    {
        var tileChance = UnityEngine.Random.Range(0, 100);
        if (tileChance <= level.collectableChance)
        {
            var idx = UnityEngine.Random.Range(0, eligibleCollectables.Count);
            var collectable = eligibleCollectables[idx];
            tile = tilePool.GetCollectablePool(collectable).GetObject();
            eligibleCollectables.RemoveAt(idx);
        }
        else
        {
            tile = tilePool.GetCandyPool(eligibleTiles[UnityEngine.Random.Range(0, eligibleTiles.Count)])
                .GetObject();
        }
    }
    else
    {
        tile = tilePool.GetCandyPool(eligibleTiles[UnityEngine.Random.Range(0, eligibleTiles.Count)])
            .GetObject();
    }

    tile.GetComponent<Tile>().board = this;
    tile.GetComponent<Tile>().x = x;
    tile.GetComponent<Tile>().y = y;
    return tile;
}
```

Figure 5.9: Create random tiles

The player only can move and exchange the adjacent tiles. The function (Figure 5.10) shows the x and y coordinate value as a condition of whether players can move tiles in two cells. The move animation is implemented by *LeanTween* plug-ins.

```
{
    var selectedTileCopy = selectedTile;
    var hitTileCopy = hit.collider.gameObject;
    selectedTile.GetComponent<SpriteRenderer>().sortingOrder = 1;

    var selectedTilePos = tilePositions[tiles.FindIndex(x => x == selectedTile)];
    var hitTilePos = tilePositions[tiles.FindIndex(x => x == hit.collider.gameObject)];

    var tileA = hit.collider.gameObject;
    var tileB = selectedTile;
    if (!(tileA.GetComponent<Tile>().x != tileB.GetComponent<Tile>().x &&
          tileA.GetComponent<Tile>().y != tileB.GetComponent<Tile>().y))
    {
        currentlySwapping = true;
        LeanTween.move(selectedTile, hitTilePos, 0.2f);
        LeanTween.move(hit.collider.gameObject, selectedTilePos, 0.2f).setOnComplete(() =>
        {
            LeanTween.move(selectedTileCopy, selectedTilePos, 0.2f).setOnComplete(() =>
            {
                currentlySwapping = false;
                selectedTileCopy.GetComponent<SpriteRenderer>().sortingOrder = 0;
                selectedTileCopy.transform.rotation = Quaternion.identity;
                hit.collider.gameObject.transform.rotation = Quaternion.identity;
            });
            LeanTween.move(hitTileCopy, hitTilePos, 0.2f);
        });
    }
    selectedTile = null;

    SoundManager.instance.PlaySound("Error");
```

Figure 5.10: Check players' input

The below function is to check the matching in a horizontal dimension (Figure 5.11). Only when the number of tiles is equal to or larger than 3, the matching is successful. The same method was used in vertical match judgment.

```
private bool HasHorizontalMatch(int x, int y)
{
    var tile = GetTile(x, y);
    if (tile.GetComponent<Candy>() != null)
    {
        var horzLen = 1;
        for (var i = x - 1;
            i >= 0 && GetTile(i, y) != null && GetTile(i, y).GetComponent<Candy>() != null &&
            GetTile(i, y).GetComponent<Candy>().color == tile.GetComponent<Candy>().color;
            i--, horzLen++) ;
        for (var i = x + 1;
            i < level.width && GetTile(i, y) != null && GetTile(i, y).GetComponent<Candy>() != null &&
            GetTile(i, y).GetComponent<Candy>().color == tile.GetComponent<Candy>().color;
            i++, horzLen++) ;
        if (horzLen >= 3) return true;
    }

    return false;
}
```

Figure 5.11: Horizontal matching function

When the matching is got approved, the tiles will be eliminated. The tile will be destroyed with special particle effects and the sound effects will be played (Figure

5.12). The particle effects are stored as prefabs in the *fxPool* list to spawn each time when the *ShowExlposionFx ()* function is called.

```
public void ExplodeTile(GameObject tile, bool didAnySpecialCandyExplode = false)
{
    var explodedTiles = new List<GameObject>();
    ExplodeTileRecursive(tile, explodedTiles);
    var score = 0;
    foreach (var explodedTile in explodedTiles)
    {
        var idx = tiles.FindIndex(x => x == explodedTile);
        if (idx != -1)
        {
            explodedTile.GetComponent<Tile>().ShowExplosionFx(fxPool);
            explodedTile.GetComponent<Tile>().UpdateGameState(gameState);
            score += gameConfig.GetTileScore(explodedTile.GetComponent<Tile>());
            DestroyElements(explodedTile);
            DestroySpecialBlocks(explodedTile, didAnySpecialCandyExplode);
            explodedTile.GetComponent<PooledObject>().pool.ReturnObject(explodedTile);
            tiles[idx] = null;
        }

        SoundManager.instance.PlaySound("Crush");
    }

    UpdateScore(score);
    gameUi.UpdateGoals(gameState);
}
```

Figure 5.12: Eliminate tiles after matching

After the tiles are eliminated, a function (Figure 5.13) will apply the gravity to other tiles in the grid and newly generated tiles.

```
if (bottom != -1)
{
    var tile = GetTile(i, j);
    if (tile != null)
    {
        var numTilesToFall = bottom - j;
        tiles[tileIndex + (numTilesToFall * level.width)] = tiles[tileIndex];
        var tween = LeanTween.move(tile,
            tilePositions[tileIndex + level.width * numTilesToFall],
            0.5f);
        tween.setEase(LeanTweenType.easeInQuad);
        tween.setOnComplete(() =>
        {
            if (tile.GetComponent<Tile>() != null)
            {
                tile.GetComponent<Tile>().y += numTilesToFall;
                if (tile.activeSelf && tile.GetComponent<Animator>() != null)
                {
                    tile.GetComponent<Animator>().SetTrigger("Falling");
                    if (!fallingSoundPlayed)
                    {
                        fallingSoundPlayed = true;
                        SoundManager.instance.PlaySound("CandyFalling");
                    }
                }
            }
        });
        tiles[tileIndex] = null;
```

Figure 5.13: Make tiles falling

When there is no possible matching condition at the level, the game will automatically regenerate using the *IEnumerator* function.

```
private IEnumerator RegenerateLevel()
{
    yield return new WaitForSeconds(2.0f);
    for (var i = 0; i < level.width; i++)
    {
        for (var j = 0; j < level.height; j++)
        {
            var idx = i + (j * level.width);
            var tile = tiles[idx];
            if (tile != null &&
                tile.GetComponent<Candy>() != null)
            {
                var newTile = CreateTile(i, j, false);
                newTile.transform.position = tile.transform.position;
                tile.GetComponent<PooledObject>().pool.ReturnObject(tile);
                SetTile(newTile, i, j);
            }
        }
    }
```

Figure 5.14: Regenerate level

The game board consists of a number of grids used for storing tiles. The game board is created using the width and height value of the game scene (Figure 5.15). The size of the whole grid was adjusted using the camera orthographic size.

```
var totalWidth = (level.width - 1) * (tileW + horizontalSpacing);
var totalHeight = (level.height - 1) * (tileH + verticalSpacing);
for (var j = 0; j < level.height; j++)
{
    for (var i = 0; i < level.width; i++)
    {
        var tilePos = new Vector2(i * (tileW + horizontalSpacing), -j * (tileH + verticalSpacing));
        var newPos = tilePos;
        newPos.x -= totalWidth / 2;
        newPos.y += totalHeight / 2;
        newPos.y += boardCenter.position.y;
        var tile = tiles[i + (j * level.width)];
        if (tile != null)
        {
            tile.transform.position = newPos;
        }

        tilePositions.Add(newPos);
        var levelTile = level.tiles[i + (j * level.width)];
        if (!(levelTile is HoleTile))
        {
            GameObject bgTile;
            if (j % 2 == 0)
            {
                bgTile = i % 2 == 0
                    ? tilePool.darkBgTilePool.GetObject()
                    : tilePool.lightBgTilePool.GetObject();
            }
            else
            {
                bgTile = i % 2 == 0
                    ? tilePool.lightBgTilePool.GetObject()
                    : tilePool.darkBgTilePool.GetObject();
            }
            bgTile.transform.position = newPos;
        }
```

Figure 5.15: Generate the game board

Except for the normal animal tiles, the game also designs other special tiles such as: Biscuits (immovable blocks), Ice (layers), and Cherry and Watermelons (droppings). They will be introduced in the following part.

The Biscuits element are immovable blocks in the game, so they cannot be moved and matched themselves. But they can be eliminated by their neighbor tiles, the function in Figure 5.16 shows the how Biscuits element be eliminated by using *DestroySpecialBlocksInternal(neighbour)* function.

```
private void DestroySpecialBlocks(GameObject tile, bool didAnySpecialCandyExplode)
{
    if (!didAnySpecialCandyExplode)
    {
        var x = tile.GetComponent<Tile>().x;
        var y = tile.GetComponent<Tile>().y;
        var leftTile = GetTile(x - 1, y);
        var rightTile = GetTile(x + 1, y);
        var topTile = GetTile(x, y + 1);
        var bottomTile = GetTile(x, y - 1);
        var neighbourTiles = new List<GameObject> {leftTile, rightTile, topTile, bottomTile};
        foreach (var neighbour in neighbourTiles)
        {
            DestroySpecialBlocksInternal(neighbour);
        }
```

Figure 5.16: Destroy Biscuit elements

When the type of tile is Ice, then the ice prefabs will be covered on that tile (Figure 5.17). When the tiles in the Ice are destroyed, the Ice elements will be destroyed at the same time (Figure 5.18).

```
if (levelTile != null && levelTile.elementType == ElementType.Ice)
{
    var ice = tilePool.icePool.GetObject();
    ice.transform.position = tilePositions[i + (j * level.width)];
    ice.GetComponent<SpriteRenderer>().sortingOrder = 1;
    ices.Add(ice);
}
```

Figure 5.17: Add Ice on the tile

```
// Check for ices.
if (idx != -1 && level.tiles[idx] != null && level.tiles[idx].elementType == ElementType.Ice)
{
    ices[idx].GetComponent<PooledObject>().pool.ReturnObject(ices[idx]);
    level.tiles[idx].elementType = ElementType.None;
    ices[idx] = null;
    gameState.AddElement(ElementType.Ice);
    UpdateScore(gameConfig.GetElementScore(ElementType.Ice));

    var fx = fxPool.GetElementExplosion(ElementType.Ice).GetObject();
    fx.transform.position = tilePositions[idx];

    SoundManager.instance.PlaySound("Ice");
}
```

Figure 5.18: Destroy Ice

The Dropping tiles are also called collectible tiles. Only when the collectible items are moved to the bottom of the grid, they will be destroyed. Therefore, the height is the

condition to check whether the collectible items can be destroyed (Figure 5.19).

```
    if (levelTile is CollectableTile)
    {
        var collectableTile = (CollectableTile) levelTile;
        var tile = tilePool.GetCollectablePool(collectableTile.type).GetObject();
        tile.GetComponent<Tile>().board = this;
        tile.GetComponent<Tile>().x = x;
        tile.GetComponent<Tile>().y = y;
        return tile;
    }

    return null;
}

private bool CheckCollectables()
{
    var collectablesToDestroy = new List<Tile>();
    for (var i = 0; i < level.width; i++)
    {
        Tile bottom = null;
        var tileIndex = 0;
        for (var j = level.height - 1; j >= 0; j--)
        {
            tileIndex = i + (j * level.width);
            if (tiles[tileIndex] == null)
            {
                continue;
            }

            var tile = tiles[tileIndex].GetComponent<Tile>();
            if (tile != null)
            {
                if (tile.GetComponent<Unbreakable>() != null)
                {
                    continue;
                }

                bottom = tile;
            }

            break;
        }

        if (bottom != null && bottom.GetComponent<Collectable>() != null)
        {
            collectablesToDestroy.Add(bottom);
            tiles[tileIndex] = null;
        }
    }
```

Figure 5.19: Dropping tiles functions

The limitation of steps, goals, and score progress are arranged on the top of the Game Scene as Figure 5.20 shows. The moves limitation locates on the left of the top bar, it will exchange with the count-down timer according to the level type. The reach goal or collect items shows on the left of the top bar, players should take it as a goal reference to finish level. The progress bar is in the middle of the top bar, it shows the progress of the score player earned.

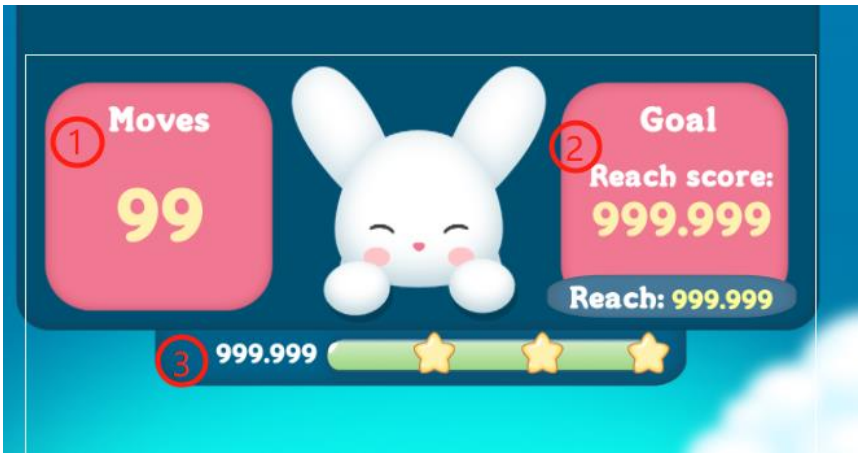


Figure 5.20: Top bar of Game Scene

The values in the top bar are stored as serialized fields and can be called each time when the level is generated (Figure 5.21).

```
[SerializeField] private Text limitTitleText;
[SerializeField] private Text limitText;
[SerializeField] private Text scoreText;
[SerializeField] private ProgressBar progressBar;
[SerializeField] private GameObject goalPrefab;
[SerializeField] private GameObject scoreGoalItem;
[SerializeField] private Text scoreGoalItemText;
[SerializeField] private GameObject scoreGoalOnlyItem;
[SerializeField] private Text scoreGoalOnlyItemText;
```

Figure 5.21: List of serialized values of game UI

There are two types of limits in the game: one is the move limitation while another is the time limitation. If the type of limit is Moves, then the limit text on UI is shown as the number of moves. On the contrary, if the type of limit is a timer, the limit text on UI is shown as the time left (Figure 5.22).

```
private void UpdateLimitText()
{
    if (level.limitType == LimitType.Moves)
    {
        gameUi.SetLimit(currentLimit);
    }
    else if (level.limitType == LimitType.Time)
    {
        var timeSpan = TimeSpan.FromSeconds(currentLimit);
        gameUi.SetLimit(string.Format("{0:D2}:{1:D2}", timeSpan.Minutes, timeSpan.Seconds));
    }
}
```

Figure 5.22: Limit text in UI

The goal panel also has two versions: one is reaching scores and another is to collect a certain number of animals. Therefore, if the goal is reaching scores, only the score number is presented on the goal panel. If the goal is collecting items, the images of animal icons are printed on the goal panel (Figure 5.23).

```
public void SetGoals(List<Goal> goals, bool scaleImages = false)
{
    var childrenToRemove = goalGroup.GetComponentsInChildren<GoalUiElement>().ToList();
    foreach (var child in childrenToRemove)
    {
        Destroy(child.gameObject);
    }

    var reachScoreGoal = goals.Find(x => x is ReachScoreGoal);
    if (reachScoreGoal != null)
    {
        if (goals.Count == 1)
        {
            scoreGoalItem.SetActive(false);
            scoreGoalOnlyItemText.text = ((ReachScoreGoal) reachScoreGoal).score.ToString();
        }
        else
        {
            scoreGoalOnlyItem.SetActive(false);
            scoreGoalItemText.text = ((ReachScoreGoal) reachScoreGoal).score.ToString();
        }
    }
    else
    {
        scoreGoalItem.SetActive(false);
        scoreGoalOnlyItem.SetActive(false);
    }

    foreach (var goal in goals)
    {
        if (!(goal is ReachScoreGoal))
        {
            var goalObject = Instantiate(goalPrefab);
            goalObject.transform.SetParent(goalGroup.transform, false);
            goalObject.GetComponent<GoalUiElement>().Fill(goal);
        }
    }
```

Figure 5.23: Goal panel implementation

The progress bar used the filled type image to show the dynamic progress. The stars will be lightened one by one when the players reach a certain score. The location of stars is automatically set according to the proportion (Figure 5.24).

```
public void UpdateProgressBar(int score)
{
    progressBarImage.fillAmount = GetProgressValue(score) / 100.0f;

    if (score >= star1 && !star1Achieved)
    {
        star1Achieved = true;
        star1Image.Activate();
        SoundManager.instance.PlaySound("StarProgressBar");
    }
    if (score >= star2 && !star2Achieved)
    {
        star2Achieved = true;
        star2Image.Activate();
        SoundManager.instance.PlaySound("StarProgressBar");
    }
    if (score >= star3 && !star3Achieved)
    {
        star3Achieved = true;
        star3Image.Activate();
        SoundManager.instance.PlaySound("StarProgressBar");
    }

    star1Image.transform.localPosition = progressBarImage.transform.localPosition +
                                         new Vector3(
                                             progressBarImage.rectTransform.rect.width *
                                             (GetProgressValue(star1) / 100.0f) - 0.0f, 0, 0);
    star2Image.transform.localPosition = progressBarImage.transform.localPosition +
                                         new Vector3(
                                             progressBarImage.rectTransform.rect.width *
                                             (GetProgressValue(star2) / 100.0f) - 0.0f, 0, 0);
    star3Image.transform.localPosition = progressBarImage.transform.localPosition +
```

Figure 5.24: Progress bar and stars

The configuration and attribute of each level are written as documents in the sequence of level numbers. Here takes a configuration document example of level 8 (Figure 5.25). In configuration documents, the gird design and game level design both can be implemented.

Figure 5.25: Level 8 configuration document

5.4 Internal Test

When the proposed game is basically implemented, an internal test (Figure 5.26) was conducted to evaluate the functionality, usability, and bug review.

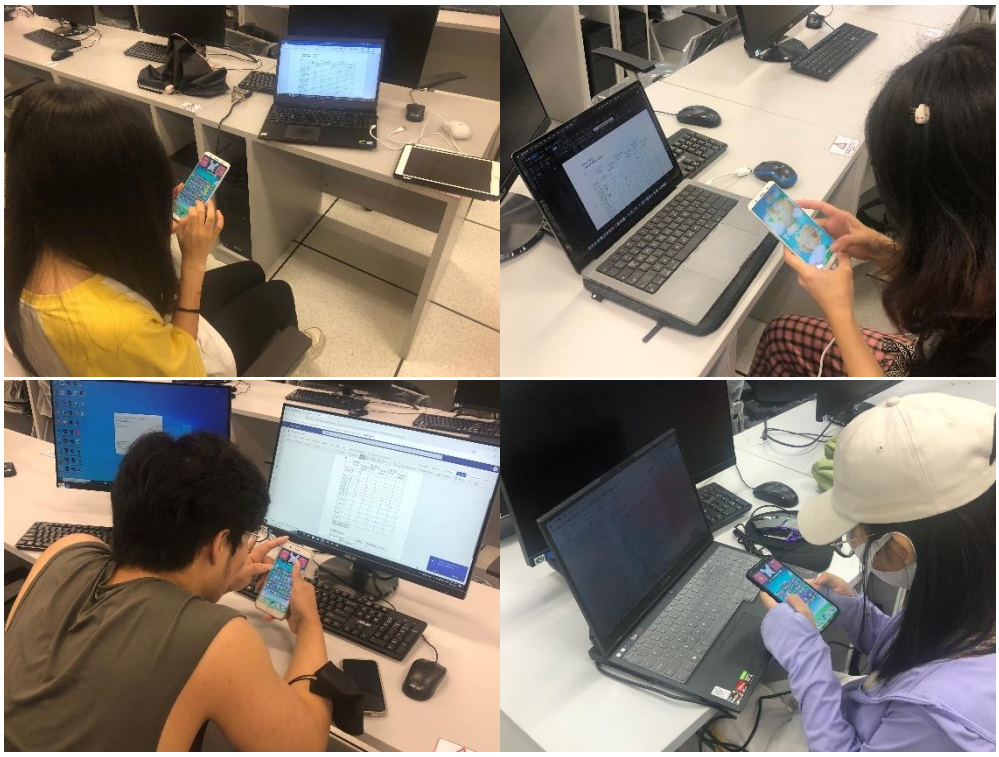


Figure 5.26: Internal test

Four students participated in the internal test. They played Happy Zoo from level 1 to level 15 in sequence. During the gameplay, they recorded the failure times and the number of moves or remaining time at each level (Table 5.8). The level checklist was used to adjust the difficulties of each level. After finishing 15 levels, they were required to answer an overall checklist to evaluate the game (Table 5.9).

Table 5.8: Level difficulty checklist for internal test

	First Try		Second Try		Third Try	
n	Tick ✔	remaining Turn/time	Tick ✔	remaining Turn/time	Tick ✔	remaining Turn/time
Level 1	4	3 steps	0	/	0	/
Level 2	4	5 steps	0	/	0	/
Level 3	3	9 steps	1	5 steps	0	/
Level 4	4	9 steps	0	/	0	/

Level 5	3	5 steps	1	2 steps	0	/
Level 6	2	10 steps	1	8 steps	1	8 steps
Level 7	1	15 steps	3	10 steps	0	/
Level 8	1	12 steps	2	10s steps	1	5 steps
Level 9	0	/	2	8 steps	2	4 steps
Level 10	0	/	0	/	4	1step
Level 11	0	/	1	2 steps	3	1 step
Level 12	1	5 steps	0	/	3	1 step
Level 13	3	32s	1	21s	0	/
Level 14	2	15s	2	12s	0	/
Level 15	2	28s	1	6s	1	11s

Table 5.9: Overall check list for internal test

	Element	Check ✔	Problem and Description
Functionality	Button	✔	/
	Match-3 elimination system		Some animals overlapped on the screen
	Score system	✔	/
	Player history data	✔	/
	Level system	✔	/
Game Design	User Interface	✔	/
	BGM and Audio Effects	✔	/
Overall	Game completeness	✔	/
	Achievable goals		Level 9-Level 12 are difficult. Especially Level 10
	Reasonable difficulty		Some animals in the corner are difficult to eliminate

	Fit with Screen Size	✔	/
Feedback	1. The level difficulty need adjust. 2. In 12 level, the level number is wrong. 3. Some level may add more steps.		

After the internal game, some bugs related to the user interface and tile presentation were found. Collecting and analyzing the level difficulty checklist (Table 5.7) and overall checklist (Table 5.8), the most outstanding problem of the proposed game is that some levels are too difficult to pass. Players became frustrated when they failed at the same level many times. Therefore, the level difficulty was modified after the internal testing.

According to players' feedback, the cells in the corner are hard to match (Figure 5.27). Only when they are lucky enough could eliminate the tiles in the corner, so all the tiles in the corner are removed to reduce the difficulty.

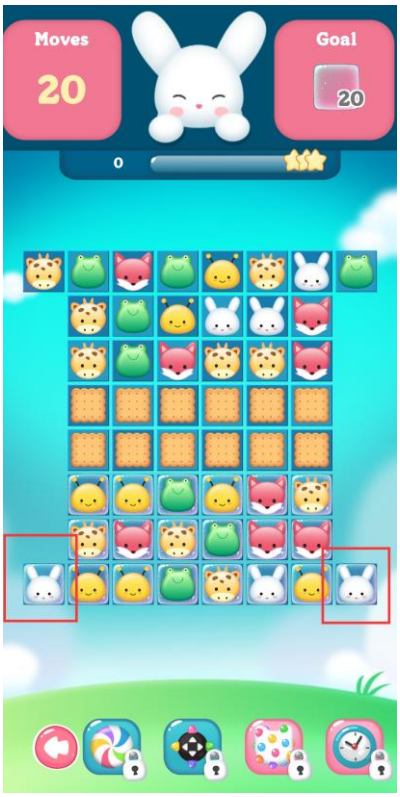


Figure 5.27: The cells in the corner

In order to speed up passing the game, a power-up bomb was added to the game. When there is a four-tile matching or a five-tile matching, a bomb will be generated (Figure 5.28). The bomb can facilitate players to eliminate all tiles of the same type in the grid by exchanging bombs with that tile.

```
if (match.tiles.Count >= 4)
{
    if (swapDirection == SwapDirection.Horizontal)
    {
        if (isPlayerMatch)
        {
            if (match.tiles.Contains(lastSelectedTile))
            {
                CreateColorBomb(lastSelectedTileX, lastSelectedTileY);
            }
            else if (match.tiles.Contains(lastOtherSelectedTile))
            {
                CreateColorBomb(lastOtherSelectedTileX, lastOtherSelectedTileY);
            }
        }
        else if (randomIdx != -1)
        {
            var i = randomIdx % level.width;
            var j = randomIdx / level.width;
            CreateColorBomb(i, j);
        }
    }

}
else
{
    if (isPlayerMatch)
    {
        if (match.tiles.Contains(lastSelectedTile))
        {
            CreateColorBomb(lastSelectedTileX, lastSelectedTileY);
        }
        else if (match.tiles.Contains(lastOtherSelectedTile))
        {
            CreateColorBomb(lastOtherSelectedTileX, lastOtherSelectedTileY);
        }
    }
    else if (randomIdx != -1)
    {
        var i = randomIdx % level.width;
        var j = randomIdx / level.width;
        CreateColorBomb(i, j);
    }
}
```

Figure 5.28: Power-up bomb function

5.5 Final Game Presentation

The following figures (Figure 5.29 – Figure 5.50) are the screenshots of the final game.

- Home Page

  The first page of the game, players can turn on / off the sound and check the setting.

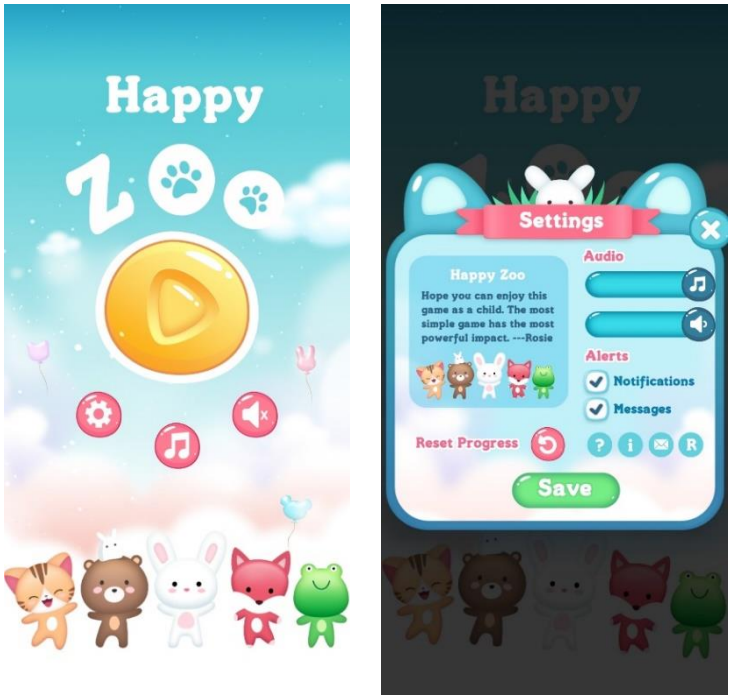


Figure 5.29: Home page

- Level Page

  The level page presents all levels, player only can open levels one by one.

Figure 5.30: Level page

- Game Goals

  The two types of goals at each level pop up.

Figure 5.31: Collect items (left) and Reach score(right) goal

- Game goal reminder

  The reminder of level goals pops up.

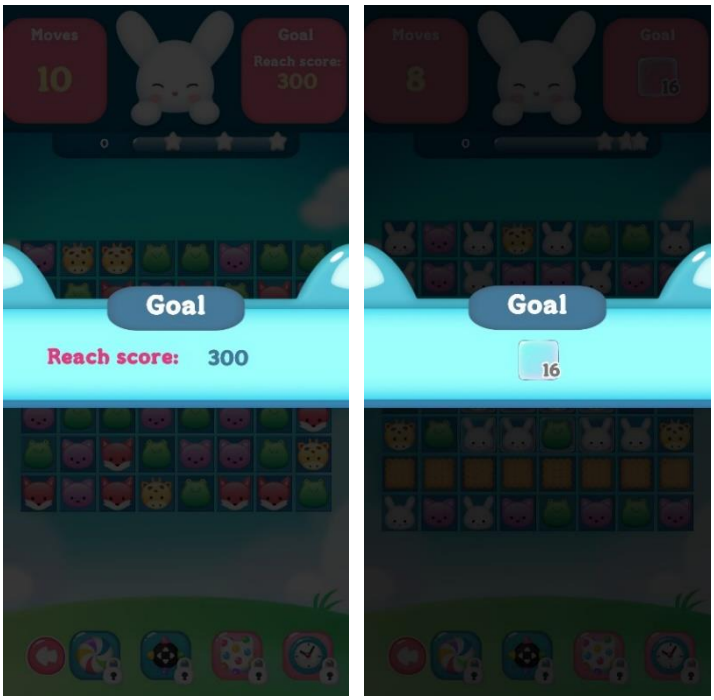


Figure 5.32: Game goal reminders

- Game board (turn-based version)

  The turn-based version with two different goals.

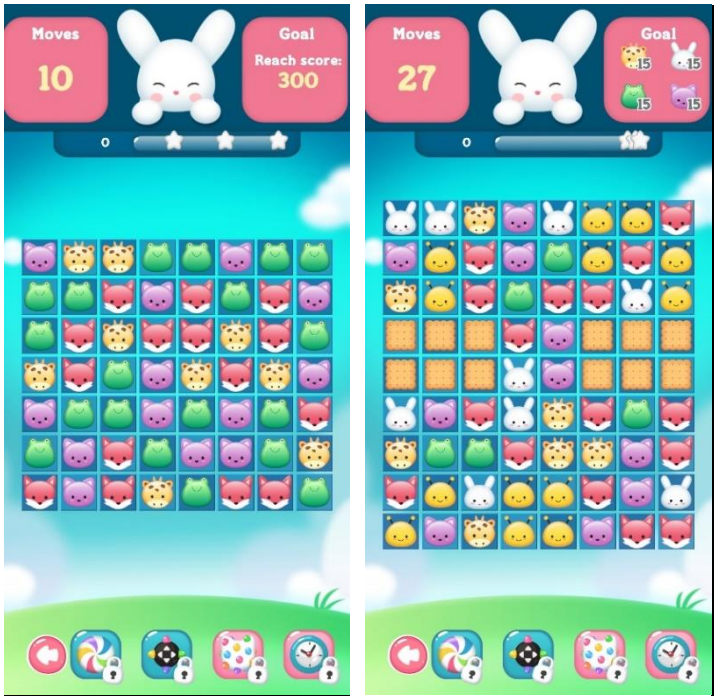


Figure 5.33: Game scenes of Reach score (left) and Collect items(right)

- Game board (timer version)

  The game board of timer version.

Figure 5.34: Game scenes of timer version

- Game board (timer version)

  The success page and failed page.

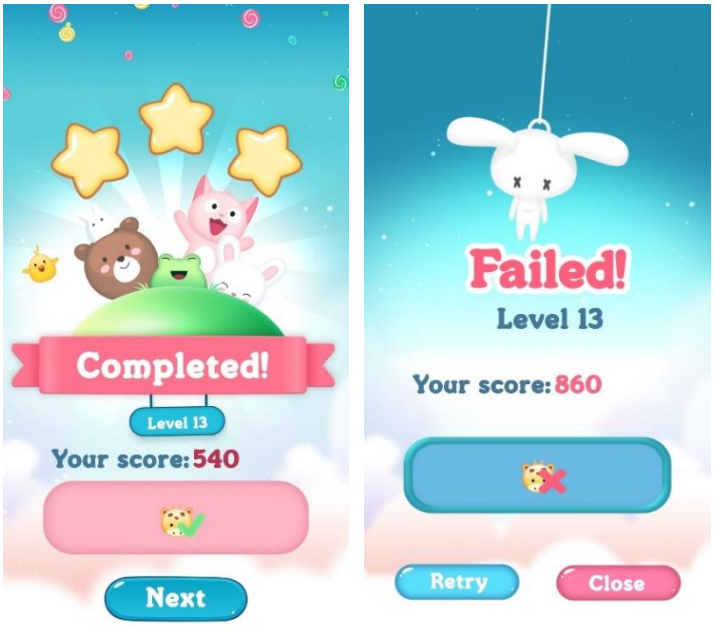


Figure 5.35: Success page (left) and the Failed page(right)

- Game Setting

  The setting function in the game.

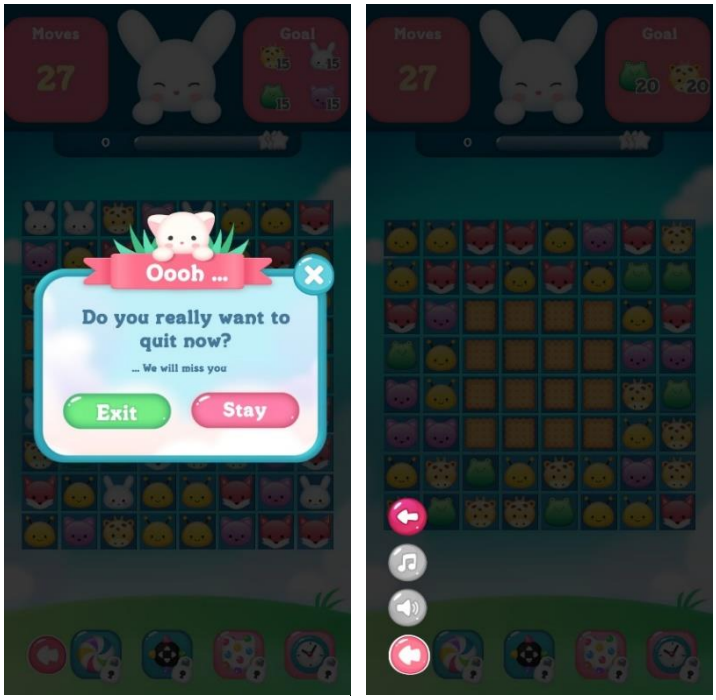


Figure 5.36: Quit game (left) and music controller (right)

- Screenshots of 15 levels

Figure 5.37: Level 1 *Happy Zoo* Interface

Figure 5.38: Level 2 *Happy Zoo* Interface

Figure 5.39: Level 3 *Happy Zoo* Interface

Figure 5.40: Level 4 *Happy Zoo* Interface

Figure 5.41: Level 5 *Happy Zoo* Interface

Figure 5.42: Level 6 *Happy Zoo* Interface

Figure 5.43: Level 7 *Happy Zoo* Interface

Figure 5.44: Level 8 *Happy Zoo* Interface

Figure 5.45: Level 9 *Happy Zoo* Interface

Figure 5.46: Level 10 *Happy Zoo* Interface

Figure 5.47: Level 11 *Happy Zoo* Interface (Left)

Figure 5.48: Level 12 *Happy Zoo* Interface (Right)

Figure 5.49: Level 13 *Happy Zoo* Interface (Left)

Figure 5.50: Level 14 *Happy Zoo* Interface (Right)

Figure 5.51: Level 15 *Happy Zoo* Interface

5.6 Summary

The proposed game Happy Zoo was implemented in three months from game design to game development. The final work presents 15 levels featured different Match-3 puzzle game mechanics. The internal test was conducted before the playtest for evaluation. The result analysis is discussed more detailed in Chapter 6.

CHAPTER 6

RESULT AND DISCUSSION

6.1 Overview

This chapter presents the data and analysis of playtest questionnaire. The result is organized according to the research questions. Quantitative findings are the main information source. The participants' feedback is supplemented with quantitative findings.

6.2 Participants

50 participants took part in the Happy Zoo playtest. From the initial 50 responses, 45 responses remained after data validation and cleaning. The data validation consisted of the elimination of participants who finished the questionnaire within 90 seconds and participants who do not allow to use their data. The participants are females studying at Xiamen University Malaysia. Most of them are year-four students (57.78%), some of them are year-two (28.89%) and year-three (11.11%) students, and several of them are taking year-one study (2.22%).

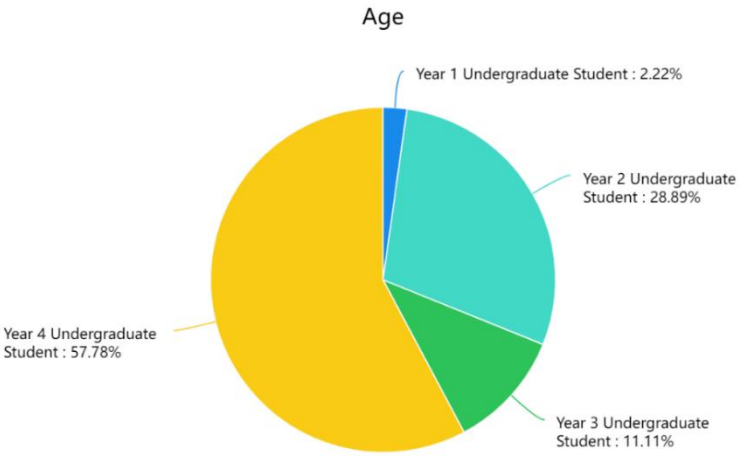


Figure 6.1: Participants' age range chart

Among 45 participants, 15 players (33.33%) only have one-year experience in the

Match-3 puzzle game, the majority of participants (42.22%) are progressive players who played Match-3 puzzle game two to five years, a few participants (24.44%) consider them as senior players with more than a five-year game experience (see Figure 6.2). In general, all participants have more or less experience in the Match-3 puzzle game before.

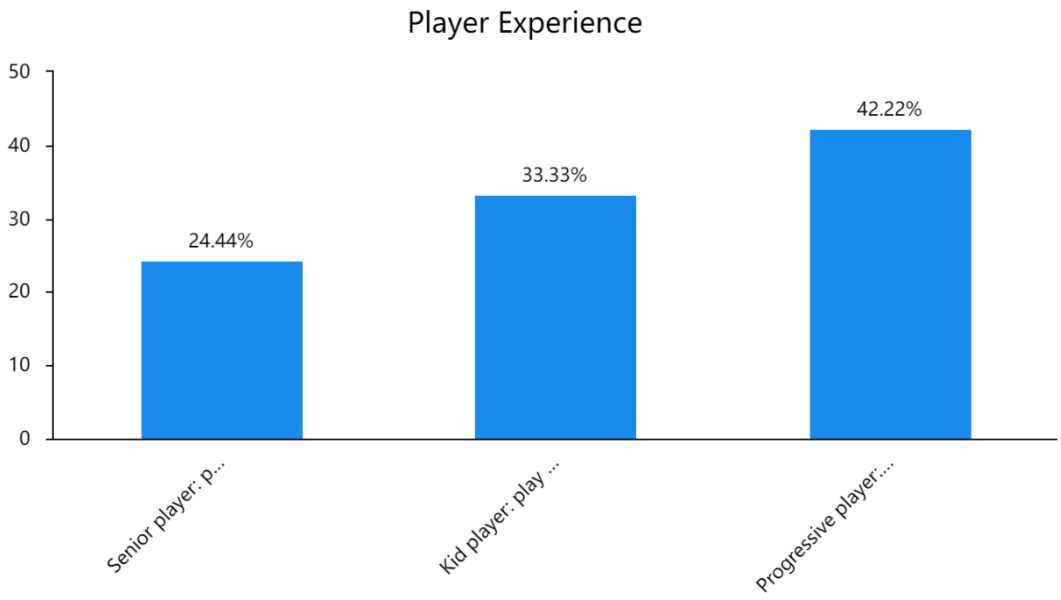


Figure 6.2: Match-3 puzzle game experience diagram

All participants were asked to test their player types before answering the questionnaire. From Table 6.1, the majority player type of participants is Thinker (42.22%), followed by Achiever (33.33%) and Thrill Seeker (17.78%). The number of Skill Master players only takes 6.67% of participants. The proportion of four player types exactly matches the trend (Thinker > Achiever > Thrill Seeker > Skill Master) which was found in the preliminary research (Figure 4.6).

Table 6.1: Participants' player types

Player Type	n	%
Thinker	19	42.22%
Achiever	15	33.33

Player Type	n	%
Thrill Seeker	8	17.78
Skill Master	3	6.67
Total	45	100

6.3 RQ1: Does the proposed game meet the player's expectations?

The player expectation was reflected in the player experience. In this research, the Player Experience Need Satisfaction (PENS) and GUESS questionnaires were used to measure the player experience from competence, autonomy, intuitive control, and personal gratification to four subscales. The subscales were calculated from the mean value of related statements from each player type, for example, Competence was presented as the average score from "I feel competent at the game.", "I feel very capable and effective when playing." And "My ability to play the game is well matched with the game's challenges.". The following list scores more detailed:

Table 6.2: Average value of statements related to Competence

Competence				
Player Type (Mean Value)				
	Thinker (*n*=19)	Achiever (*n*=15)	Thrill Seeker(*n*=8)	Skill Master (*n*=3)
I feel competent at the game.	4.00	3.93	3.38	4.67
I feel very capable and effective when playing.	4.00	3.53	3.75	4.67
My ability to play the game is well-matched with the game's challenges.	4.05	3.87	3.75	4.33
Average Value	4.02	3.78	3.63	4.56

Table 6.2 is the average value of statements that belong to Competence. Thinkers scored 4.02 in Competence while Achiever scored 3.78, and Thrill Seeker rated lower than Achiever (M = 3.78). The data from Skill master is 4.56, the highest mark may be because the sample is too small.

Table 6.3: Average value of statements related to Autonomy

Autonomy				
Player Type (Mean Value)				
	Thinker (*n*=19)	Achiever (*n*=15)	Thrill Seeker(*n*=8)	Skill Master (*n*=3)
The game provides me with interesting options and choices.	4.16	3.93	3.13	4.33
The game lets me do interesting things.	4.05	3.73	3.50	467
I experienced a lot of freedom in the game.	3.89	3.67	3.25	4.33
Average Value	4.04	3.78	3.29	4.44

Table 6.3 is the average value of statements that belong to Autonomy. The average scores from Thinker and Achiever are 4.04 and 3.78 respectively. Thrill Seeker only rated Autonomy as 3.29 on average. The data from Skill master is 4.44, the highest mark may be because the sample is too small.

Table 6.4: Average value of statements related to Intuitive Control

Intuitive Control				
Player Type (Mean Value)				
	Thinker (*n*=19)	Achiever (*n*=15)	Thrill Seeker(*n*=8)	Skill Master (*n*=3)
Learning the game controls (User interface/ menu/ button) were easy.	4.58	3.87	4.00	4.67
The game controls (User interface/ menu/ button) are intuitive.	4.58	4.20	4.13	4.67
When I wanted to do something in the game, it was easy to remember the corresponding control.	4.42	4.20	4.63	4.67
Average Value	4.53	4.09	4.25	4.67

Table 6.4 is the average value of statements that belong to Intuitive Control. Thinker and Thrill Thinker both scored this subscale higher than 4.20. While Achiever scored 4.09 which is a little bit lower. The data from Skill master is 4.67, the highest mark may because the sample is too small.

Table 6.5: Average value of statements related to Personal Gratification

Personal Gratification				
Player Type (Mean Value)				
	Thinker (*n*=19)	Achiever (*n*=15)	Thrill Seeker(*n*=8)	Skill Master (*n*=3)
I feel successful when I overcome the obstacles in	4.47	4.20	4.38	4.67

Personal Gratification				
Player Type (Mean Value)				
	Thinker (*n*=19)	Achiever (*n*=15)	Thrill Seeker(*n*=8)	Skill Master (*n*=3)
the game.				
I want to do as well as possible during the game.	4.53	4.13	4.25	4.67
I am very focused on my own performance while playing the game.	4.32	4.00	4.00	4.33
I am very focused on my own performance while playing the game.	4.16	3.87	3.75	4.33
I find my skills gradually improve through the course of overcoming the challenges in the game.	4.16	3.60	3.88	4.33
Average Value	4.33	3.96	4.05	4.47

Table 6.5 is the average value of statements that belong to Personal Gratification. Thinker and Skill Master scored 4.33 and 4.47 respectively. Achiever and Thrill Seeker scored 3.96 and 4.05 on average.

The descriptive analysis was used in the Audio Aesthetics and Visual Aesthetics. From Table 6.6, participants enjoyed both audio aesthetic (Mean = 4.206, SD = 0.784) and visual aesthetics (Mean = 4.504, SD= 0.606). The music and audio effects were suitable and enhanced the player experience. The visual appeal of game graphics played an important role in the proposed game.

Table 6.6: Evaluation of audio aesthetics and visual aesthetics

Items	N of samples	Min	Max	Mean	Std. Deviation	Median
Audio Aesthetics	45	1.750	5.000	4.206	0.784	4.250
Visual Aesthetics	45	2.667	5.000	4.504	0.606	5.000

- **Summary and Discussion**

The comparison of average player experience scores for each type of player is shown in Figure 6.3. Thinker and Thrill Seeker thought the proposed game have high intuitive control during gameplay to a great extent, Achiever agreed the proposed game have intuitive control. The game satisfied players' Personal Gratifications in terms of completeness, motivation, skill improvement, and performance. It provides freedom for players, while the acceptance of Autonomy is slightly not enough than other sub-scales. Thrill Seeker held a neutral attitude toward game autonomy. Among the three types of players, Thinker rated the highest score in Competence, which shows that Thinker is most capable with the proposed game. This result also explained why the majority player type of Match-3 puzzle game is Thinker. All data from Skill Master is high, the average score is higher than the other three types, but the trend in Skill Master is similar to other types. They strongly agreed that Intuitive Control was the most outstanding part of the proposed game.

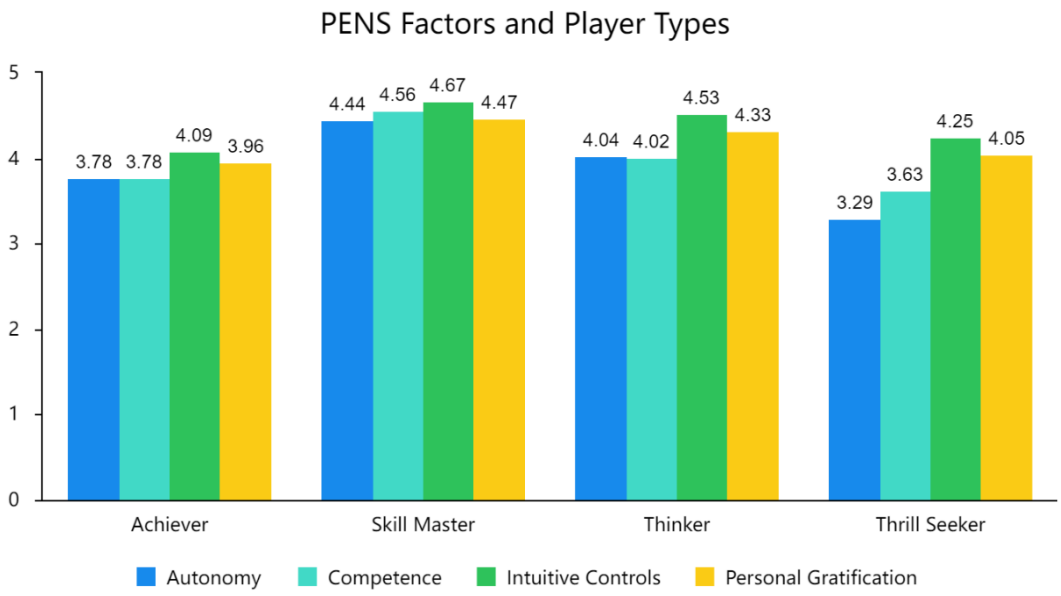


Figure 6.3: Player types for PENS (Autonomy, Competence, Intuitive Control, Personal Gratification)

In summary, from the feedback of player experience, the proposed game meets the players' expectations.

6.4 RQ2: Does the proposed game motivate players to keep playing?

After cluster statements into corresponding motivation factors of entertainment, skill development, coping, and escape of real life, the mean value of players' motivation was calculated. For example, the average score of Escape motivation was calculated from "This game helps me to forget about daily hassles.", "This game makes me forget real life.", "This game helps me escape reality.", and "This game helps me to forget about unpleasant things or offenses." The following shows each statement and group in more detail:

Table 6.7: Average value of statements related to Escape Motivation

Escape				
Player Type (Mean Value)				
	Thinker (*n*=19)	Achiever (*n*=15)	Thrill Seeker(*n*=8)	Skill Master (*n*=3)
This game helps me to forget about daily hassles.	4.00	3.60	3.63	4.33
This game makes me forget real life.	3.68	3.40	3.38	4.00
This game helps me escape reality.	3.74	3.53	3.13	4.00
This game helps me to forget about unpleasant things or offenses.	3.89	3.93	3.63	4.00
Average Value	3.83	3.62	3.44	4.08

Table 6.7 shows the average score of Escape motivation. Thinker scored their Escape motivation in 83.83, followed by Achiever and Thrill Seeker in 3.62 and 3.44. Among them, Skill Master rated this factor with the highest mark (M = 4.08).

Table 6.8: Average value of statements related to Coping Motivation

Coping				
Player Type (Mean Value)				
	Thinker (*n*=19)	Achiever (*n*=15)	Thrill Seeker(*n*=8)	Skill Master (*n*=3)
This game helps me get into a better mood.	3.89	3.73	3.50	4.33
This game helps me get rid of stress.	3.79	3.67	3.88	4.67

Coping				
Player Type (Mean Value)				
	Thinker (*n*=19)	Achiever (*n*=15)	Thrill Seeker(*n*=8)	Skill Master (*n*=3)
This game helps me channel my aggression.	3.74	3.73	3.88	4.00
This game reduces my tension.	4.05	3.87	3.63	4.33
Average Value	3.87	3.75	3.72	4.33

Table 6.8 shows the average score of Coping motivation. Thinker scored their motivation at 3.87. The attitude toward this subscale is similar to Achiever and Thrill Seeker, which are 3.75 and 3.72 respectively. The data is 4.33 from Skill master, the reason for the high score may be because of the small sample.

Table 6.9: Average value of statements related to Skill Development Motivation

Skill Development				
Player Type (Mean Value)				
	Thinker (*n*=19)	Achiever (*n*=15)	Thrill Seeker(*n*=8)	Skill Master (*n*=3)
This game sharpens my senses.	3.74	3.73	4.00	4.00
This game improves my skills.	3.79	3.60	3.13	4.33
This game improves my concentration.	4.37	4.07	3.88	4.00
This game improves my coordination skills.	3.84	3.80	4.13	4.33
Average Value	3.93	3.80	3.78	4.17

Table 6.9 shows the average score of Skill Development motivation. Thinker scored their motivation at 3.93. The attitude toward this subscale is similar to Achiever and Thrill Seeker, which are 3.80 and 3.78 respectively. The data is 4.17 from Skill master, the reason for the high score may be because of the small sample.

Table 6.10: Average value of statements related to Recreation Motivation

Recreation				
Player Type (Mean Value)				
	Thinker (*n*=19)	Achiever (*n*=15)	Thrill Seeker(*n*=8)	Skill Master (*n*=3)
I think this game is entertaining.	4.58	4.47	3.88	5.00
I will play this game for recreation.	4.26	4.13	4.00	4.67
I enjoy playing this game.	4.47	4.07	4.00	5.00
Average Value	4.44	4.22	3.96	4.89

Table 6.10 shows the average score of Recreation motivation. All player types scored this subscale with high marks. Thinker scored their motivation at 4.44. Achiever rated it at 4.22, and Thrill Seeker rated it as 3.96 on average. The data is 4.89 from Skill master, the reason for the high score may be because of the small sample.

- **Summary and Discussion**

It shows players have a high interest in keep playing the proposed game. Figure 6.4 presented the motivation factors of different types of players. Recreation is the top motivating factor for all types of players to play the proposed game, followed by skill development, coping, and escape from real life. Skill Master and Thinker have the strongest motivation to play the proposed game among the three player types, and the Achiever’s motivation is stronger than Thrill Seeker's to play the game. The ranking

of motivation also verified why the main player type of Match-3 puzzle game is Thinker. The stronger the motivation Thinker has, the more interest they perform to continue to play the game. The scores from Skill Master are higher than other types generally.

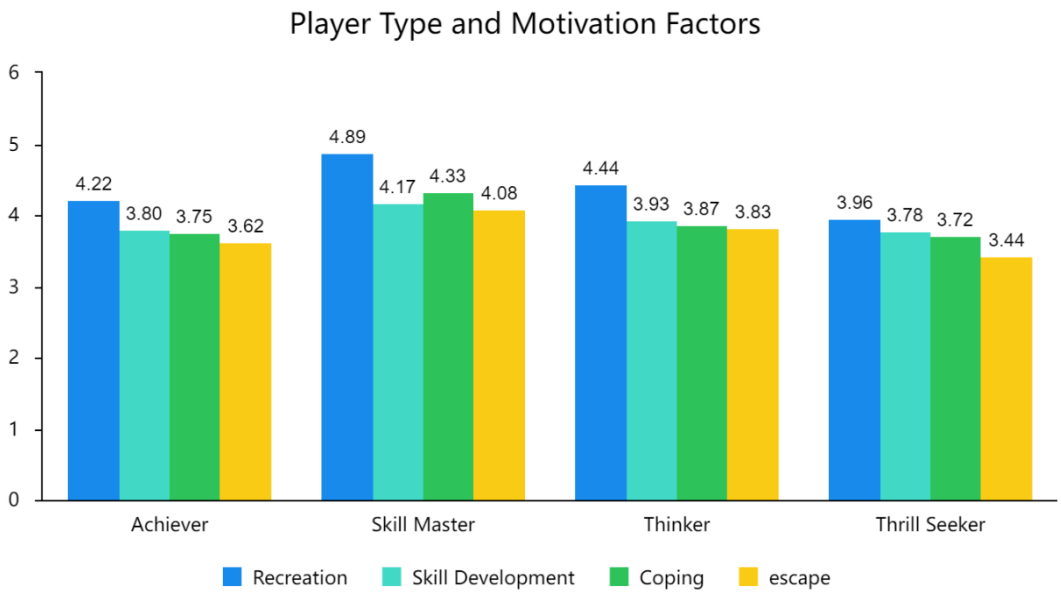


Figure 6.4: Each type of player's motivation evaluation

6.5 Other Findings

Apart from the research questions, other interesting results are also found during the data analysis.

6.5.1 Players' Game Mechanics Preference

Players' game mechanics preference is measured by the score of enjoyment. The higher score means players like it after gameplay. If the mean value is the same, the lower standard deviation can be used to compare. The following list of the average score of enjoyment in each game mechanic:

Table 6.11: Players' preferences of different game mechanics

Player Type (Mean ±Std. Deviation)	Timer	Turn-based	Dropping	Collect Items	Reach Score	Ice Layers	Immovable Obstacles
Thinker (n=19)	3.68±0.87	4.00±0.85	4.11±0.84	3.97±0.86	3.79±0.71	4.05±0.74	3.89±0.81
Achiever (n=15)	3.93±0.70	3.67±0.94	4.03±0.95	3.97±0.81	3.70±0.96	4.07±0.70	3.77±0.86
Thrill Seeker(n=8)	3.88±0.58	3.81±0.53	4.13±0.79	3.94±1.18	3.25±1.00	3.69±1.03	4.06±0.56
Skill Master(n=3)	5.00±0.00	4.67±0.58	4.50±0.50	4.50±0.50	4.50±0.50	4.33±0.58	4.67±0.29

Different types of players' preferences towards seven Match-3 puzzle game mechanics (Table 6.11) are consistent with the result shown in the preliminary research (Table 4.2). Thinker and Achiever are more fond of Dropping and Ice Layers mechanics, while Thrill Seeker tends to prefer Dropping and Immovable Obstacles mechanics. Skill Master prefer Timer and Immovable Obstacles. All four types of players enjoyed Collect Items more than Reach Score. Therefore, the game mechanic design meets the players' expectations which is conducive to the player experience to some extent.

Through analyzing the Timer and Turn-based mechanics in more detail, Figure 6.5 reflected that Thinker like Turn-based mechanics more than Timer. Because the Turn-based mechanic allows the player to take time to consider each choice, it meets the characteristics of Thinker player type. Whereas, Achiever, Thrill Seeker, and Skill Master players deemed the Timer mechanic more enjoyable and interesting than Turn-based mechanics.

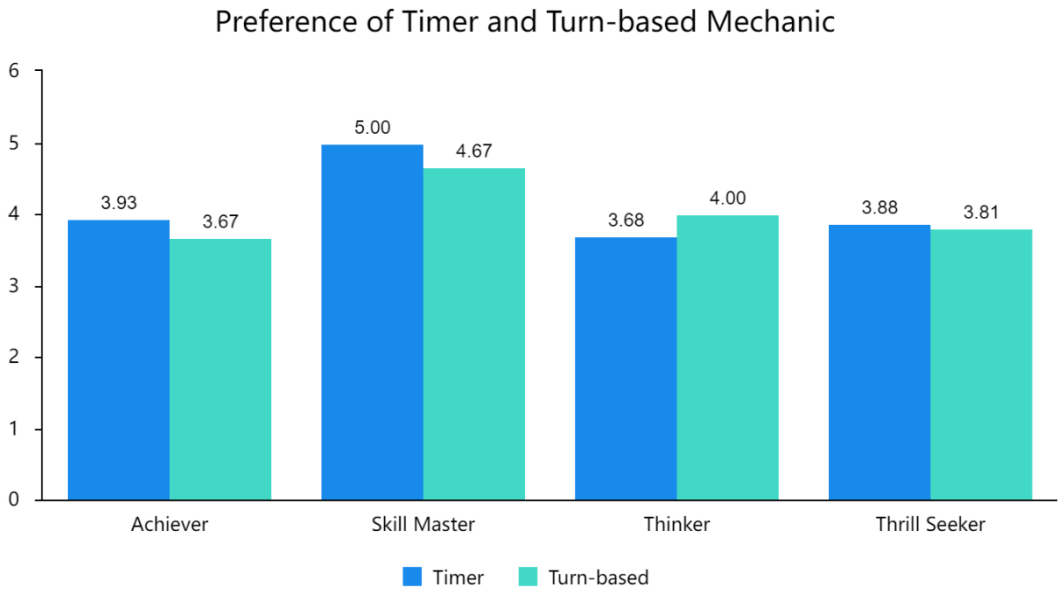


Figure 6.5: Players' attitude to Timer and Turn-based mechanics

6.5.2 The Relation Between Game Mechanics and Player Experience

Linear regression analysis is a method to predict the value of a variable based on the value of another variable (IBM, n.d.). In this study, linear regression analysis is used to explore whether the player experience can be predicted based on game mechanics. The player experience consists of four factors: Autonomy, Competence, Intuitive Control, and Personal Gratification. Four factors are taken as the dependent variables respectively. Table 6.12 showed the linear regression analysis in the relation between game mechanics and Competence.

Table 6.12: Linear regression analysis in predicting the game mechanics have an impact on player experience (Competence)

Parameter Estimates (n=45)

	Unstandardized Coefficients		Standardized Coefficients	t	p	VIF
	B	Std. Error	*Beta*			
Constant	1.941	0.719	-	2.698	0.010*	-
Timer	-0.307	0.206	-0.298	-1.491	0.144	2.164

	Unstandardized Coefficients		Standardized Coefficients	*t*	*p*	VIF
	B	Std. Error	*Beta*			
Turn-based	0.026	0.178	0.026	0.144	0.886	1.818
Dropping	0.120	0.182	0.124	0.663	0.512	1.900
Collect Items	0.304	0.177	0.326	1.710	0.096	1.964
Reach Score	0.375	0.162	0.401	2.314	0.026*	1.626
Ice Layers	0.032	0.190	0.030	0.168	0.867	1.758
Immovable Obstacles	-0.044	0.198	-0.042	-0.221	0.826	1.964
R^2	0.315					
Adj R^2	0.186					
F	*F* (7,37) =2.436, *p*=0.037					
D-W	1.782					
Dependent Variable: Competence						

* $p<0.05$ ** $p<0.01$

Table 6.13 shows seven game mechanics change 31.5% of the Competence (R^2 =0.315). It is found that the model passes the F test (F=2.436, p=0.037 < 0.05), so there is at least one factor that has an impact on the Competence. Comparing the *p* values, the regression coefficient value of Reach Score is 0.375(*t*=2.314， *p*=0.026 < 0.05). It indicates that Reach Score mechanic has a significant positive influence on Competence. The Reach Score mechanic benefits players to feel capable and competent during gameplay. Others game mechanics are not found to have a significant influence on Competence.

Table 6.13 Linear regression analysis in predicting the game mechanics have impact on player experience (Autonomy)

Parameter Estimates (n=45)

	Unstandardized Coefficients		Standardized Coefficients	*t*	*p*	VIF
	B	Std. Error	Beta			
Constant	1.079	0.630	-	1.714	0.095	-
Timer	-0.041	0.180	-0.039	-0.230	0.819	2.164
Turn-based	-0.126	0.156	-0.127	-0.810	0.423	1.818
Dropping	0.434	0.159	0.437	2.733	0.010**	1.900
Collect Items	0.380	0.155	0.398	2.447	0.019*	1.964
Reach Score	0.278	0.142	0.289	1.958	0.058	1.626
Ice Layers	-0.038	0.166	-0.035	-0.228	0.821	1.758
Immovable Obstacles	-0.195	0.174	-0.182	-1.120	0.270	1.964
R^2	0.502					
Adj R^2	0.408					
F	F (7,37) =5.334, p=0.000					
D-W value	2.174					
Dependent Variable: Autonomy						

* $p<0.05$ ** $p<0.01$

Table 6.13 shows seven game mechanics that can explain 50.2% of Autonomy's change (R^2 =0.502). It is found that the model passes the F test (F=5.334, p=0.000 < 0.05), so there is at least one factor that has an impact on the Autonomy. The regression coefficient values show that Dropping, and Collect Items have a significant positive influence on Autonomy, while Timer, Turn-based, Reach Score, Ice Layers, and Immovable Obstacles would not influence Autonomy.

Table 6.14: Linear regression analysis in predicting the game mechanics have impact on player experience (Intuitive Control)

Parameter Estimates (n=45)

	Unstandardized Coefficients		Standardized Coefficients	*t*	*p*	VIF
	B	Std. Error	Beta			
Constant	2.633	0.553	-	4.757	0.000**	-
Timer	-0.262	0.158	-0.329	-1.656	0.106	2.164
Turn-based	0.009	0.137	0.012	0.065	0.948	1.818
Dropping	0.108	0.140	0.144	0.772	0.445	1.900
Collect Items	0.273	0.137	0.379	2.002	0.053	1.964
Reach Score	-0.009	0.125	-0.013	-0.073	0.942	1.626
Ice Layers	0.153	0.146	0.188	1.050	0.301	1.758
Immovable Obstacles	0.146	0.153	0.181	0.958	0.344	1.964
R^2	0.326					
Adj R^2	0.198					
F	F (7,37) =2.552, p=0.030					
D-W value	1.938					
Dependent Variable: Intuitive Controls						

* $p<0.05$ ** $p<0.01$

From Table 6.14, seven game mechanics can explain 32.6% of Intuitive Control change (R^2 =0.326). Concluding all parameters in the *p* value of seven game mechanics, there is no *p* value reflecting the significant influence on Intuitive Controls.

Table 6.15: Linear regression analysis in predicting the game mechanics have impact on player experience (Player Gratification)

Parameter Estimates (*n*=45)

	Unstandardized Coefficients		Standardized Coefficients	*t*	*p*	VIF
	B	Std. Error	*Beta*			
Constant	0.653	0.479	-	1.365	0.180	-
Timer	-0.072	0.137	-0.076	-0.529	0.600	2.164
Turn-based	-0.052	0.118	-0.058	-0.442	0.661	1.818
Dropping	0.469	0.121	0.520	3.879	0.000**	1.900
Collect Items	0.200	0.118	0.231	1.695	0.098	1.964
Reach Score	0.078	0.108	0.089	0.721	0.476	1.626
Ice Layers	0.081	0.126	0.083	0.644	0.523	1.758
Immovable Obstacles	0.166	0.132	0.172	1.261	0.215	1.964
R^2	0.650					
Adj R^2	0.584					
F	$F(7,37) = 9.819$, $p=0.000$					
D-W Value	2.497					
Dependent Variable: Personal Gratification						

* $p<0.05$ ** $p<0.01$

Table 6.15 shows seven game mechanics that can explain 65% of Personal Gratification's change (R^2 =0.650). It is found that the model passes the F test (F=9.819, p=0.000 < 0.05), so there is at least one factor that has an impact on Personal Gratification. The regression coefficient values show that the Dropping has a significant positive influence on Personal Gratification, while Timer, Turn-based, Collect Items, Reach Score, Ice Layers, and Immovable Obstacles would not influence

Personal Gratification.

In conclusion, Reach Scores, Dropping, and Collect items are three game mechanics that have significant positive influences on player experience. While other game mechanics do not show a significant influence on player experience.

6.5.3 Players' Level and Player Experience

Table 6.16: The difference between player level and player experience

	Player Experience (Mean ± Std. Deviation)			F	p
	Kid player: play match-3 puzzle game 1 year (*n*=15)	Progressive player: play match-3 puzzle game for 2-5 years (*n*=19)	Senior player: play match-3 puzzle game more than 5 years(*n*=11)		
Intuitive Controls	4.09±0.71	4.32±0.59	4.73±0.39	3.690	0.033*
Autonomy	3.82±0.93	3.68±0.84	4.15±0.64	1.108	0.340
Competence	3.40±1.00	4.02±0.46	4.39±0.66	6.296	0.004**
Personal Gratification	4.08±0.57	4.16±0.89	4.29±0.77	0.240	0.788

* $p<0.05$ ** $p<0.01$

From Table 6.16, the One-way ANOVA analysis method was adopted to analyze the difference between player level (kid player, progressive player, senior player) and player experience. No significance is found that player level will affect Autonomy and Personal Gratification ($p>0.005$). For Intuitive Controls, the Player level demonstrated a significant value of 0.05 (F=3.690, p=0.033). As can be seen from the specific comparison differences, the comparison result of the average score of groups with obvious differences is Senior player > Kid Player. For Competence, the Player level

demonstrated a significant value of 0.01 (F=6.296, p=0.004). As can be seen from the specific comparison differences, the comparison result of the average score of groups with obvious differences is Senior player >Progressive player > Kid Player. Players who are more experts in Mathc-3 puzzle games felt more competent and more familiar with the user interface control.

6.5.4 Open-ended Feedbacks

The participants gave feedback and related comments after they played *Happy Zoo*. The following table shows the feedback and suggestions after integration:

Table 6.17: Feedback from participants

No.	Feedback and Comments
1	The BGM can be more active and chill. Some levels should try several times to pass while some levels are easier.
2	The game graphics design is really good. The speed of swapping game objects can be faster.
3	The audio effects of elimination are too slight. The reward system should be more motivated.
4	If the remained bombs can be eliminated automatically at the end of the game and adding the scores would be better.
5	The game is funny. If there are more tips for game playing, it will be better.
6	The game rules are unclear at first. In general, it is a fun game, I will download it to play.
7	If players can move when the bomb booms or other icons are eliminated it will be more efficient.
8	It will be better if the display content like 'start' can be skipped or the time displayed the content can decrease.
9	The game is very funnnn!! You should publish the game to the public, my mom would love it.

10	A bit easy to achieve the goals. Able to set more mechanics in the game. The audio effect and graphic design are nice.
11	Nice game. I will continue to play if have more levels.
12	It will be better if the instructions can guide at first or during the first.
13	Can show the level in the game interface, so I can know which level I am in when I am playing the game.
14	Very fun till I want to play it again. Later want to download back candy crush again!!
15	The game is very interesting and I enjoyed it so much.
16	It is easy and friendly to players who are experienced in such games. Can add some interesting game mechanics to differentiate it from other similar games on the market.

From the feedback listed above, most of the participants thought the proposed game is fun and were willing to continue playing it. The audio effects and game graphics design was frequently mentioned in the feedback. The audio and visuals gave participants a deep impression after they played the game. Players who have experience with the Match-3 puzzle games deemed the game easy and friendly, while some fresh players thought some levels are too difficult. Participants also gave various and sincere advice in terms of innovative game mechanics, game tutorials, motivating reward systems, etc. These suggestions are meaningful and significant for further study.

6.5 Summary

To sum up, the result and discussion above show the proposed game meet the players' expectation and players are willing to continue to play such games in the future. The participants are satisfied in terms of Competence, Autonomy, Intuitive Control, Personal Gratification, Audio Aesthetics and Visual Aesthetics. The result also shows that the top motivation factors are recreation, skill development, coping, and escape. The players' preference for game mechanics is consistent with the result in the

preliminary result. Different player types demonstrate unidentical game mechanics preferences. Dropping was the one game mechanic preferred by three types (Thinker, Achiever, Thrill Seeker) of players in this study, the Ice Layer mechanic was chosen by Thinker and Achiever, and the Immovable Obstacle mechanic was only picked by Thrill Seeker and Skill Master. Through analysing the game mechanics and player experience, the Dropping, Reach Scores, Collect Items have a significant positive influence on player experience (Competence, Autonomy, Personal Gratification). The player level also is found to have significant differences in terms of Competence and Intuitive Control. Therefore, the appropriate game mechanics design for different player groups is conducive to enhancing the player experience.

CHAPTER 7

CONCLUSION

7.1 Research Achievements

The research has successfully achieved all objectives raised.

1) To identify puzzle game female players' main player archetypes via preliminary analysis.

The preliminary research was conducted before the proposed game design. The quantitative research method was adopted during the preliminary research using a questionnaire. In the end, there are 144 valid samples are used to analyse the player types and predict players' preference for game mechanics. The preliminary research result identified the female players' main types and provided instructional advice in the Match-3 puzzle game mechanics combination (see Chapter 4).

2) To develop a mobile platform puzzle game by incorporating specific game mechanics and design elements.

An integrated Match-3 puzzle game *Happy Zoo* was designed and implemented with 15 levels in this research (see Chapter 5). The game was designed based on preliminary research to meet different types of players' expectations and preferences. The game featured the permutation and combination of difficulty and complexity.

3) To evaluate the effectiveness of the proposed game on player experience for different female player archetypes.

A physical playtest was conducted in order to evaluate the effectiveness of the proposed game. The questionnaire was used as a quantitative method to measure the player experience and motivation. Finally, 45 participants took part in the playtest and provide valuable feedback and suggestions. A comprehensive and complete result

analysis between player experience, player motivation, and game mechanics was provided in Chapter 6.

7.2 Research Contributions

1) A general analysis of puzzle game female players' types

The preliminary research has successfully analyzed the main female player types of Match-3 puzzle games, which consists of Thinker, Achiever, Thrill Seeker, and Skill Master in the proportion sequence. The result of main female player types can not only be used as a reference in further Match-3 puzzle game design but also can be regarded as a resource in other puzzle game player types research.

2) A developed Match-3 puzzle game with specific game mechanics combination

A Match-3 puzzle game was designed and developed in this study. The game has significance not only for daily entertainment but also for academic research. Apart from the proposed game itself, the game design concept also is regarded as a heuristic method in other related studies.

3) Player type and motivation evaluation result

Comprehensive and detailed results and analysis through playtest have been provided. From the research result, the Match-3 puzzle game player types and motivation are demonstrated. The favorable game mechanics are listed through statistical analysis. The results are meaningful and valuable for Match-3 puzzle game design, whether from a market perspective or an academic perspective. The exploration of female players' motivation contributed to some extent in bridging the gap in this field.

7.3 Research Limitation

One of the main limitations of this research is the small sample size for player experience data collection. Because the physical playtest should control the environment and other factors, the one-to-one data collection also is a time-consuming

activity. The limitation of site and time lead to the sample size limitation.

Additionally, the proposed game can be improved based on the participants' feedback and suggestions. The game is only designed based on the existing Match-3 puzzle game mechanics, while lacks innovative game mechanics to explore the new findings. What's more, participants are assumed to be familiar with the Match-3 puzzle game in the game design phase. It leads to the tutorials has been left out of the game, so many participants gave the advice that adding tutorials in the game would be better.

7.4 Future Work and Recommendations

This research mainly explored Thinker, Achiever, and Thrill Seeker three female player types in Match-3 puzzle games due to the sample limitation. More player types of players can be considered in future studies. Meanwhile, a player's type is multiple rather than exclusive. Therefore, the multielement player types classification is expected in player types classification.

The proposed game can be improved with game mechanics and game reward systems to explore the game experience in a more complete and accurate way. Some innovative game mechanics can be added to the proposed game as well, to verify players' experience with the existing game mechanics.

The study only researched the impact of player experience in motivation and game mechanics two aspects. More dimensions of research related to player experience and player archetypes can be implemented in the future. Also, the research target can expand to other game genres.

REFERENCES

About Linear Regression | IBM. (n.d.). https://www.ibm.com/topics/linear-regression

Ahmad, I., Hamid, E., Abdullasim, N., & Jaafar, A. (2017). Game Interface Design: Measuring the Player's Gameplay Experience. *Advances in Visual Informatics*, 500–509. https://doi.org/10.1007/978-3-319-70010-6_46

App Download Data (2022). (2022, May 4). Business of Apps. https://www.businessofapps.com/data/app-statistics/

Bailey, J. (2015, February 27). *Match Game Mechanics: An exhaustive survey*. Game Developer. https://www.gamedeveloper.com/design/match-game-mechanics-an-exhaustive-survey

Bartle, R. (1994). Hearts, Clubs, Diamonds, Spades: Players who suit MUDs. *Journal of MUD Research*, *1*(1).

Brockmyer, J. H., Fox, C. M., Curtiss, K. A., McBroom, E., Burkhart, K. M., & Pidruzny, J. N. (2009). The development of the Game Engagement Questionnaire: A measure of engagement in video game-playing. *Journal of Experimental Social Psychology*, *45*(4), 624–634. https://doi.org/10.1016/j.jesp.2009.02.016

Busch, M., Mattheiss, E., Hochleitner, W., Hochleitner, C., Lankes, M., Fröhlich, P., Orji, R., & Tscheligi, M. (2016). Using Player Type Models for Personalized Game Design – An Empirical Investigation. *Interaction Design and Architecture(S)*, *28*, 145–163.

Busch, M., Mattheiss, E., Orji, R., Fröhlich, P., Lankes, M., & Tscheligi, M. (2016). Player Type Models – Towards Empirical Validation. *Extended Abstract Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*.

Carlyn, M. (1977). An Assessment of the Myers-Briggs Type Indicator. *Journal of Personality Assessment*, *41*(5), 461–473. https://doi.org/10.1207/s15327752jpa4105_2

Chris Bateman & Richard Boon. (2005). 21st Century Game Design (Game Development Series). *Charles River Media, Inc. EBooks*.

Craz3 Match. (n.d.). Craz3 Match. https://peng.qq.com/index.shtml

Daneels, R., Malliet, S., Geerts, L., Denayer, N., Walrave, M., & Vandebosch, H. (2021). Assassins, Gods, and Androids: How Narratives and Game Mechanics Shape Eudaimonic Game Experiences. *Media and Communication*, *9*(1), 49–61. https://doi.org/10.17645/mac.v9i1.3205

Dillon, A., & Watson, C. (1996). User analysis in HCI — the historical lessons from individual differences research. *International Journal of Human-Computer Studies*, *45*(6), 619–637. https://doi.org/10.1006/ijhc.1996.0071

Duan, X. (2019, December 17). *Universal design principles on game design —- take Candy Crush as an example | CCTP-820: Leading By Design*. https://blogs.commons.georgetown.edu/cctp-820-fall2019/2019/12/17/universal-design-principles-on-game-design-take-candy-crush-as-an-example/

Gravetter, F., & Forzano, L. (2012). Selecting Research Participants. *Res Methods Behav Sci*, 125–139.

Greenberg, B. S., Sherry, J., Lachlan, K., Lucas, K., & Holmstrom, A. (2008). Orientations to Video Games Among Gender and Age Groups. *Simulation &Amp; Gaming*, *41*(2), 238–259. https://doi.org/10.1177/1046878108319930

Hamari, J., & Tuunanen, J. (2014). Player Types: A Meta-synthesis. *Transactions of the Digital Games Research Association*, *1*(2), 57–84. https://doi.org/10.26503/todigra.v1i2.13

Hao Wang & Chuen-Tsai Sun. (2011). Game reward systems: Gaming experiences and social meanings. *Digital Games Research Association Conference*, *6*.

Happy Elements. (n.d.). https://en.happyelements.com/games/xiaoxiaole/

Hite, M. (2010). “Fun Actually Was Becoming Quite Subversive”: Herbert Marcuse, the Yippies, and the Value System of Gravity’s Rainbow. *Contemporary Literature*, *51*(4), 677–702. https://doi.org/10.1353/cli.2011.0004

Hsiao, C. H., Chang, J. J., & Tang, K. Y. (2016). Exploring the influential factors in continuance usage of mobile social Apps: Satisfaction, habit, and customer value perspectives. *Telematics and Informatics*, *33*(2), 342–355. https://doi.org/10.1016/j.tele.2015.08.014

International Hobo - BrainHex - Intro. (n.d.). http://survey.ihobo.com/BrainHex/

Juul, J. (2007). SWAP ADJACENT GEMS TO MAKE SETS OF THREE: A HISTORY OF MATCHING TILE GAMES. *Artifact*, *1*(4), 205–216. https://doi.org/10.1080/17493460601173366

Keith, J. (2018, March 1). *Candy Crush Difficulty Analysis*. https://rstudio-pubs-static.s3.amazonaws.com/365533_07d8ce7115a04baeb7a2daefe4dd0d6c.html

King. (n.d.). *King.com*. https://www.king.com/

Kirill. (2018, August 10). *45 Match-3 Mechanics*. Game Developer. https://www.gamedeveloper.com/design/45-match-3-mechanics

Lazzaro. (2004). *Why we play games: Four keys to more emotion without story*. In Game Developers 49 Conference. http://www.citeulike.org/group/596/article/436449

Let's play! (n.d.). https://www.playrix.com/games/gardenscapes

Liu, C. (2018). The Motivation of Gaming Behaviors : the Implicit Measurement in the PlayerUnknown's Battleground Study. *The Human Factor and Engineering Psychology*.

Lopez-Fernandez, O., Williams, A. J., Griffiths, M. D., & Kuss, D. J. (2019). Female Gaming, Gaming Addiction, and the Role of Women Within Gaming Culture: A Narrative Literature Review. *Frontiers in Psychiatry*, *10*. https://doi.org/10.3389/fpsyt.2019.00454

Marc Busch, Elke Mattheiss, Wolfgang Hochleitner, Christina Hochleitner, Michael Lankes, Peter Fröhlich, Rita Orji, & Manfred Tscheligi. (2016). Using Player Type Models for Personalized Game Design - An Empirical Investigation. *IxD&Amp;A*, *28*, 145–163.

McLean, L., & Griffiths, M. D. (2013). Female gamers: A thematic analysis of their gaming experience. *International Journal of Games-Based Learning*, *3*(3), 54–71.

Mikaelorpana, M. (2022, August 10). *What Motivates Different Types of Players? – Infographic*. GameRefinery. https://www.gamerefinery.com/what-motivates-players-infographic/

Moll, P., Frick, V., Rauscher, N., & Lux, M. (2020). How players play games. *Proceedings of the 12th ACM International Workshop on Immersive Mixed and Virtual Environment Systems*. https://doi.org/10.1145/3386293.3397113

Nacke, L. E., Bateman, C., & Mandryk, R. L. (2014). BrainHex: A neurobiological gamer typology survey. *Entertainment Computing*, *5*(1), 55–62. https://doi.org/10.1016/j.entcom.2013.06.002

Newzoo. (2022, December 8). *Puzzle Games: Popularity& Opportunities Across East and West*. https://newzoo.com/insights/trend-reports/puzzle-games-comparing-contrasting-eastern-and-western-markets

Omori, M. T., & Felinto, A. S. (2012). Analysis of Motivational Elements of Social Games: A Puzzle Match 3-Games Study Case. *International Journal of Computer Games Technology*, *2012*, 1–10. https://doi.org/10.1155/2012/640725

Patten, M. (2014). Questionnaire Research: A Practical Guide (4th ed.). *Routledge*.

Phan, M. H., Keebler, J. R., & Chaparro, B. S. (2016). The Development and Validation of the Game User Experience Satisfaction Scale (GUESS). *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *58*(8), 1217–1247. https://doi.org/10.1177/0018720816669646

Player Motivations & Archetypes. (2020, May 8). GameRefinery. https://www.gamerefinery.com/gamerefinery-player-motivations-archetypes/

Ramadan, R., & Widyani, Y. (2013). Game development life cycle guidelines. *2013 International Conference on Advanced Computer Science and Information Systems (ICACSIS)*. https://doi.org/10.1109/icacsis.2013.6761558

Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The Motivational Pull of Video Games: A Self-Determination Theory Approach. *Motivation and Emotion*, *30*(4), 344–360. https://doi.org/10.1007/s11031-006-9051-8

SAGE Research Methods - Introduction to Quantitative Research Methods. (2011, January 1). https://methods.sagepub.com/book/introduction-to-quantitative-research-methods

Sheep a Sheep - Apps on Google Play. (n.d.). https://play.google.com/store/apps/details?id=tile.master.onect.match.connect.freegames

Smith, C. (2022, November 19). *Candy Crush*. VGS - Video Game Stats and Player Counts. https://videogamesstats.com/candy-crush-facts-statistics/

State of Mobile 2020. (2021). App Anie. https://f.hubspotusercontent20.net/hubfs/8885028/App%20Annie%20-The%20State%20Of%20Mobile%202021%20.pdf

State of Mobile 2021. (2021). App Anie. https://www.data.ai/en/go/state-of-mobile-2022/

Sullivan, G. M., & Artino, A. R. (2013). Analyzing and Interpreting Data From Likert-Type Scales. *Journal of Graduate Medical Education*, *5*(4), 541–542. https://doi.org/10.4300/jgme-5-4-18

Toh, W. (2022). The Player Experience and Design Implications of Narrative Games. *International Journal of Human–Computer Interaction*, 1–28. https://doi.org/10.1080/10447318.2022.2085404

Tondello, G. F., & Nacke, L. E. (2019). Player Characteristics and Video Game Preferences. *Proceedings of the Annual Symposium on Computer-Human Interaction in Play*. https://doi.org/10.1145/3311350.3347185

Tondello, G., Wehbe, R., Orji, R., Ribeiro, G., & Nacke, L. (2017). A framework and taxonomy of videogame playing preferences. *In Proceedings of the Annual Symposium on Computer-Human Interaction in Play*, 329–340.

Van Looy, J., Courtois, C., & Vermeulen, L. (2010). Why Girls Play Video Games: a Gender-Comparative Study into the Motivations for and Attitudes towards Playing Video Games. *Future and Reality of Gaming (FROG)*.

Vermeulen, L., Van Bauwel, S., & Van Looy, J. (2017). Tracing female gamer identity. An empirical study into gender and stereotype threat perceptions. *Computers in Human Behavior*, *71*, 90–98. https://doi.org/10.1016/j.chb.2017.01.054

WA Wijnand IJsselsteijn, de Yaw Yvonne Kort, & Karolien Poels. (2013). The Game Experience Questionnaire. *Technische Universiteit Eindhoven*.

Williams, D., Consalvo, M., Caplan, S., & Yee, N. (2009). Looking for Gender: Gender Roles and Behaviors Among Online Gamers. *Journal of Communication*, *59*(4), 700–725. https://doi.org/10.1111/j.1460-2466.2009.01453.x

Yee, N. (2006). Motivations for Play in Online Games. *CyberPsychology &Amp; Behavior*, *9*(6), 772–775. https://doi.org/10.1089/cpb.2006.9.772

Yee, N., & Yee, N. (2015, December 15). *The Gamer Motivation Model in Handy Reference Chart and Slides – Quantic Foundry*. http://quanticfoundry.com/2015/12/15/handy-reference/

Zeigler-Hill, V., & Monica, S. (2015). The HEXACO model of personality and video game preferences. *Entertainment Computing*, *11*, 21–26. https://doi.org/10.1016/j.entcom.2015.08.001

APPENDIX A

Identify Female Puzzle Game Players' Types and Motivations
探究益智类游戏女性玩家的玩家类型和动机来源

Puzzle mobile games are designed to test problem-solving skills including pattern recognition, logic, word completion, or understanding a process. Puzzle games include match-3 puzzles, action puzzles, coloring games, etc. Puzzle games are so popular in the market such as Candy Crush, Gardenscape, Fishdom, and so on. The research mainly focuses on Match-3 (three identical objects will be eliminated) puzzle game as study case. This questionnaire is for exploring female and male players' player type and their preference for different mechanics.

解谜手机游戏旨在测试解决问题的能力，包括模式识别、逻辑、文字完成或理解过程。益智游戏包括三消类益智游戏、动作类益智游戏、着色游戏等。目前市场上流行的益智类游戏有：开心消消乐、纪念碑谷，愤怒的小鸟等。此研究主要选择了目前市面上最热门的三消游戏 (出现三个相同的物品时被消除) 为案例。此问卷是为了探究女性和男性玩家的玩家类型以及对不同益智游戏机制的偏好。

* 必答题

Part 1: About You
第一部分：你的信息

This is the first part of the survey. This part asks about you and your gaming habits.
这是问卷的第一部分，这一部分主要询问你的基本信息以及你玩游戏的习惯。

1

Email (Your email would only be used in data collection.)
邮箱（你的邮箱账号仅用于数据收集。） *

2

Age:
年龄： *

- ◯ Below 18 （18以下）
- ◯ 18-23 （18-23）
- ◯ 23-28 （23-28）
- ◯ Above 28 （28以上）

3

Gender:
性别： *

- ◯ Female （女性）
- ◯ Male （男性）

4

I typically play puzzle game:
我玩益智类游戏： *

- ◯ Every day （每天）
- ◯ Every week （每周）
- ◯ Every month （每月）
- ◯ Occasionally （偶尔）
- ◯ Rarely （很少）
- ◯ Never （从不）

My favorite match-3 game I have played before (Maximum **THREE**)
我玩过的最喜欢的益智类游戏（最多选**三个**）：
*

请最多选择 3 个选项。

- [ ] Candy Crush （糖果传奇）
- [ ] Gardenscapes （梦幻花园）
- [ ] Toon Blast （卡通爆炸）
- [ ] Royal Match （皇家消除）
- [ ] Merge Dragon （萌龙进化论）
- [ ] Woodoku （Woodoku）
- [ ] Yang Le Ge Yang （羊了个羊）
- [ ] Fishdom （梦幻水族箱）
- [ ] Homescapes （梦幻家园）
- [ ] Anipop（开心消消乐）
- [ ] Craz3 Match （天天爱消除）
- [ ] PopStar! （消灭星星）

6

In puzzle game, I would consider myself as
在益智游戏里，我认为我自己是： *

- ◯ Kid player: play puzzle game 1 year 初级玩家：只玩过一年的益智类游戏
- ◯ Progressive player: play puzzle game for 2-5 years 中极玩家：玩过2-5年的益智类游戏
- ◯ Senior player: play puzzle game more than 5 years 高级玩家：玩益智类游戏超过5年

Part 2: Game Experience
第二部分：游戏体验

This is the second part of the survey and asks you to rate each puzzle game experience listed. Choose from a scale between "Strongly Agree" for experiences you enjoy through "Strongly disagree" for experiences you would rather avoid. The result of your player type would be based on your selection, so please try to avoid choosing neutrality.

这是问卷的第二部分，你将要对列出的每项解谜游戏体验进行评价。"非常同意"代表你很喜欢这样的体验，"非常不同意"代表你希望避免这样的体验。最终的结果将基于你的

7

I enjoy working out how to crack a challenging puzzle.
我喜欢解决有挑战性的难题。 *

1	2	3	4	5
Strongly Disagree (非常不同意)				Strongly Agree (非常同意)

8

I enjoy the moment of completeness that I have strove for.
我享受付出努力后获得的成果。 *

1	2	3	4	5
Strongly Disagree (非常不同意)				Strongly Agree (非常同意)

I like risk-taking and high-speed action.
我喜欢冒险和速度快的运动。 *

1	2	3	4	5

Strongly Disagree
（非常不同意）

Strongly Agree
（非常同意）

10

I enjoy devising a promising strategy in next try.
每当我在准备下一步的行动时，我都会制定详尽的策略。 *

1	2	3	4	5

Strongly Disagree
（非常不同意）

Strongly Agree
（非常同意）

11

I will be motivated by a nervous and exciting game environment.
紧张而刺激的游戏环境设计会让我想要不断玩游戏。 *

1	2	3	4	5

Strongly Disagree
（非常不同意）

Strongly Agree
（非常同意）

I prefer working out on my own.
我更喜欢独立解决问题。 *

1	2	3	4	5

Strongly Disagree
（非常不同意）

Strongly Agree
（非常同意）

13

I always look for ways to become better and better in a game.
我总是会想办法在游戏中变得越来越厉害。 *

1	2	3	4	5

Strongly Disagree
（非常不同意）

Strongly Agree
（非常同意）

14

I will be motivated if I need to collect the items in the game.
在游戏中收集道具会成为我继续玩这个游戏的原因。 *

1	2	3	4	5

Strongly Disagree
（非常不同意）

Strongly Agree
（非常同意）

The excitement and suspense attract me more than slow-paced game play requiring lots of strategic planning and thinking.
比起需要大量战略规划和思考的慢节奏游戏，刺激和悬念更吸引我。 *

1	2	3	4	5

Strongly Disagree
（非常不同意）

Strongly Agree
（非常同意）

16

I love getting 100% (completing everything in a game).
我喜欢把游戏中所有任务做完。 *

1	2	3	4	5

Strongly Disagree
（非常不同意）

Strongly Agree
（非常同意）

17

I gain satisfaction when others acknowledge my high level of skill.
当别人夸我的游戏水平技能高超是我会感到十分满足。 *

1	2	3	4	5

Strongly Disagree
（非常不同意）

Strongly Agree
（非常同意）

I enjoy the moment when the solution to a difficult puzzle clicks in my mind.
我享受一个难题的解决方案在我脑海中出现的那个瞬间。 *

1	2	3	4	5

Strongly Disagree
（非常不同意）

Strongly Agree
（非常同意）

19

I enjoy finding what I need to complete a collection.
我享受在游戏里为了完成任务去寻找东西的过程。 *

1	2	3	4	5

Strongly Disagree
（非常不同意）

Strongly Agree
（非常同意）

20

I play the puzzle game time a time again because of the sense of accomplishment.
我一直玩解谜游戏是因为它能给我带来成就感。 *

1	2	3	4	5

Strongly Disagree
（非常不同意）

Strongly Agree
（非常同意）

I am passionate about improving and honing all aspects of game play.
我热衷于改进和磨练各种游戏玩法。 *

1	2	3	4	5

Strongly Disagree
（非常不同意）

Strongly Agree
（非常同意）

22

I seek excitement as a positive experience and a reward enhancer.
寻求刺激对于我来说是积极的体验和更强的奖励机制。 *

1	2	3	4	5

Strongly Disagree
（非常不同意）

Strongly Agree
（非常同意）

Part 3: Game Mechanic
第三部分：游戏机制

It is the third part of the survey. There are swapping match-3 (three same objects can be eliminated) game mechanics listed below, please give the thumbs up to score them based on your past game experience. The more thumbs up you give, the more you like the mechanic.

这是问卷的第三部分。以下列出了一些三消(三个相同的物品靠近消除)游戏的机制，请根据你过往的游戏经验为这些游戏机制点赞打分。点赞越多意味着你越喜欢这个机

23

Immovable obstacles
固定的障碍物 *

An element that cannot be matched with any other stays immovable on the grid.
在三消游戏中充当障碍物的方块，玩家一搬不能移动它。

替换文字： Immovable obstacle

No preference （没有偏爱） Strongly Prefer （非常偏爱）

24

Blocked element
固定的可消除物 *

An element that cannot be moved until it is unblocked. In order to unblock it, player needs to make a match with it.
不能移动的物品，需要周围别的同种物品匹配后进行消除。

No preference （没有偏爱） Strongly Prefer （非常偏爱）

25

Turn-based
步数限制 *

Players are limited to moving certain steps in each level.
玩家在每一关内只能使用规定的步数。

No preference （没有偏爱） Strongly Prefer （非常偏爱）

26

Timer
倒计时 *

There is a countdown in each level, players should complete the level in the given time.
玩家需要在倒计时结束前完成本关的任务。

27

Dropping
掉落物 *

The level contains special elements that need to be dropped down in order to be removed.
关卡中含有一些特殊的元素需要让他们下落才能消除。

No preference （没有偏爱） Strongly Prefer （非常偏爱）

28

Collect Items
收集物品 *

The goal of each level is to collect certain items.
通关的目标是收集一定数量的物品。

No preference （没有偏爱） Strongly Prefer （非常偏爱）

29

Reach the Score
得到分数 *

The goal of each level is to reach the certain score.
通关的目标是达到一定的分数。

No preference （没有偏爱） Strongly Prefer （非常偏爱）

30

Layer
消除冰块 *

To erase a layer, player needs to make a match in its cell one or several times.
玩家需要消除冰块内或是冰块周围的物品，才能把冰块移除。

No preference （没有偏爱） Strongly Prefer （非常偏爱）

Contact
联络方式

This research will conduct a game test related to the match-3 puzzle game, it would be so grateful if you are willing to participate in game test in the future.
此研究之后将会有关于三消类游戏的游戏测试，如果您愿意参与游戏测试，将不胜感激。

31

Would you like to participate in game test?
你想要参与之后的游戏测试吗？ *

- ◯ Yes （是的）
- ◯ Maybe （或许）
- ◯ No （不是）

APPENDIX B

Research on Happy Zoo Match-3 Game Female Players' Game Experience and Motivational Drivers

This questionnaire is to collect the feedback of female players after playing Happy Zoo. The questionnaire includes 4 sections in total, including players' information, players' game experience, players' motivational drivers and players' attitude toward different mechanics.

* 必答题

* 此表单将记录你的姓名，请填写该信息。

Part 1: Your Information

This is the first section. This section asks about player basic information and player type.

1

Email (Your email would only be used in data collection.) *

2

Age: *

3

In Match-3 Puzzle Game, I would consider myself as: *

- ◯ Kid player: play match-3 puzzle game 1 year
- ◯ Progressive player: play match-3 puzzle game for 2-5 years
- ◯ Senior player: play match-3 puzzle game more than 5 years

4

Your main player type: *

- ◯ Thinker
- ◯ Achiever
- ◯ Thrill Seeker
- ◯ Skill Master

Part 2: Your overall Game Experience

This is the second part. This section will ask your game experience from competence, autonomy, controls, personal gratifications, audio and visual aesthetics six aspects.

5

Competence *

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
I feel competent at the game.	◯	◯	◯	◯	◯
I feel very capable and effective when playing.	◯	◯	◯	◯	◯
My ability to play the game is well matched with the game's challenges.	◯	◯	◯	◯	◯

6

Autonomy *

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
The game provides me with interesting options and choices.	◯	◯	◯	◯	◯
The game lets me do interesting things.	◯	◯	◯	◯	◯
I experienced a lot of freedom in the game.	◯	◯	◯	◯	◯

7

Intuitive Controls *

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Learning the game controls (User interface/ menu/ button) were easy.	◯	◯	◯	◯	◯
The game controls (User interface/ menu/ button) are intuitive.	◯	◯	◯	◯	◯
When I wanted to do something in the game, it was easy to remember the correspondin g control.	◯	◯	◯	◯	◯

Personal Gratification *

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
I feel successful when I overcome the obstacles in the game.	○	○	○	○	○
I want to do as well as possible during the game.	○	○	○	○	○
I am very focused on my own performance while playing the game.	○	○	○	○	○
I feel the game constantly motivates me to proceed further to the next stage or level.	○	○	○	○	○
I find my skills gradually improve through the course of overcoming the challenges in the game.	○	○	○	○	○

9

Audio Aesthetics *

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
I enjoy the sound effects in the game.	◯	◯	◯	◯	◯
I enjoy the music in the game.	◯	◯	◯	◯	◯
I feel the game's audio (e.g., sound effects, music) enhances my gaming experience.	◯	◯	◯	◯	◯
I think the game's audio fits the mood or style of the game.	◯	◯	◯	◯	◯

10

Visual Aesthetics *

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
I enjoy the game's graphics.	◯	◯	◯	◯	◯
I think the graphics of the game fit the mood or style of the game.	◯	◯	◯	◯	◯
I think the game is visually appealing.	◯	◯	◯	◯	◯

Your motivation factors toward the game

This is the third section of the questionnaire. This section would ask your motivations toward game.

11

This game helps me to forget about daily hassles. *

1	2	3	4	5

Strongly Disagree — Strongly Agree

12

This game helps me get into a better mood. *

1	2	3	4	5

Strongly Disagree — Strongly Agree

13

This game sharpens my senses. *

1	2	3	4	5

Strongly Disagree — Strongly Agree

I enjoy playing this game. *

1	2	3	4	5

Strongly Disagree Strongly Agree

15

This game improves my coordination skills. *

1	2	3	4	5

Strongly Disagree Strongly Agree

16

This game helps me get rid of stress. *

1	2	3	4	5

Strongly Disagree Strongly Agree

17

This game makes me forget real life. *

1	2	3	4	5

Strongly Disagree Strongly Agree

This game helps me channel my aggression. *

1	2	3	4	5

Strongly Disagree Strongly Agree

19

This game improves my concentration. *

1	2	3	4	5

Strongly Disagree Strongly Agree

20

I think this game is entertaining. *

1	2	3	4	5

Strongly Disagree Strongly Agree

21

This game helps me escape reality. *

1	2	3	4	5

Strongly Disagree Strongly Agree

This game improves my skills. *

1	2	3	4	5

Strongly Disagree Strongly Agree

23

This game reduces my tension. *

1	2	3	4	5

Strongly Disagree Strongly Agree

24

This game helps me to forget about unpleasant things or offences. *

1	2	3	4	5

Strongly Disagree Strongly Agree

25

I will play this game for recreation. *

1	2	3	4	5

Strongly Disagree Strongly Agree

The gaming experience towards different mechanics

This is the last section. The following statements list some important mechanics in the Happy Zoo. You can rate your feelings accroding to each mechanic.

26

Immovable Obstacles *

	Not at all	slightly	moderately	fairly	extremely
I felt challenged.	○	○	○	○	○
I had to put a lot of effort into it.	○	○	○	○	○
I thought it was fun.	○	○	○	○	○
I enjoyed it.	○	○	○	○	○

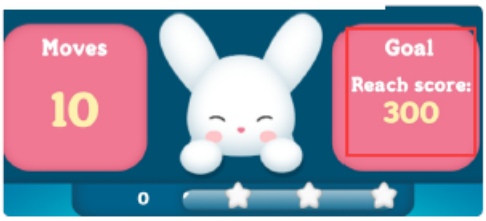
27

Ice Layers *

	Not at all	slightly	moderately	fairly	extremely
I felt challenged.	○	○	○	○	○
I had to put a lot of effort into it.	○	○	○	○	○
I thought it was fun.	○	○	○	○	○
I enjoyed it.	○	○	○	○	○

28

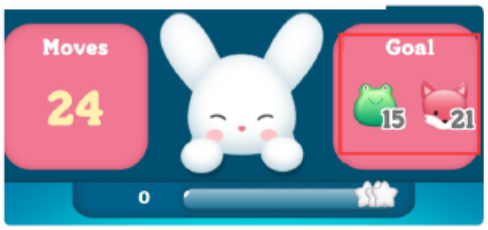
Reach the Score *



	Not at all	slightly	moderately	fairly	extremely
I felt challenged.	◯	◯	◯	◯	◯
I had to put a lot of effort into it.	◯	◯	◯	◯	◯
I thought it was fun.	◯	◯	◯	◯	◯
I enjoyed it.	◯	◯	◯	◯	◯

29

Collect Items *



	Not at all	slightly	moderately	fairly	extremely
I felt challenged.	◯	◯	◯	◯	◯
I had to put a lot of effort into it.	◯	◯	◯	◯	◯
I thought it was fun.	◯	◯	◯	◯	◯
I enjoyed it.	◯	◯	◯	◯	◯

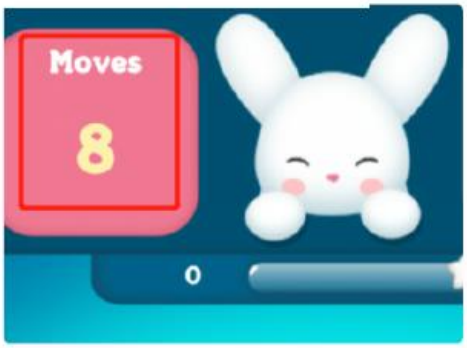
30

Dropping *

	Not at all	slightly	moderately	fairly	extremely
I felt challenged.	◯	◯	◯	◯	◯
I had to put a lot of effort into it.	◯	◯	◯	◯	◯
I thought it was fun.	◯	◯	◯	◯	◯
I enjoyed it.	◯	◯	◯	◯	◯

31

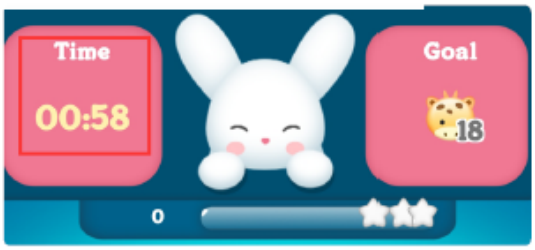
Turn-based *



	Not at all	slightly	moderately	fairly	extremely
I felt challenged.	◯	◯	◯	◯	◯
I had to put a lot of effort into it.	◯	◯	◯	◯	◯
I thought it was fun.	◯	◯	◯	◯	◯
I enjoyed it.	◯	◯	◯	◯	◯

32

Timer *



	Not at all	slightly	moderately	fairly	extremely
I felt challenged.	◯	◯	◯	◯	◯
I had to put a lot of effort into it.	◯	◯	◯	◯	◯
I thought it was fun.	◯	◯	◯	◯	◯
I enjoyed it.	◯	◯	◯	◯	◯

33

Do you have any other feedback or comment?

APPENDIX C

Model Participant Consent Form

Title of Research Project: Exploring the Motivational Drivers on Female Puzzle Game Players

Name of Researcher: Beining Chen

Please initial box

1. I confirm that I have read and understand the information sheet/letter (delete as applicable) dated *[insert date]* explaining the above research project and I have had the opportunity to ask questions about the project. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline. *Insert contact number here of lead researcher/member of research team (as appropriate).* ☐

3. I understand that my responses will be kept strictly confidential (only if true). I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the report or reports that result from the research. ☐

4. I agree for the data collected from me to be used in future research ☐

5. I agree to take part in the above research project. ☐

Name of Participant (*or legal representative*)	Date	Signature
Name of person taking consent (*if different from lead researcher*)	Date	Signature
Chen Beining	30/11/2022	
Lead Researcher	Date	Signature

To be signed and dated in presence of the participant

To be signed and dated in presence of the participant

Copies:

Once this has been signed by all parties the participant should receive a copy of the signed and dated participant consent form, the letter/pre-written script/information sheet and any other written information provided to the participants. A copy of the signed and dated consent form should be kept with the project's main documents which must be kept in a secure location.

Date: Name of Applicant: