GAME-BASED LEARNING APPROACH FOR LEARNING

BY

TAN HUEI LIE

A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

In partial fulfilment of the requirements

For the degree of

BACHELOR OF COMPUTER SCIENCE (HONS)

Faculty of Information and Communication Technology
(Kampar Campus)

APRIL 2019

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DECLARATION OF ORIGINALITY

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Date : 7 April 2019

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ABSTRACT

Game-based learning indicates the idea of using video games as education tools. The main purpose of this project is to deliver a game on mobile platform with the idea of game-based learning concept. Several problems and flaws from existing education system and game are analyzed in order to overcome them in this project. For example, traditional teaching method consists of shortcoming which requires much effort from the teacher to deliver the knowledge to the students by using instructions and guidance. At the same time, students have to stay focus in order to remember those instructions from teacher. Furthermore, the existing education games have repetition contents and limited choice of difficulty option. The player may lose their motivation if the game is too easy and get bored or too hard and get frustrating after trying the game. If either situations happen, it is just a matter of time for the player to give up the game eventually. These issues will be taken into consideration during the development of the game as some important features of the game. Android Studio with the involvement of LibGDX will be used as the programming tools to build the game. Eventually, the game developed will be playable on mobile device with Android platform. Lastly, in order to validate the functional and non-functional requirements of this project, black box testing will be conducted on the application to ensure minimum amount of defects in the system. This project has proposed in hope of the games can offer an enjoyable and unforgettable experience and most importantly, granting the possibility for the advancement of learning.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION

1.1 Project Background

In the past decade, many researches regarding educational computer games have been conducted. Interactive education and motivation in learning are brought by the combination of games with educational objectives. Kids learn teamwork and strategic thinking when playing games just like they learn to talk by listen to sounds. It has been found that students were more active while learning throughout the practice of the game-based learning approach. The adoption of game-based learning has resulted a traditional teacher-centred learning environment change to a student-centred environment (Sung & Hwang, 2012).

Although video games are usually thought as a pure entertainment, it is essential to realize that they are remarkably capable as learning tools as well. The role of video games in learning and teaching is a source of debate among many educators, analysts, researchers and in press. They have been arguing and talking about the impacts and the possibilities of video games for a long time owing to the rapid advancement of multimedia technologies. In the 21st Century, video games can be a new approached to education and targets to identify rewarding learning experiences that will encourage and challenge all young individuals, preparing them with necessary skills and attitudes for life, learning and work.

'Game-based learning' typically refers to the use of video games to enhance learning and teaching. In spite of the fact that it is a generally set up idea, it is difficult to characterize absolutely. While 'Gamification' is a much more current concept than Game-based learning. It is approximately utilizing 'elements' derives from video-game design, and then deployed in an assortment of settings instead of just using individual video games. Game-based learning may or may not include 'educational' video games (those with exact focus on improving and learning attainment) rather than 'leisure-use' video games (Perrotta et al., 2013).

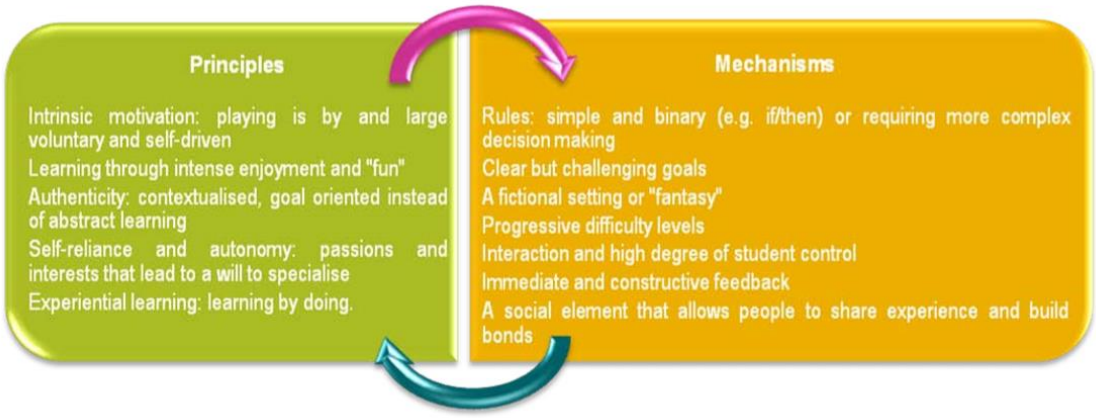


Figure 1.1: The principles and mechanism of game-based learning (Perrotta et al., 2013)

Incorporating game-based learning has become plenty effortless with new applications and technologies being developed (Pho & Dinscore, 2015). Rich virtual worlds have making games to be powerful contexts for learning. Learning no longer means confronting words and symbols separated from the things those words and symbols are about in the first place in the game worlds. In virtual worlds, people can experience the concrete realities that words and symbols describe. Through such experiences, across multiple contexts, people can understand complex concepts without losing the connection between abstract ideas and the authentic problems that can be used to solve (Admiraal et al., 2012).

Games are used as a form of play and for fun. Games have undoubtedly contributed to informal and formal learning. Trybus (2015) proposed that game-based learning indicates to the borrowing of some principles in gaming and connecting them to real-life settings to engage players. For example, playing multiplayer games can be an important components of players' social development and social life. The motivational psychology involved in game-based learning helps students to approach with learning activities in a cheerful and vital way (Pho & Dinscore, 2015).

1.2 Problem Statement and Motivation

- **Lack of interactivity in traditional classroom-based learning**

Cheng & Su (2012) has proposed that attention of youths are not attracted by the unilateral learning and traditional teaching due to the accessibility of network and interactivity. The trend of learning and education has developed by e-learning because of extra time and greater flexibility in location wise. According to Meluso et al. (2012), game-based learning has enhanced fifth graders' knowledge and self-efficacy in learning science. 32 empirical studies stated traditional classroom instruction was less effective on learners' academic knowledge gains and intellectual skill development as compared to interactive games. Similarly, studies found that elementary and middle school students showed improvement in a variety of studies and in a diversity of content range on the learning of science through digital games. According to Perrotta et al. (2013), a group of students have expressed that they enjoyed the elements of the game which contained adventure, exploration that changes their mood and challenge that were entertaining. In conclude, game is often more enjoyable and interesting.

- **Loss of motivation in game with inadequate difficulty**

Motivation is an important component in both teaching and learning process. According to Hull et al. (2013), player will start to lost interest in the game if the challenges of the game stay at the same level throughout. According to Ke and Abras (2013), the students will unwilling to continue the game once they realized the game is impossible to win because challenge no longer act as a motivation but a deterrent. Studies have investigated the effectiveness of using game-based learning to help upon students' self-efficacy in multiple subject areas and have determined that playing education-related games help to improve students' self-efficacy (Meluso et al., 2012). Eseryel proposed that when people achieve their objective, self-efficacy can be increased. However, learners are possible to lose self-efficacy as they struggle in the game for too much (Eseryel et al., 2014). A proper gameplay difficulty and interesting game design are essential factors in the development of the game to keep the engagement of players.

- **Lack of progress tracking in user's learning progression**

As students' practice, a game can track their performance, providing them with useful feedback and teachers with information for assessment. Some of the games do not give players immediate feedback on the effects of their actions, in this case, players cannot see how they are doing and decide on what to do next. Students are not able to know where they have gone off track, try corrections, and see results while they engage deeply in the problem. According to Tan et al. (2013), students will be motivated to complete more tasks if there is reward systems in the game because this will increase their satisfaction levels while they are playing the game.

1.3 Impact, Significance and Contribution

According to Mosavit and Nezarat (2012), games with game-based learning can improve user's second language skills such as vocabulary, pronunciation and listening. Furthermore, mobile devices provide an ideal platform for learning since they are common, affordable, and wireless.

Gaming elements and gameplay impacts and outcomes

	Gameplay impact on engagement		Learning and motivational outcomes		
Elements of engagement	Emotional engagement	Cognitive engagement	Positive	Negative	Papers
Multimedia elements: Attractive gaming features for attention to gameplay and learning					
1. Visuals	X (3)	X (2)	X (3)	X (3)	7
3. Text	X (2)	X (2)	—	X (3)	3
2. Video	X (1)	—	—	X (1)	1
4. Audio	X (1)	X (1)	X (2)	—	2
Fun elements: Playful gaming features for enjoyable gameplay and learning					
5. Virtual characters/ environments	X (12)	X (9)	X (12)	X (2)	21
6. Challenges	X (7)	X (12)	X (10)	X (4)	11
7 Control/choices	X (7)	X (2)	X (7)	X (2)	9
8 Narrative/storyline	X (7)	X (3)	X (5)	X (3)	9
Interactive elements: Gaming features for participation and involvement in gameplay and learning					
9. Role-play	X (6)	X (4)	X (7)	X (2)	13
10 Obstacles	X (1)	X (2)	X (2)	—	6
11. Quests	X (3)	X (2)	X (3)	X (1)	7
12. Problems/scenarios	—	X (1)	X (1)	—	4
13. Mini-games (educational/ noneducational)	X (1)	X (3)	X (1)	X (3)	4
Motivational elements: Supportive gaming features for meaningful gameplay and learning					
14. Scaffolding	X (13)	X (12)	X (15)	X (9)	17
15. Rewards	X (7)	—	X (6)	X (1)	14
16. Built-in learning tools	X (9)	X (7)	X (11)	X (5)	12
17. Offline help tools	—	X (2)	X (2)	—	1

Figure 1.2: Researches on gaming elements and gameplay impact and outcomes (Jabbar and Felicia, 2015)

To determine the gaming elements have been used in this project that affects user's commitment and learning in gameplay, table above shows the elements identified in the game studied and their effect on both emotional and cognitive engagement and also how these connect to learning and motivational outcomes. Among the multimedia elements, visual elements including graphics and animations are most commonly adopted in game-based learning for content presentation and feedback (Jabbar and Felicia, 2015). Children are not favour long, text-rich context, due to they might have reading difficulties and different language background. According to Admiraal et al. (2012), video clips were not efficient in learning outcomes because children paid minor

attention to videos, sound of narratives and embedded text messages in the video. On the other hand, audio helps in language learning and strengthening reading by linking sounds and pictures.

In fun elements, 12 papers among 21 papers have featured that the use of virtual characters and environments within a game give positive result in learning and motivational outcomes. Children are motivated and desired to play more as they felt immersed in the game. Furthermore, children were more curious and engaged about the game's content while playing games that included challenges. There are 7 papers out of 9 papers implied that control and choices are useful in learning and motivational outcomes. Mobile devices' touchscreens allow more interaction opportunities while playing games. Most of the children are enjoyed using mobile devices to learn while play games because they can easily manipulate objects through the phone screen. The use of narratives can aid children to figure out the situation described in game and encourage children to explore and complete more tasks in game. However, some papers have discovered that some children did not understand the introduction part of the narratives and no compelling differences in terms of learning and motivational outcomes since they did not take the storyline as part of the gameplay.

Since most of the elements does have both positive and negative result in bringing learning and motivational outcomes to children, only partial of the elements are chose to be included in this project. Since including all the elements do not implies bringing to the best results, some of the elements will be excluded or to be used in future enhancement in this project.

1.4 Project Scope

The scope of this project consist of developing a game which brings excitement and enjoyment to players and at the same time also help them in education and learning in mobile platform. By using mobile as platform of the game, most of the people are able to access to the game since almost everyone will at least own a personal phone in this era. Gaming elements mentioned in Chapter 1.3 such as visuals, text, audio, visual characters, challenges, control or choices will be included in the gameplay. The game is targeting to develop a proper level of gameplay difficulty of game which is suitable for kids to play. Children will be advanced to more challenging level if they able to complete the easier level. There are total of 3 levels with 3 kind of difficulties are included in the game. Specific requirement are included in every stage of the game to teach the user about different seasons of fruits. If the user has passed a stage with required score, the collection of the stage will be unlocked and by clicking the fruits in the collection module, the pronunciation of the fruits can be listened by the user. Total of 9 stages with different seasons and categories of fruit are included in the gameplay. Each stage has 4 types of fruits for children to differentiate while playing. Lastly, the user are able to choose different control of gaming style in option, which are either tilting the phone or touching the phone surface to control the character in the game.

1.5 Project Objectives

The objectives of this project is to solve the existing problems in current teaching method in both game and traditional teaching which have been stated in the problem statement.

- **To compensate the lack of interactivity in traditional teaching method through game-based learning.**

  A game with graphics and sound effects will be developed. The game will include some learning material which let the user to learning while playing. For example, including some graphics of fruit and rules to follow which helping the players to distinguish different type of fruit. With the aids of animation, the learning progress will become enjoyable and interactive.

- **To develop a game with appropriate level of gameplay difficulty to prevent the loss of motivation while learning.**

  A game with appropriate difficulty will be developed. Since the targeting user will be preschool children, simple language and minor amount of rules are required throughout the gameplay in order for the players to understand the way to play game. The gameplay will neither be too easy nor too difficult to keep the proper level of challenge in the game and to prevent them stuck in the same level for a long time.

- **To develop a collection module to track learner activity in the game.**

  A module called Collection will be developed. In this module, user can track the level progression they have completed. If user have not complete a particular stage, the icon of the fruits of the stage will be locked. This provide students with feedback on their success or failure in meeting objectives, to enable them to make changes to improve results.

1.6 Motivation

This project was split on the extent to which explaining game-based learning concept by proving video games can bring fun and make users to learn things at the same time, as most of the studies constantly stated that video games can effect positively on knowledge acquisition and problem-solving skills. For instance, video games can affect young-aged in motivation and engagement to achieve positive results in their education. Furthermore, this project will provide a simple and easy game with game-based learning concept for the target users.

CHAPTER 2: LITERATURE REVIEW

2.1 Literature Review

2.1.1 Definition of Game-based learning

From amusement and enjoyment, to learning experience and educational system, games are necessary and beneficial. Game-based learning is often mixed up with gamification. One of the major differences between game-based learning and gamification is game-based learning includes combining the learning content with the game story and rules unlike gamification using game elements to keep the students active and engage in (Furdu, Tomozei & Kose, 2017). Game-based learning is an approach of using video games to educate the players a particular of skills for example cognitive skills, or guide them to accomplish particular learning outcomes (Shan, 2015). There are educational games which are game as play and didactic games which are game as specific function of educational learning (Cojocariu & Boghian, 2014).

2.1.2 Advantages of Game-based learning

Some ideas which are complicated and hard to be taught within an ordinary framework because of the lack of simplicity and instructions. Games provide digital models and stimulations which promote easier explanations for theory that are complicated. Animations in game make message easier to be transmit and to be understand (Shan, 2015). Besides, game-based learning provides experimental learning that gives reliable learning experience. Students can learn from a comprehensive learning experience while taking part in game stimulations. Another advantages of game-based learning is it help students to involve in the active learning process. Game comprises an adequate tool to motivate students and engaging them in learning (Cojocariu & Boghian, 2014). Other than active learning, game-based learning sets up a learning environment where students can learn at their own pace while learning fundamental knowledge before proceeding to harder concepts. Unlike traditional classroom teaching method, some students with poor understanding are not able to catch up the other students since all the students need to work through tasks with same difficulty together. Games with game-based learning concept support knowledge from basic to complex, therefore students are allowed to complete each of the tasks progressively.

2.1.3 Disadvantages of Game-based learning

One of the disadvantages of including excessive game-based learning are having the risk of progressively eradicate classroom interaction, causing addiction towards games, reducing social and communication skills due to most of the knowledge has already presented on the phone or computer screen during the teaching-learning process (Cojocariu & Boghian, 2014). Furthermore, it is hard for teachers to estimate the time duration for students to finish their tasks in game. Failure to do so will resulted discouragement and low self-confident specifically for students who are not able to finish the levels of the game in the given amount of time given by the teachers. At the same time, students will possibly learn different things throughout the game since everyone has different decision-making while playing the game. According to Parisod (2014), learning disability, weak school performance and some negative health disorders are correlated with enormous amount of screen time. Children who are addicted the game may exceed the recommended duration of gameplay and increase their physical inactivity at the same time.

2.2 Existing Systems' Review

2.2.1 Kindergarten Kids Learning: Fun Educational Games

Kindergarten Kids Learning: Fun Educational Games is a learning based mobile game application that focus on educational purpose. The main targeted audiences are the toddlers and preschool children. The game consists of a sets of educative fun and interactive games for the kids to allow them to get in touch with the subjects such as alphabet, numbers, shapes, rhymes, counting, tracing, colouring, interactive charts, and body parts (vegetable/fruit/sports/profession/stars/animals). The game is very suitable for the age of 2-6 as the targeted user might be preparing to enter kindergarten as kinaesthetic learners. The gameplay is simple, once the application has started and successfully loaded into the main menu. The main menu shows all the available game modes at a glance. The user can select their preference game mode and category to begin the game based learning experience. All the game modes are sorted accordingly relative to the category. Tapping into a game mode will bring the user into the specific game. The user can press the return button to return to the main menu after interact with the game mode. Certain game mode will allow the user to score points during the play time while some of the game is purely teaching and educating about the subject.

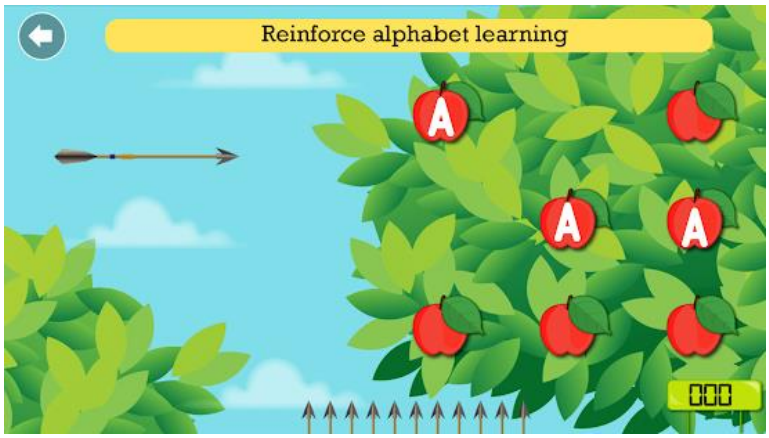


Figure 2.1: Kindergarten Kids Learning: Fun Educational Games

Strengths: The amount of game modes provided in this application is excellent. It has a large variety of game play to allow the user to choose from. The operation of the game is simple, the user just have to use their finger to navigate around the game during the gameplay. The graphical user interface is very attractive and colourful for young kids. The ability to learn the specific subject with interactive fun quizzes to test out the user knowledge and skills. The user can freely practice and revise the gameplay whenever

they feel like it. The user can hand on to learn and write and trace ABC and numbers with the ability to do alphabet tracing for English, Spanish, Hindi, and numbers. Aside from educational learning, the game futures multiples interactive game mode to allow the user to do puzzle building, drawing, colouring, intensive arcade game, simple math, learn about rhymes and poems. Furthermore, this mobile application is good for compact learning because there are many topics to be interact with. The preschooler can easily get in touch with the topic that they are going to face in the kindergarten and getting prepare for it.

Weaknesses: The user interface is very confusing at the first place. Despite there are multiple game modes and category, all the game are scattering around the places. There are no detailed instruction on each game mode and the lack of guidance will cause confusion for the user. After loading into the game, the user will have to figure out the action required to complete the game mode or the proper way to interact with the game. Despite the games are sorted according to their category, but the gameplay is very confusing in terms of educational learning and educational interactive gaming. The user will not be able to identify which game mode is just for learning or for interactive gameplay. The user will have trouble selecting the suitable game mode based on merely figure shown in the main menu. The lack of proper interface guidance will result in user abandoning the game due to unable to operate the application correctly according to the game play. Furthermore, some of the games are irrelevant and repetitive to the user. The user might feel annoyed to repeat the same action or to go through a game mode without a good purpose.

2.2.2 Preschool Kids Learning Games: ABC, Numbers, Colour

Preschool Kids Learning Games: ABC, Numbers, Colour is a mobile application that focus on providing a simple yet functional educational environment for the preschool and kindergarten kids. Through this application, the user can gain access up to 10 educational categories of preschool learning. The 10 educational categories are colours, numbers, letters (alphabet –ABC), shapes, animals, fruits, vegetables and vehicles. This application does not require internet connection after downloading is completed so that the user can use it at anywhere and anytime. The main goal of the application is to allow the user to learn as much educational category as possible. The operation of the application is very simple, the user just have to select a specific categories in the application and it will navigate to the category content. Inside the respective category content, the user can interact with the application by pressing the sound button in the page. Then, a caressing natural English voice will help the user to learn how to say each letters of the words. Furthermore, some of the category consist of a random shuffle feature that helps to ensure the user really learn the objects instead of just memorizing the order in all categories. The user can press the back button to navigate back to the main menu for more selections. Overall, it is an attractive, lovely, and colourful designs and pictures for kid's education.

Figure 2.2: Preschool Kids Learning Games: ABC, Numbers, Colour

Strengths: Good selection of educational categories that are highly recommended for young user. The user interface is very clean and simple which allows the user to navigate easily throughout the application well. All the categories are very well organized to allow the user to pick up and learn easily. It is like a dictionary but with more interesting features. The voice is accurate to help the user to understand the pronunciation of each category.

Weaknesses: No detailed instruction available to guide the user. The user may not be able to understand the function of the application at first. Despite the good content, the application lack of interactive content to stimulate the user. The graphical aspect of the application is not good enough and some of the objects in the category may not be as similar as the objects in the real world. The category lacks more detailed explanation and alternative choices to allow the user to learn and compare. The user might lost interest in the run long due to similar content in all of the categories.

2.2.3 Kids: All in One

Kids: All in one is an educational application created by Genius Games for preschool toddler to use. This apps aim to offer a platform for children to learning easily. This application consists of several topics which are alphabets, numbers, shapes, colours, fruits, transportation vehicle, days and months, parts of body, sports and professions. Pictures and pronunciation of particular things related to the topics are grouped in category for children to learn. Furthermore, there is a topic named Game which is an activity of image sequence. In every level, total six image will be displayed and the last two are missing and shown as an image of question mark. There will be four images appear below the sequence for the children to drag and drop the two correct images to the images of question mark.

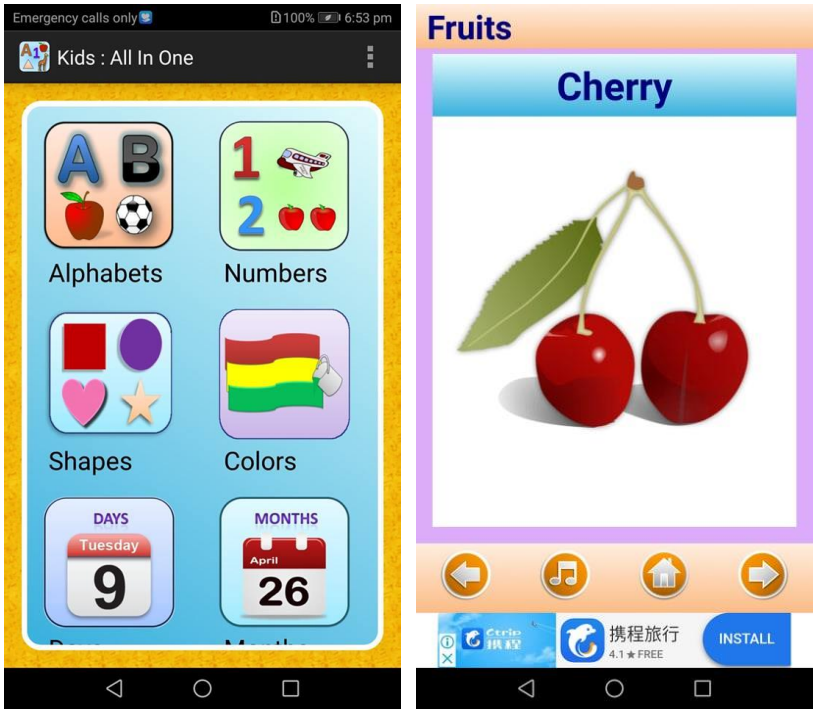


Figure 2.3: Kids: All in One

Strength: Children can learn a large range of words from this apps because the apps consists of multiple categories for users to choose. Unlike other apps which rarely involved a narrator to read out the word, children can learn the pronunciation of particular objects in this apps.

Weakness: The games included in this game is repetitive. It does not require much effort to figure out the puzzle once the users realise the pattern of the game. People can easily get bored from it as every stages have similar pattern only with different pairs of

image. This application just tells what the objects are in picture and sound without any animation and interaction. Children would most likely losing interest in this application in a short time as it just provide a slide show of objects.

2.2.4 Toddler Learning Games - Little Kids Games

Little kids learning games is an application consists a collection of games and puzzles for preschool children. Multiple topics can be learned from the apps such as alphabet, numbers, colours, shapes, fruits, vegetables, animals and musical notes with piano. This application made by Greysprings to promote interactive learning for kindergarten children. A total of 14 games included in the game to ensure children between 2 to 4 years old will be immersed with the experience of the kids' fun games. Since there is no win and lose condition in every mini games, this educational application promote children to learn at their own pace without experience frustration of losing. Each mini game act as a toy for the children and cute stickers are rewarded to the users after scoring enough points. The developer of this application thought this game are perfect for kids to implant curiosity in their early childhood.

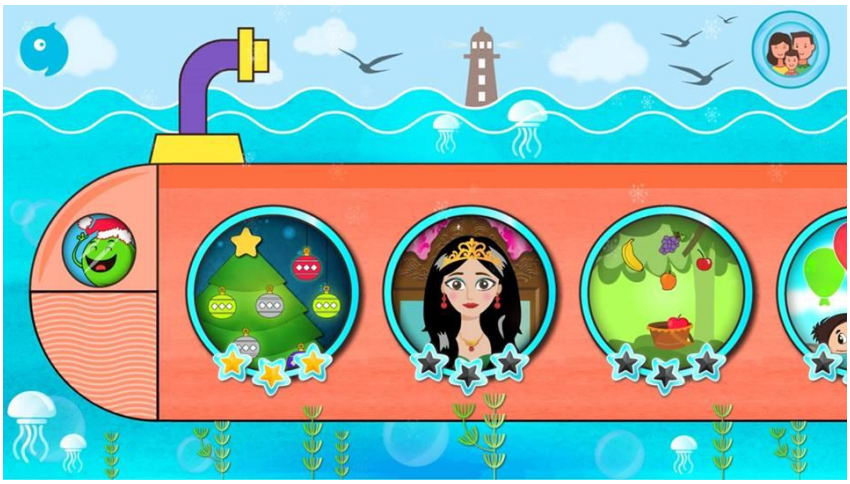


Figure 2.4: Toddler Learning Games - Little Kids Games

Strength: This application has great graphics and colours which are attractive and lovely music and narrator giving instructions for children to proceed the game. The stickers earned at the end of some mini games will act as rewards and appreciation and boost the children's morale. Furthermore, there are variety of games with different mechanics or puzzles for children to solve, every games have their special features and knowledge to learn.

Weakness: Some of the games do not have any instructions for examples piano and fashion changing princess. Children might have no idea what to do with these two activities and will no learn anything from them. Besides, every games are unique and do not have any related to each other. If there is story which can connect the games together, it will be more impressive and memorable.

2.3 Strength and weakness of existing system

	Description	Strength	Weakness
Kindergarten Kids Learning: Fun Educational Games	- A sets of educational fun games for preschool children and toddlers. Combination of educational learning and educational interactive gaming	- Large variety of gameplay to allow the user to choose from - The graphical user interface is very attractive & colourful for young kids - The ability to learn the specific subject with interactive fun quizzes to test out the user knowledge and skills	- No detailed instruction on each game mode and the lack of guidance - Hard to identify which game mode is for learning or for interactive gameplay - User interface is very confusing at the first place
Preschool Kids Learning Games: ABC, Numbers, Colour	- Educational application that consists of 10 educational categories that function similar like a dictionary.	- Good selection of educational categories - The voice is accurate to help the user to understand the pronunciation of each category - User interface is very clean and simple - Categories are very well organized	- No detailed instruction available to guide the user - The application lack of interactive content to stimulate the user - The graphical aspect of the application is not good enough - The category lacks more detailed explanation and alternative choices

Kids: All in One	- Educational application for preschool children that teaches words in form of pictures	- Massive categories of words for users to choose	- Repetitive and dull gameplay - Lack of animation and interaction to attract attention of children
Toddler Learning Games - Little Kids Games	- Educational application for toddlers with total of 14 mini games	- Great graphics and colours - Has rewarding features which boost players' morale	- Lack of instructions for some games - Games are unrelated to each other

Table 2.1: Strength and weakness of existing system

2.4 Comparison between Applications using game-based learning

System	Kindergarten Kids Learning: Fun Educational Games	Preschool Kids Learning Games: ABC, Numbers, Colour	Kids: All in One	Toddler Learning Games - Little Kids Games	Proposed Application – Fruit Catcher
Great Graphic and Sound	Yes	Yes	No	Yes	Yes
Instruction for gameplay	Yes (Voice)	No	No	No	Yes (Text)
Interactive gameplay	Yes	No	No	Yes	Yes
Vocabulary Teaching	No	Yes	Yes	Yes	Yes
Cognitive Thinking	Yes	No	No	No	Yes
Difficulty	No	No	No	No	Yes
Sense of accomplishment (Reward/Score Recorded)	Yes	No	No	Yes	Yes
Track user 's learning progress	No	No	No	No	Yes

Table 2.2: Comparison between Applications

CHAPTER 3: SYSTEM DESIGN

3.1 Top-Down System Diagram

Figure 3.1 shows the top-down system diagram which shows the design of system by specifying complicated chucks of systems and breaking them down into smaller pieces of sub-systems. The sub-systems are individual components that can be combined and entire system can be made. The functionality of each of the blocks will be further explain in Chapter 3.4.

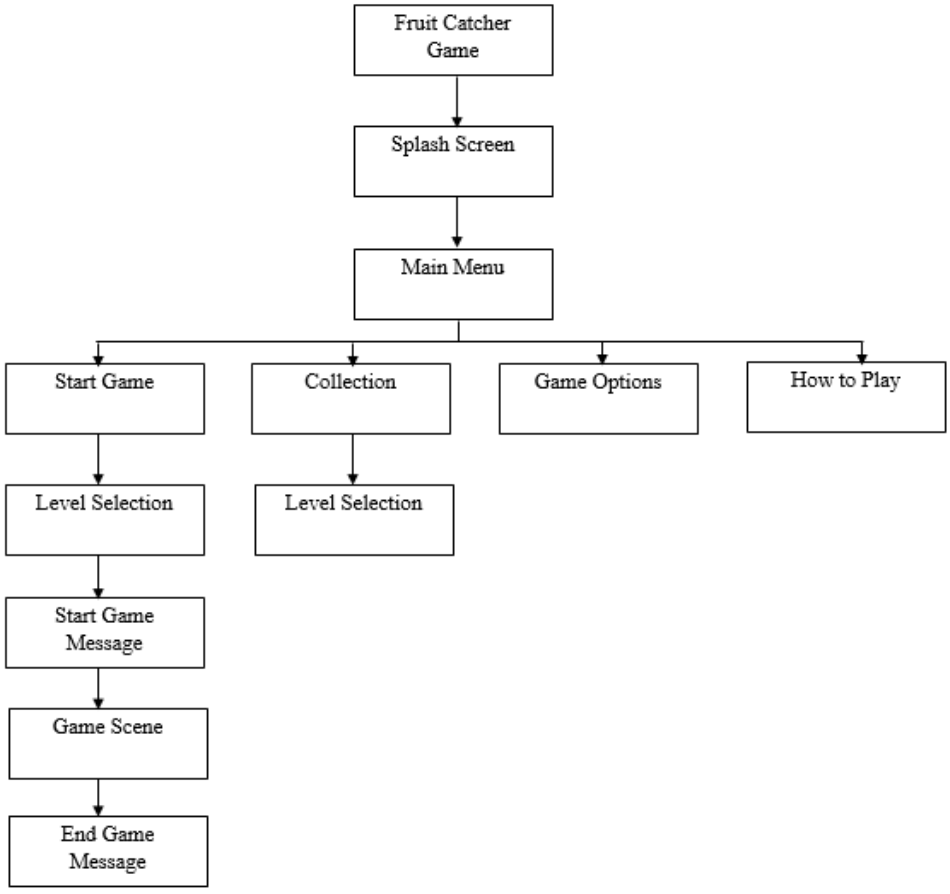


Figure 3.1: Top-down System Design

3.2 Use Case Diagram

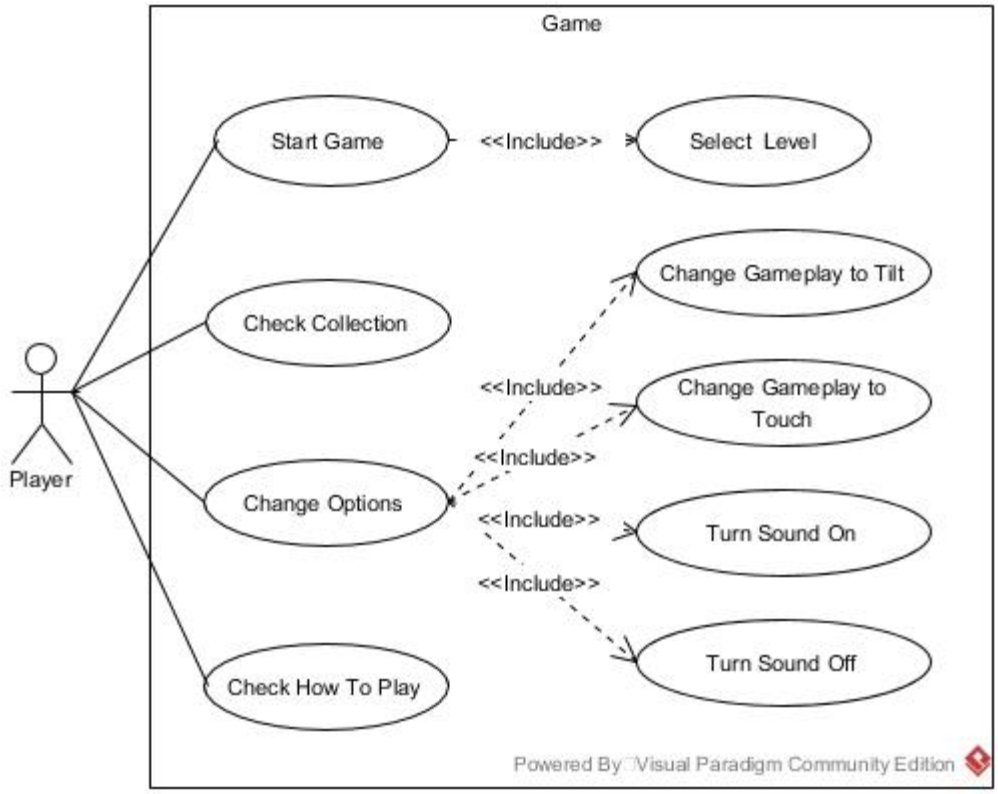


Figure 3.2: Use Case Diagram

The actor involved in the application is called player. The role of the user is to explore the game and interact the option within the application. The user can have multiple choices to operate in the main menu before the actual gameplay. From the main menu, the user can start the game by pressing the "Start Game" option which will lead the user into the next section of the application. From there, assuming the user had learnt the game mechanic and wish to proceed to the actual game play, the user will then have to select an appropriate level or by unlocking the next level depending on the player progression in the game. Once a level is selected, the game will start and the player can start playing the fruit catching game. Next, the "Check Collection" option will bring the player into another section of the application. Inside the collection section is the module where the user can check the user progression through the game. The collectable can be unlocked and view by the user after the user has completed the specific requirement in the game. Each unlockable can be acquired by completing the respective game level. This feature has integrated into the game so that the user can get the sense of accomplishment towards the game. The user also can revisit this section to get the valuable information at any time after the content has been unlocked. This will

build up an addicting effect for continuous gameplay. Furthermore, if the user wish to change or modify the settings of the game to make it more user friendly during the play time. The user can access to the “Change Option” option to make any changes available such as “Change Gameplay to tilt”, “Change Gameplay to touch”, “Turn on game sound”, and Turn off game sound”. Optimization is highly considerate to allow the user have better interactivity throughout the application. Finally, the “Check How to Play” is the last option available to the user in the main menu. In the “Check How to Play” is where the user learn the essential of the techniques to be able to play the game. A detail instruction is prepared to illustrate and point out the important key for the user during the play time to avoid any issue such as unclear instruction that leads to abandoning of the application.

3.3 Activity Diagram

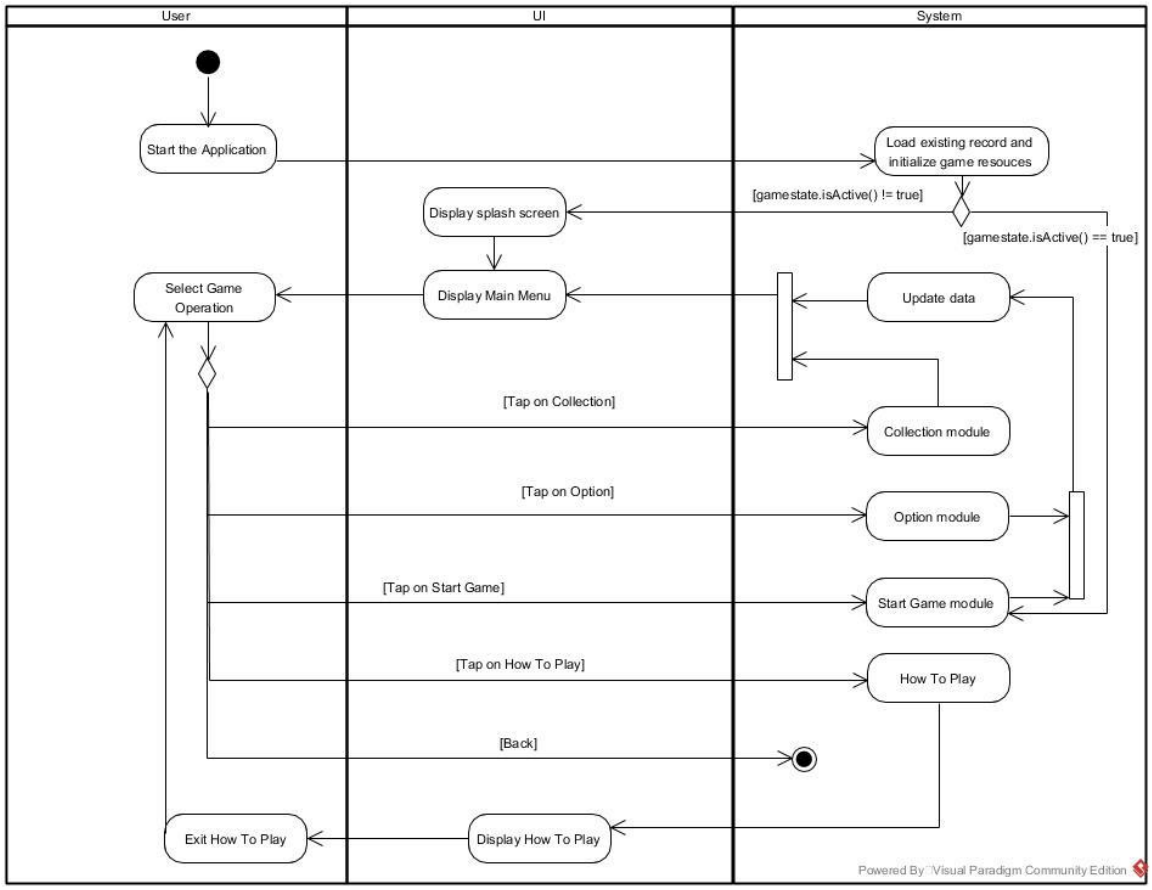


Figure 3.3: Game System Activity Diagram

The activity diagram above shown the overall flows of the modules in the game system. Once user has started the game application, the game system will load the state of the game and initialize the game resources such as images and sounds. While loading the

state of game, if gameState.isActive() is true (means game progress has been interrupted and game state is stored), the game will retrieve the game state data and display the paused game scene of the user progression of game stage that has been last played. If there is no record of state, the system will display a splash screen which is optional to be skipped by the user. After the splash screen, the system will display main menu screen which consists of several modules such as Start Game module, Collection module, Option module and How to play module for user to interact. If user chooses the Start Game module, the flow will be continued to Figure 3.4. Or else if user chooses the Collection module, the flow will be continued to Figure 3.5. Otherwise, if user chooses the Option module, the flow will be continued to Figure 3.6. If the user checks How To Play, the system will redirect the UI to How To Play screen, user can exit the How To Play screen by tapping back button to back to the main menu screen.

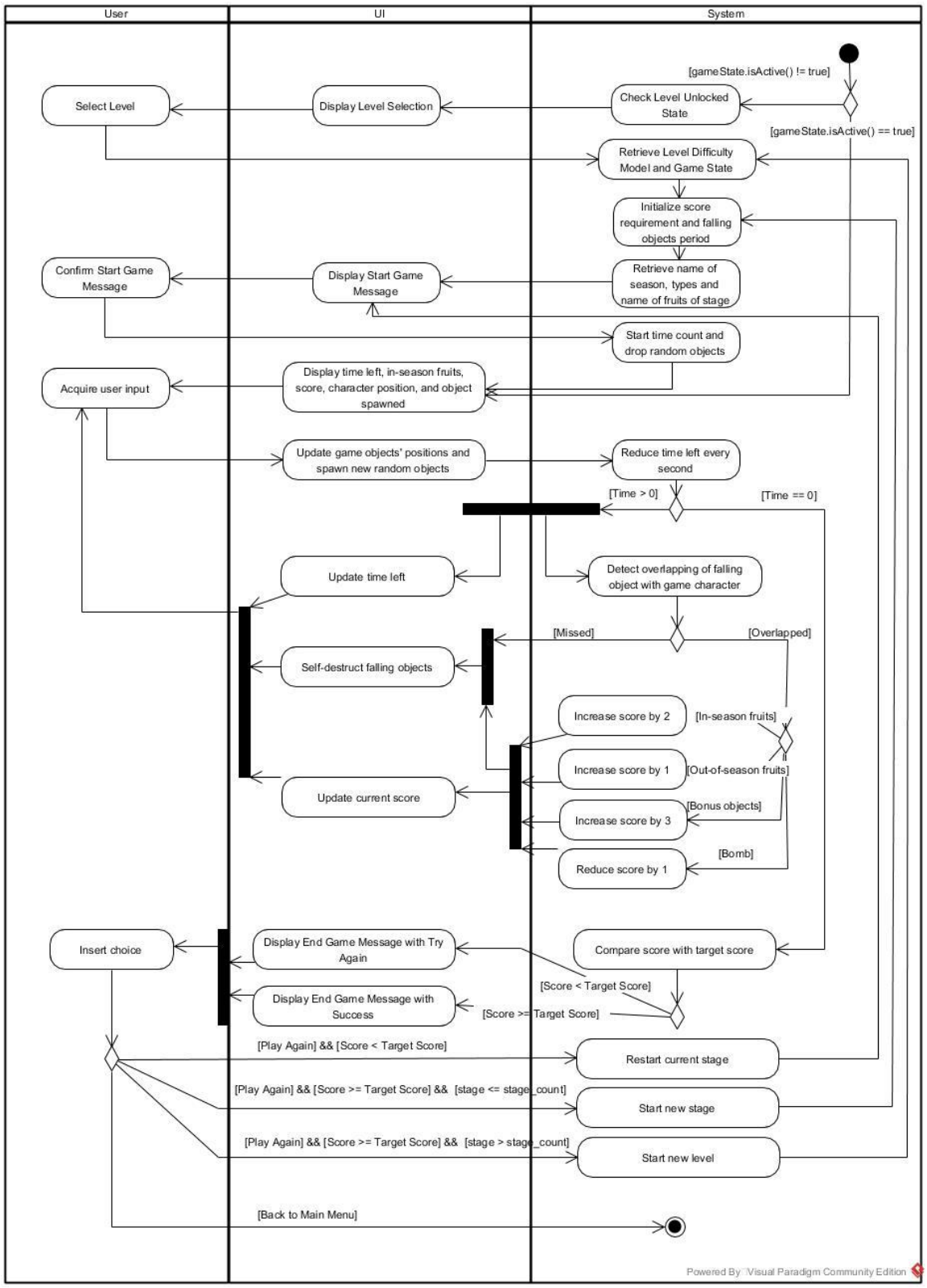


Figure 3.4: Start Game Module

While starting the game module, the system will check whether gameState.isActive() is equal to true, if yes, the state stored in JSON format will be retrieved and the stage

progression will be restored according to the data stored. If no stage progression is recorded, system will check the current level progression from shared preferences. System will display the level selection based on previous level progression. User can choose to play different levels if the user has completed the prerequisite level. After choosing the level, the system will retrieve the level difficulties and preference gameplay option stored. After that, it will initialize the first stage of the level and display the name of season, types and name of fruits and score required to pass the stage. Once the stage has started, the time will start counting down and different objects will be spawned and drop from the top of the screen. User can control the game character to catch the falling objects and different types of falling objects will affect the score differently. If the time has ran out, the stage is finished and system will display the score obtained in the stage and evaluate whether the user has passed the stage by comparing the score obtained and the score required to pass the stage. User may choose either restart the stage or exit to the main menu if user has failed the stage. If user passed the stage, user can proceed to the next stage or choose to exit to the main menu as well.

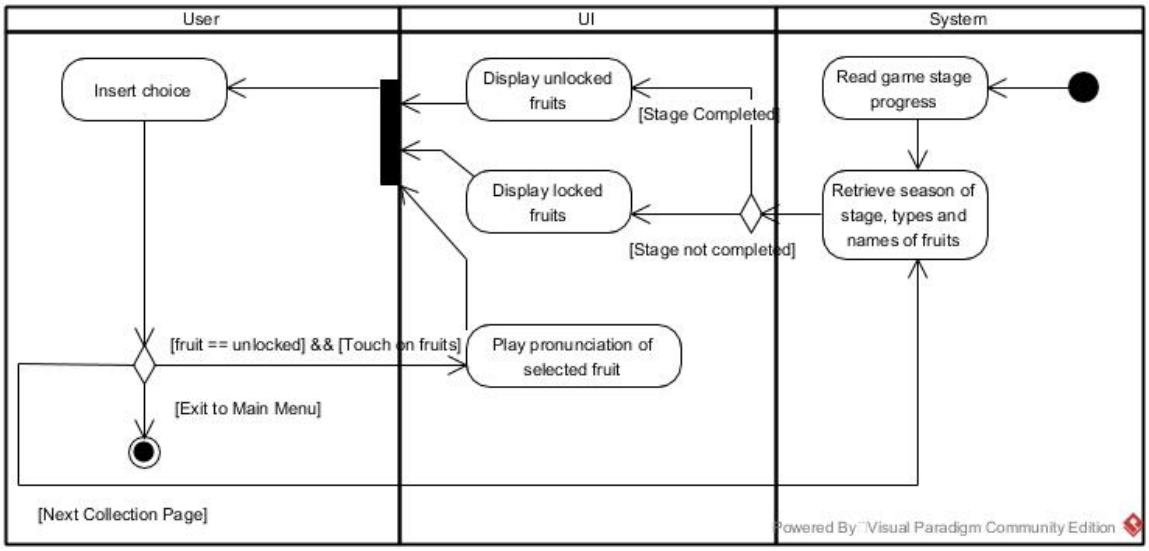


Figure 3.5: Collection Module

This module is used to track user progression of the stage in the game. If user has completed certain stage in the game, the collection of fruits will be unlocked and user can tap the unlocked fruits to play the pronunciation of the fruits. If user has not completed the stage, the fruits will be locked.

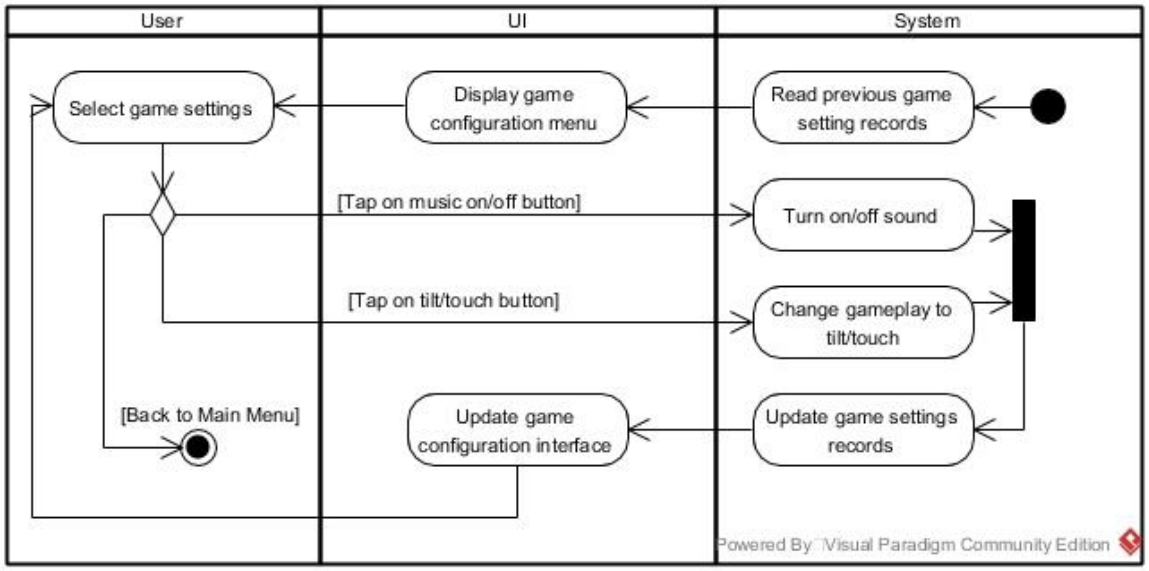


Figure 3.6: Option Module

In option module, user can manage and update the game settings. User can turns on or off the volume and changes the control of game character by tilting game screen or touching game screen. The game settings selected by user will be stored in shared preferences and will be remember every time when user starts the application.

3.4 Class Diagram

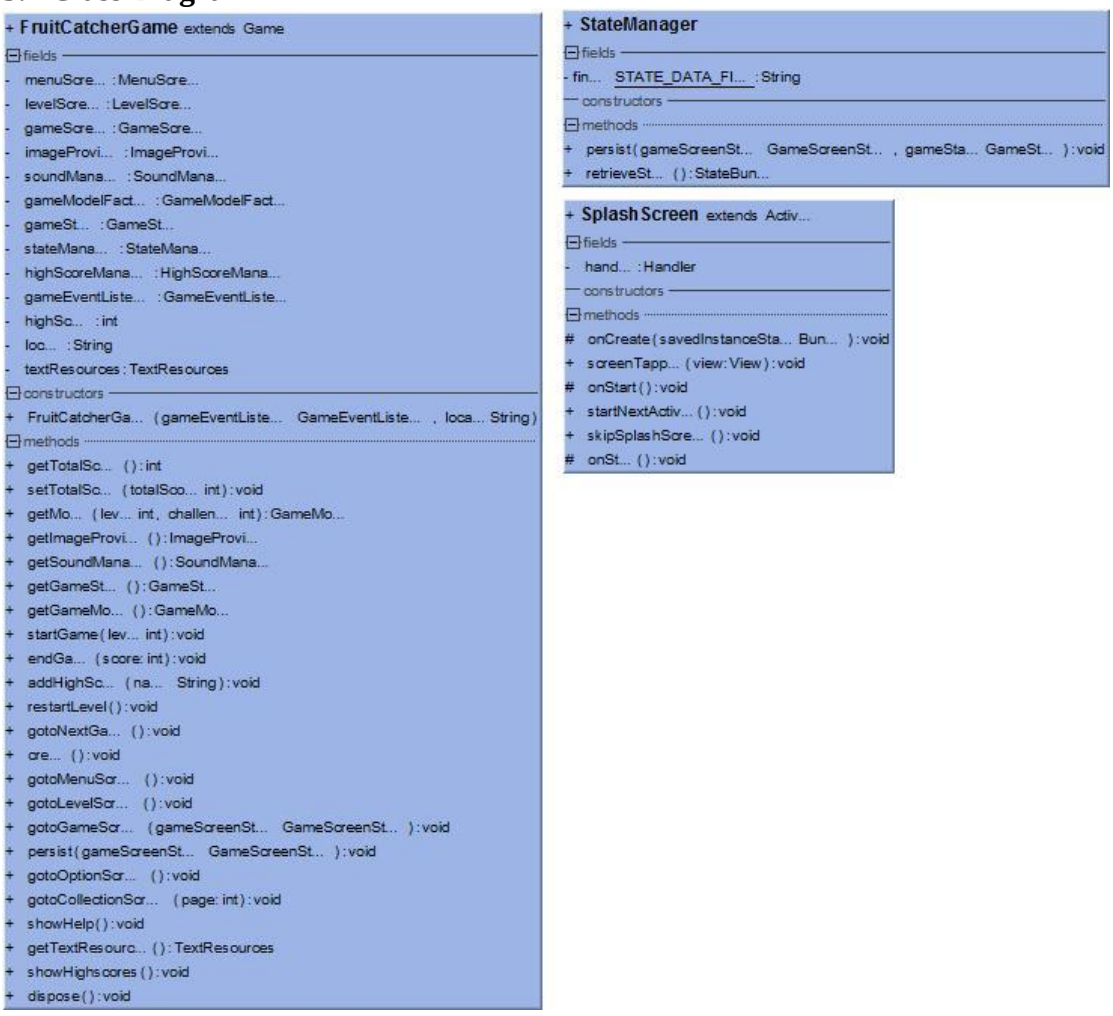


Figure 3.7: Main Activities Class Diagram

SplashScreen is the first screen displayed in the game system. A video will be called and is optional to be skipped by tapping the device's screen. FruitCatcherGame will then be created. First of all, the resources of the game will first be initialized. After that, system will check for the state bundle by calling StateManager to retrieve state data. FruitCatcherGame is used to connect all the screens consist in the game.

Figure 3.8: Screens Class Diagram

MenuScreen connects to the LevelScreen, CollectionScreen, OptionScreen and HelpScreen. LevelScreen will then connects to GameScreen. All of the Screen classes GameScreenState implements Serializable to write and read the values of current game state for examples game time, object spawned period, game character's position and score to JSON format data.

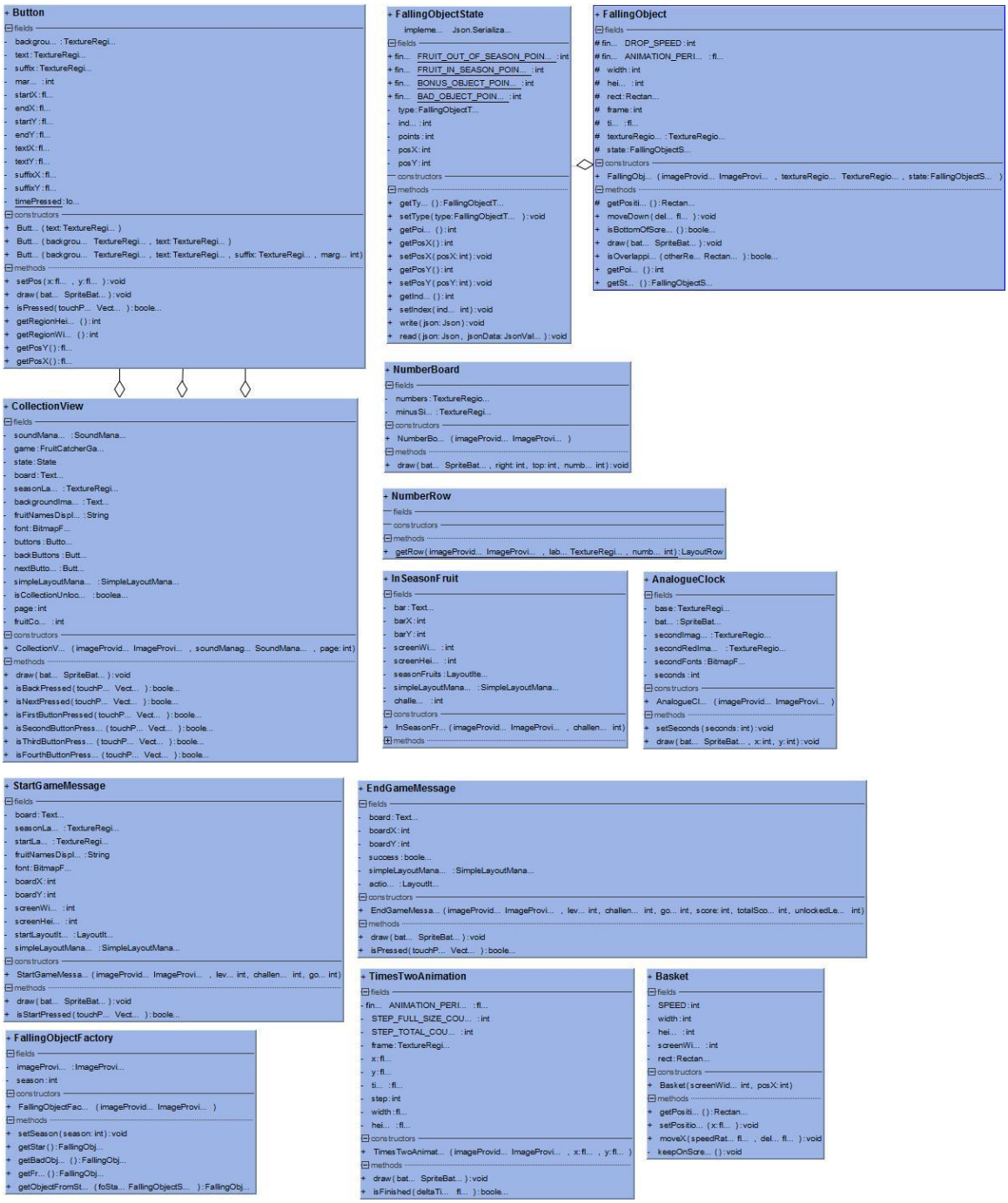


Figure 3.9: Views Class Diagram

AnalogueClock, Basket, Button, NumberBoard, NumberRow, TimesTwoAnimation and InSeasonFruit classes are view model to be used in GameScreen class to show user about information of the stage. FallingObject class is used to initialize the image, size, drop speed and movement of falling objects. FallingObjectFactory class is used with FallingObject to generate different kinds of falling objects such as fruits, bonus object and bomb. FallingObjectState class is similar to GameScreenState which has implemented Serializable to write and read the values and positions of current falling objects in JSON format data while the game is interrupted. StartGameMessage and EndGameMessage classes are to show the requirements and summary in the beginning and end of the GameScreen class is called. CollectionView is used in CollectionScreen class to show each stage of collection of fruits.

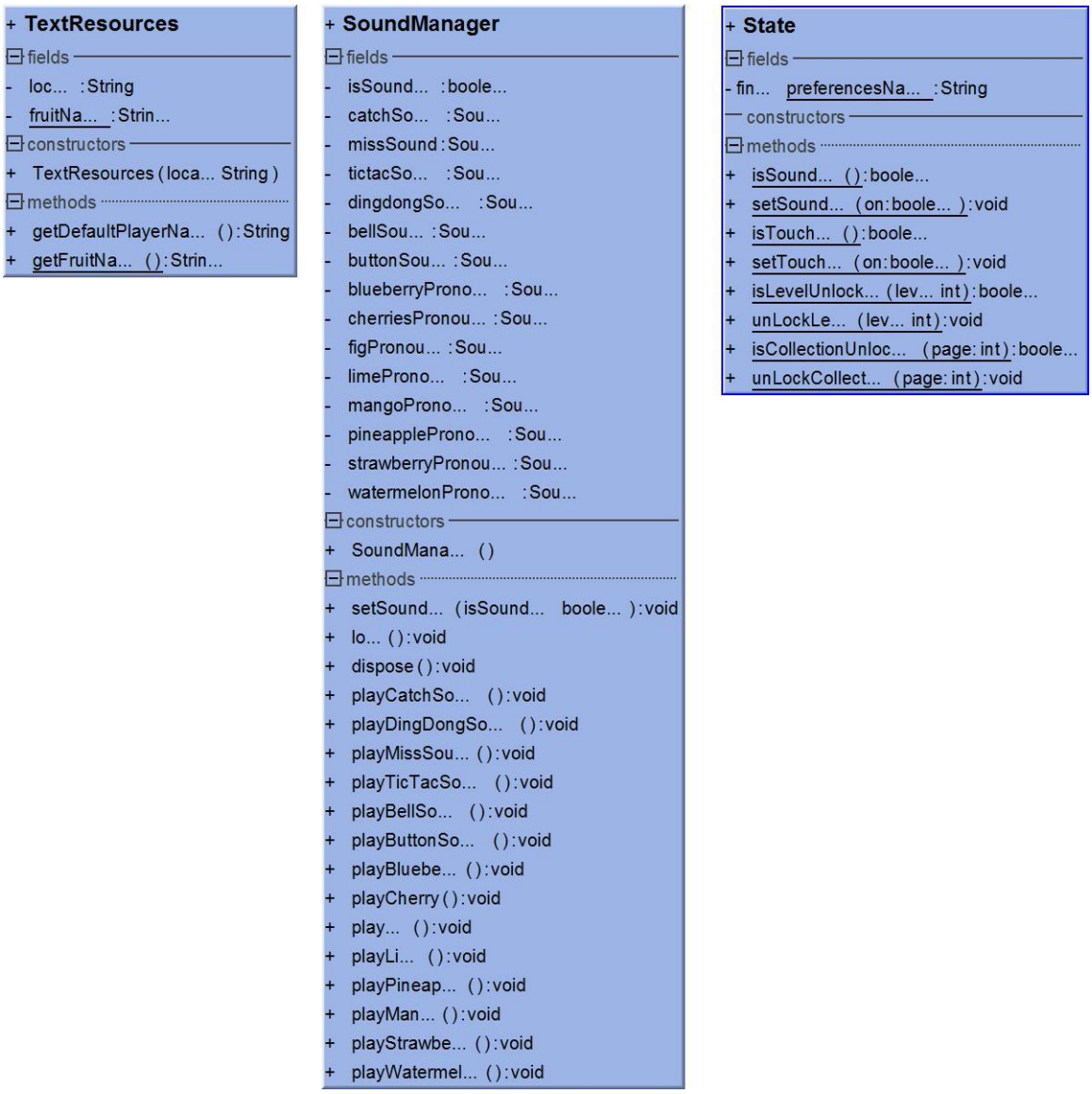


Figure 3.10: Text Resources, Sound Manager and State Class Diagram

SoundManager class is used to organize sound effects and pronunciation of fruits. In order to generate sounds and use the functions from SoundManager, *soundManager.load();*has to be called in every Screen. TextResources class is to store some String values that going to be displayed using BitmapFont in the activity. State class is different from GameScreenState class, while GameScreenState class is storing the current stage of data whereas State class is storing the game options selected by user in OptionScreen.

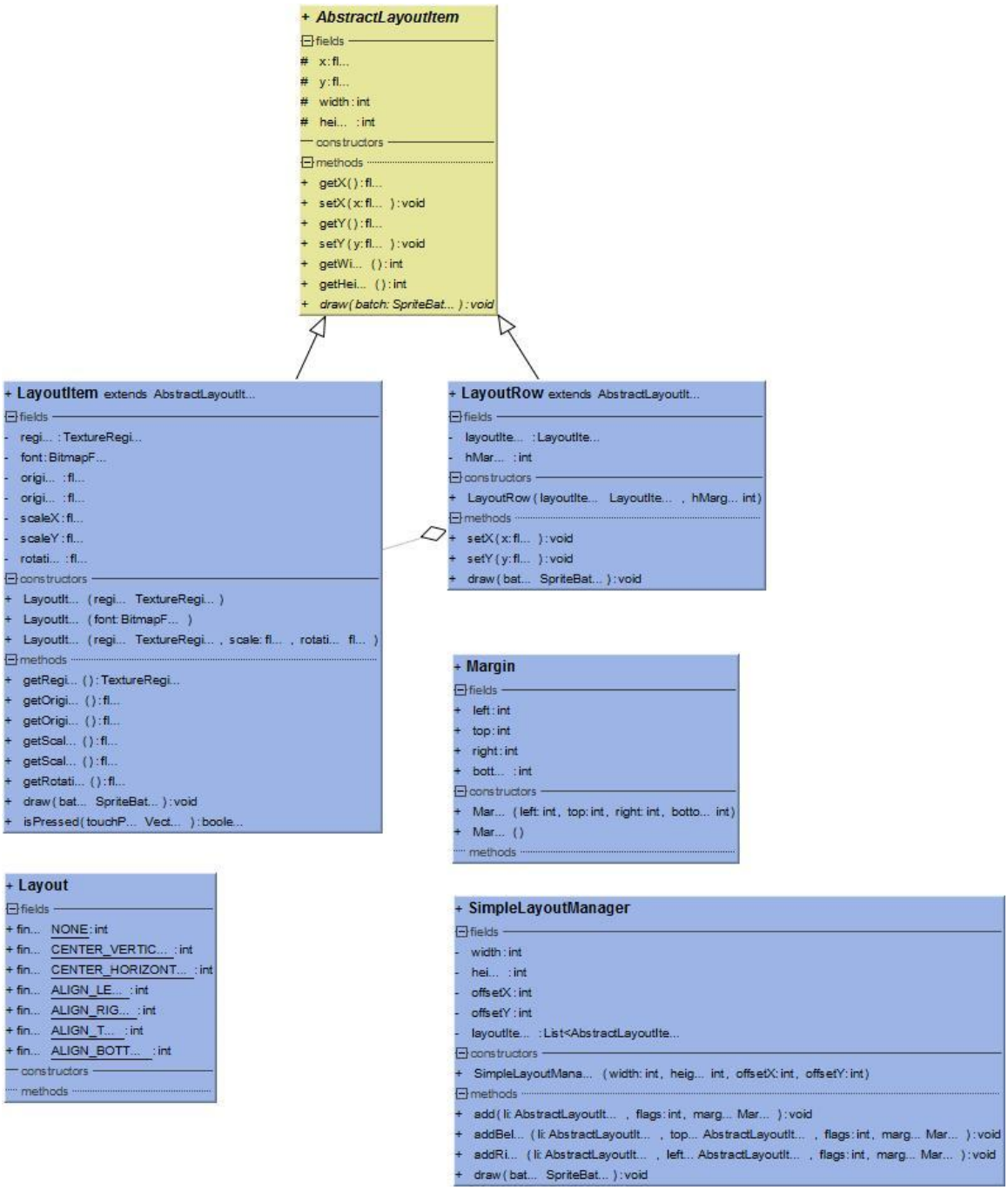


Figure 3.11: Layouts Class Diagram

AbstractLayoutItem class is an abstract class that cannot be instantiated. It is used in SimpleLayoutManager class to stores data such as height, weight, x and y. Layout class is used to store some fixed values (static final) while configuring the margin in SimpleLayoutManager. LayoutItem is a class model to place TextureRegion (images and fonts) and initialize the layout, size and scale of the TextureRegion. LayoutRow class can place several LayoutItems inside it and then can be place inside SimpleLayoutManager with the Margin to display items. Margin class is a class model

to store integer values of left, right, top and bottom and to be used in the spacing between LayoutRow in SimpleLayoutManager. SimpleLayoutManager is used to store the LayourRow and display in View such as StartGameMessage and EndGameMessage.

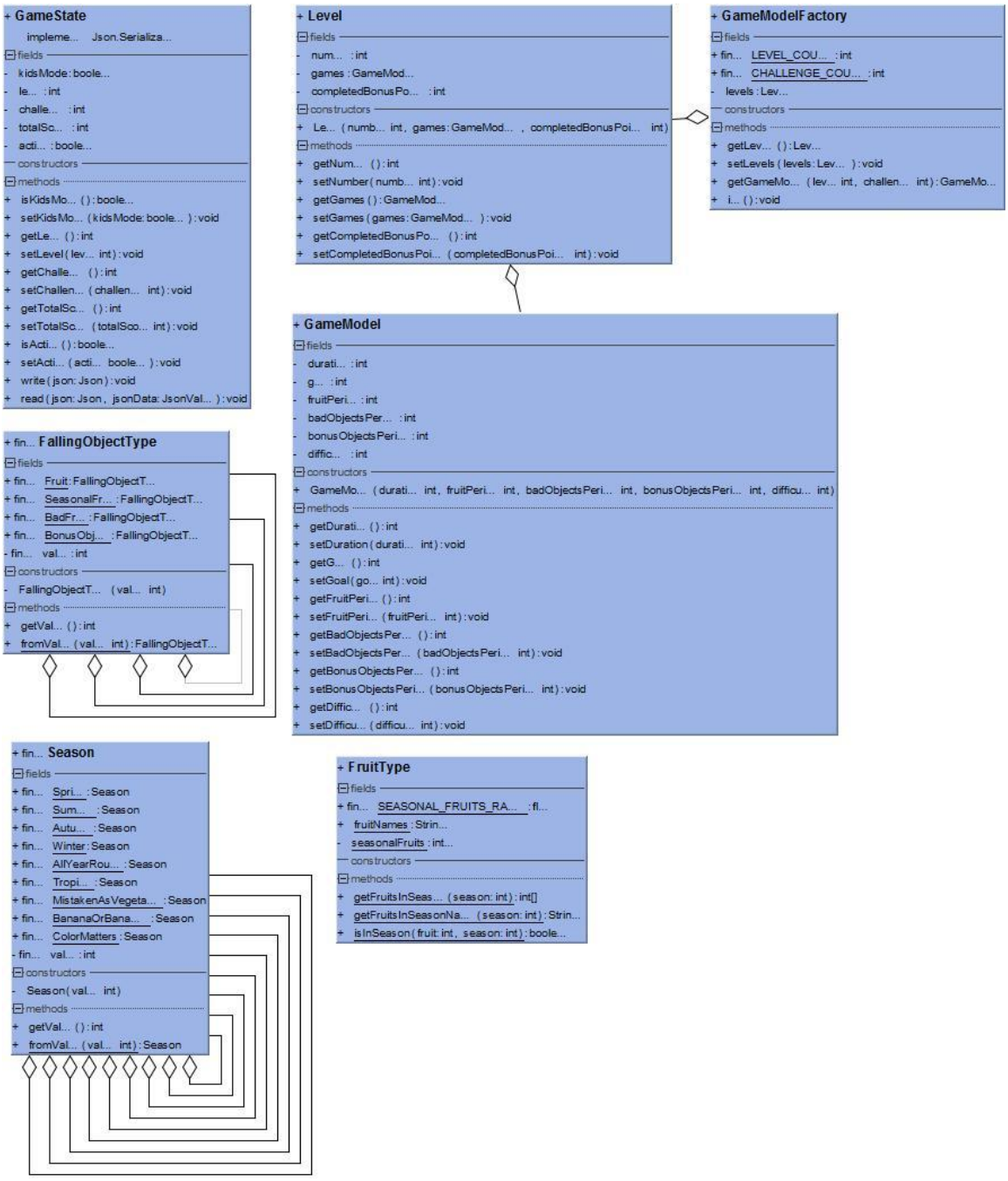


Figure 3.12: Models Class Diagram

GameModelFactory class is a model to store the values to manipulate the difficulties of each level and stages. Whereas GameModel class gets the values from GameModelFactory and initializes all the stages in game which will be called by GameScreen class. GameState class implements Serializable as well to read and write

the game progression of user in JSON data. FallingObjectType, FruitType, Level and Season classes store values of the respective models.

3.5 Storyboard

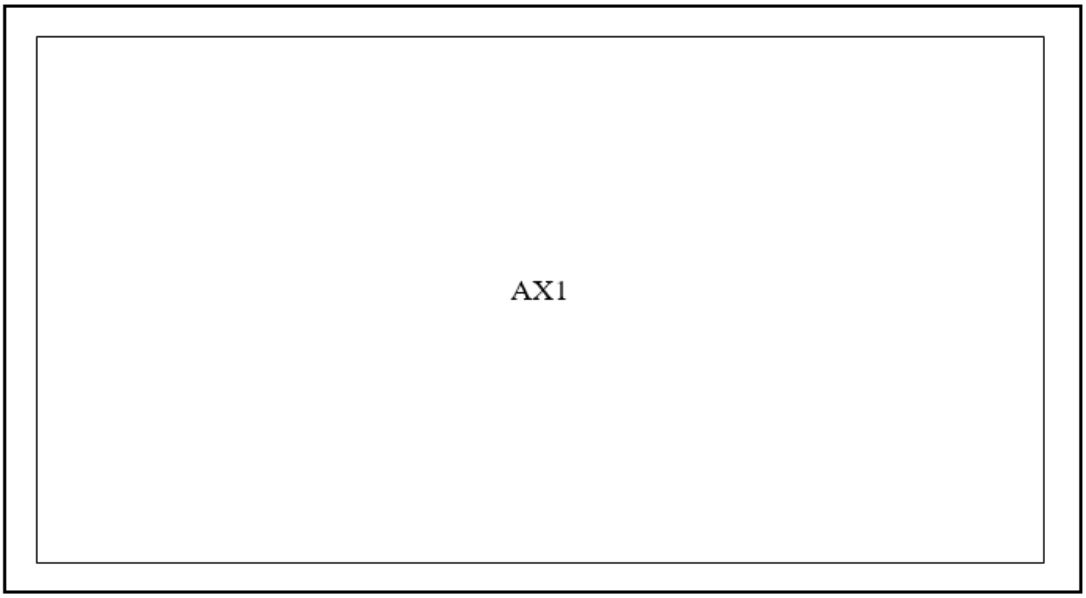


Figure 3.13: Splash Screen

Element	Description
AX1	Animation which the logo of the game will be shown.

Table 3.1: Splash Screen

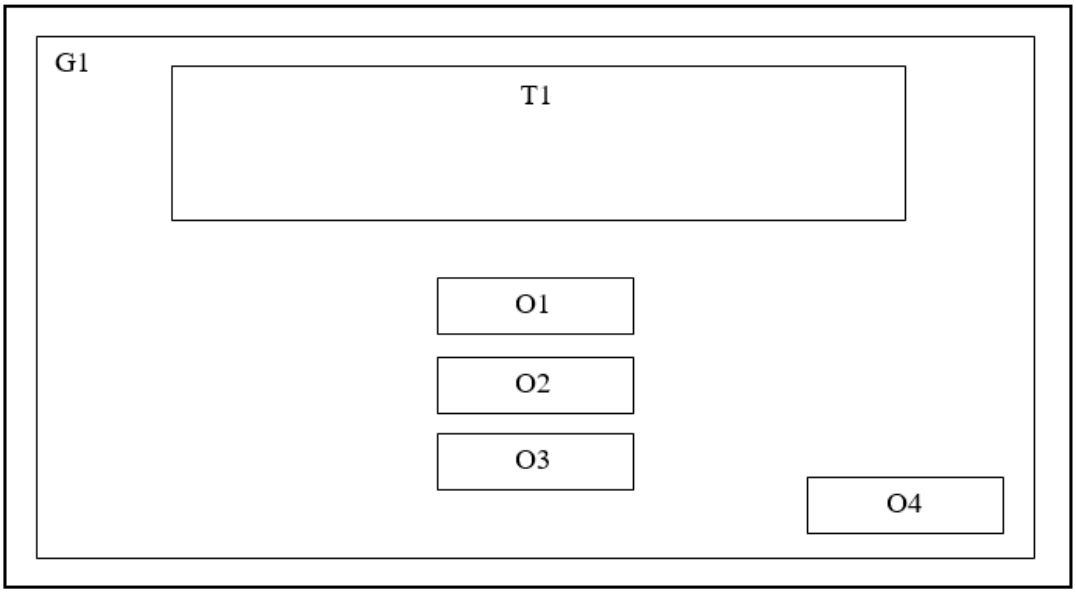


Figure 3.14: Main Menu

Element	Description
G1	Graphic that display the picture of main menu's background.
T1	Title that display the name of the game.
O1	Option button that display a text to let user link to "Start Game".
O2	Option button that display a text to let user link to "Collection".
O3	Option button that display a text to let user link to "Option".
O4	Option button that display a text to let user link to "How To Play"

Table 3.2: Main Menu

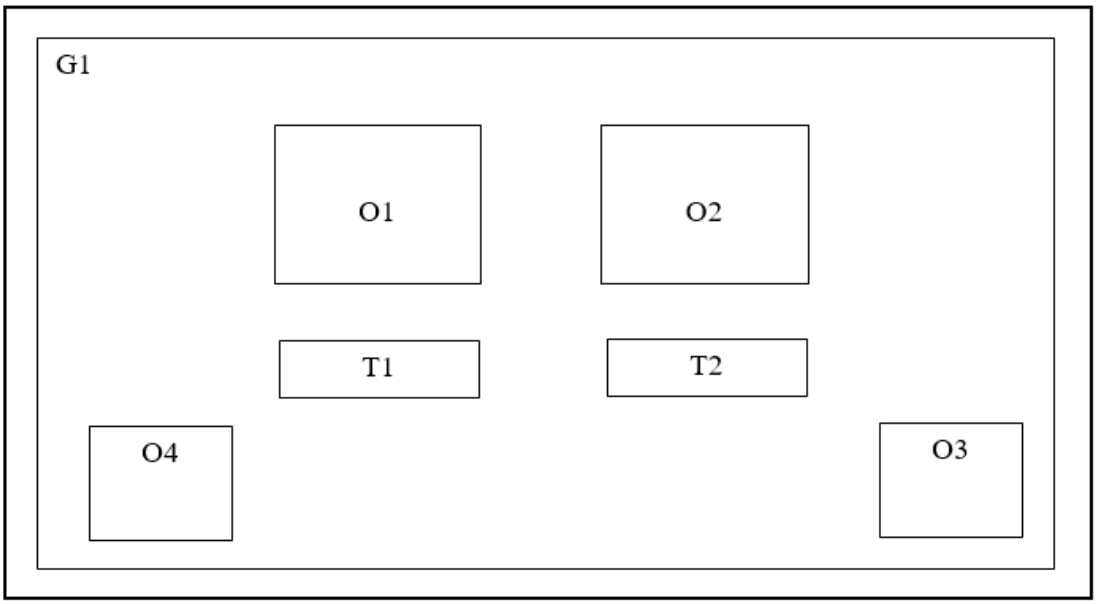


Figure 3.15: Option

Element	Description
G1	Graphic that display the picture of option's background.
O1	Option button that display a figure to let user switch the gameplay by touch.
O2	Option button that display a figure to let user switch the gameplay by tilt.
O3	Option button that display a figure to let user switch the sound on and off.
O4	Option button that display a figure to let user back to "Main Menu"
T1	Text that display "Touch".
T2	Text that display "Tilt".

Table 3.3: Option

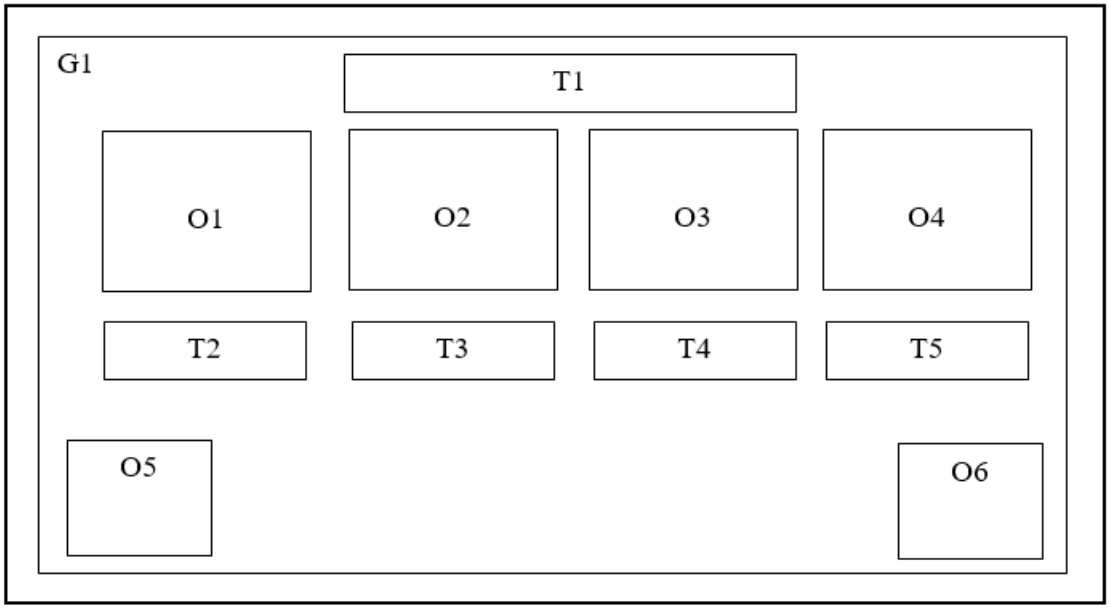


Figure 3.16: Collection

Element	Description
G1	Graphic that display the picture of collection's background.
T1	Text that display title of season for current collection.
T2	Text that display name of first fruit.
T3	Text that display name of second fruit.
T4	Text that display name of third fruit.
T5	Text that display name of fourth fruit.
O1	Option button that display a picture to pronounce the name of first fruit.
O2	Option button that display a picture to pronounce the name of second fruit.
O3	Option button that display a picture to pronounce the name of third fruit.
O4	Option button that display a picture to pronounce the name of fourth fruit.
O5	Option button that display a picture to let user back to "Main Menu"
O6	Option button that display a picture to let user link to next season of collection.

Table 3.4: Collection

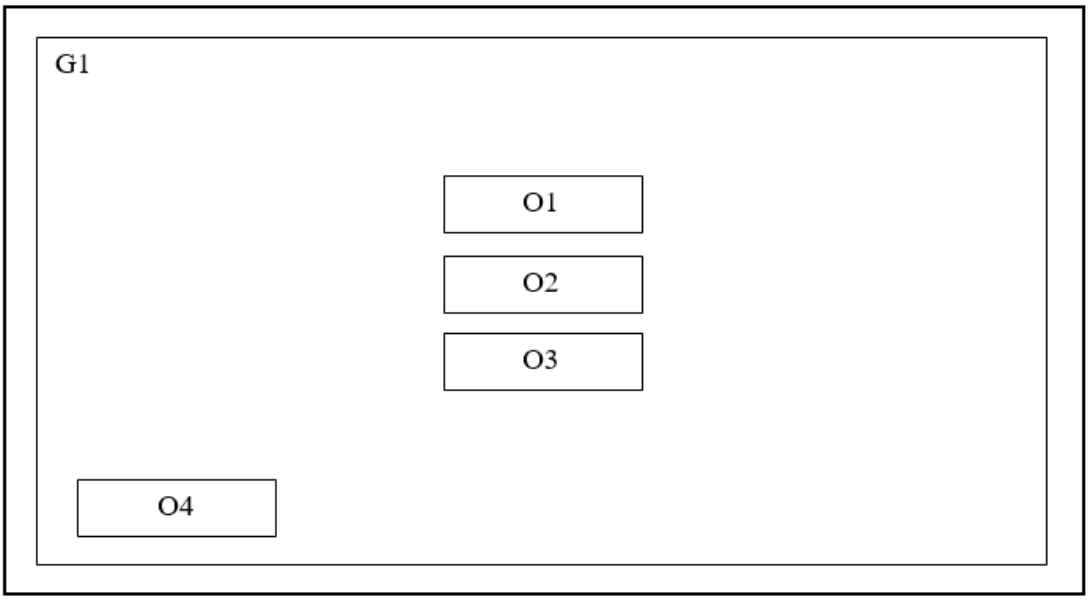


Figure 3.17: Select Level

Element	Description
G1	Graphic that display the picture of level selection's background.
O1	Option button that display a text to let user link to "Level 1".
O2	Option button that display a text to let user link to "Level 2".
O3	Option button that display a text to let user link to "Level 3".
O4	Option button that display a picture to let user back to "Main Menu".

Table 3.5: Select Level

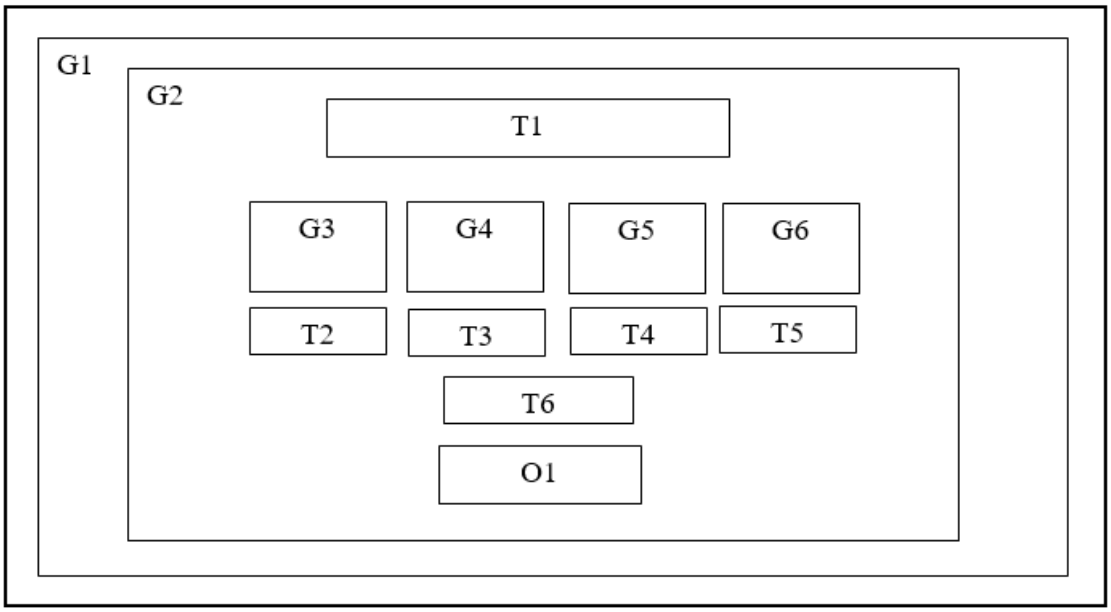


Figure 3.18: Start Game Message

Element	Description
G1	Graphic that display the picture of start game message's background.
G2	Graphic that display the picture of start game message's board.
G3	Graphic that display the picture of first fruit of the season.
G4	Graphic that display the picture of second fruit of the season.
G5	Graphic that display the picture of third fruit of the season.
G6	Graphic that display the picture of fourth fruit of the season.
T1	Text that display the name of the season of current stage.
T2	Text that display the name of the first fruit of the season.
T3	Text that display the name of the second fruit of the season.
T4	Text that display the name of the third fruit of the season.
T5	Text that display the name of the fourth fruit of the season.
T6	Text that display the requirement score to pass of current page.
O1	Option button that display a text to let the user to start the game.

Table 3.6: Start Game Message

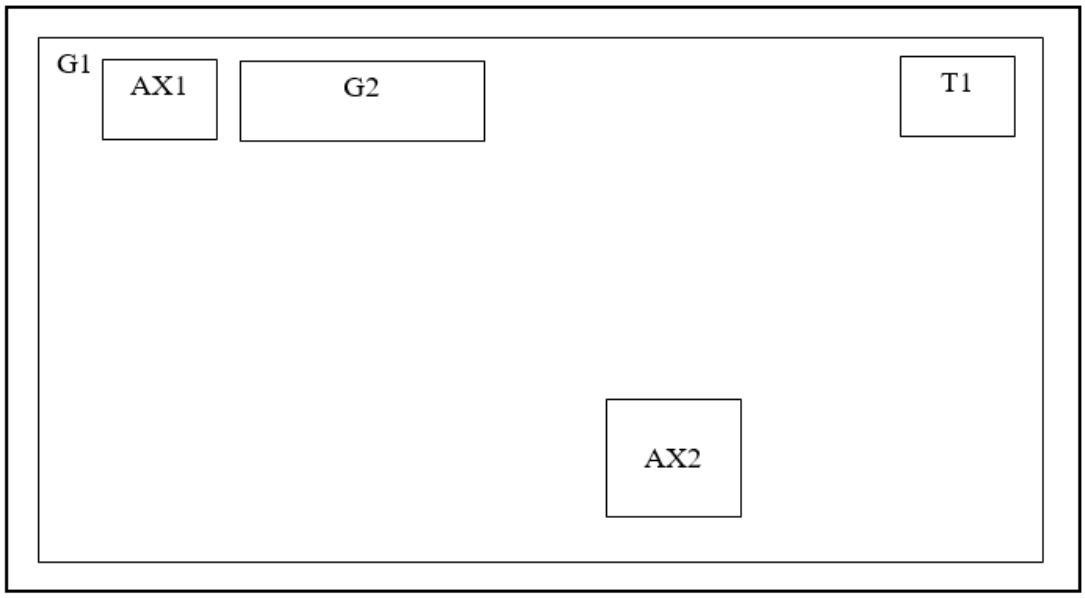


Figure 3.19: Game Scene

Element	Description
G1	Graphic that display the picture of game scene's background.
G2	Graphic that display the picture of current season fruits.
T1	Text that display the current amount of score.
AX1	Animation that display the time left for the stage.
AX2	Animation that display the character that holding the fruit basket.

Table 3.7: Game Scene

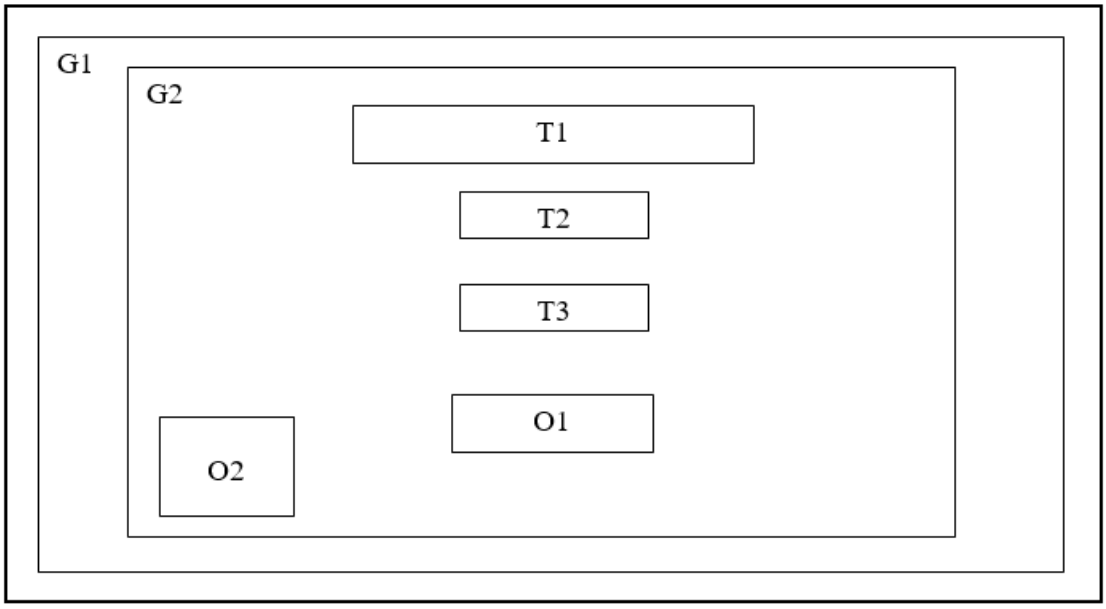


Figure 3.20: End Game Message

Element	Description
G1	Graphic that display the picture of start game message's background.
G2	Graphic that display the picture of start game message's board.
T1	Text that display "Success" if user passed the level or "Try Again" if user failed to pass the level.
T2	Text that display the score get in the stage.
T3	Text that display the total score get in all the stages.
O1	Option button that display a text to let the user to start the next stage or restart the current level.
O2	Option button that display a picture to let the user to back to main menu.

Table 3.8: End Game Message

3.6 Implementation Issues and Challenges

Beautiful and attractive graphical contents such as images and animation are a crucial features of a good game. This becomes a challenges since the lack of drawing skill and creativity. Most of the graphics have to be get on free image sources on internet and edit if necessary. The images will probably get from different website and are drawn by different artist. The result of including them in the same game might let the users feel abrupt and untidy. To avoid this, more time and effort are needed to be spend on the gather of graphics. Furthermore, pronunciation of name of the fruits are required in this project. This helps the players in listening skills. It might be troublesome with the recording process and some voice acting skills with good pronunciation will be required. In order to solve this, some online tools in converting text to speech translator will be needed.

3.7 Timeline

TASK NAME	START DATE	DAYS	END DATE	DURATION* (WORK DAYS)	DAYS COMPLETE*	PERCENT COMPLETE
Analysis Phase						
Develop problem statement	10/15	0	10/17	3	3	100%
Develop project scope	10/18	3	10/18	1	1	100%
Develop project objectives	10/19	4	10/20	2	2	100%
Develop project objectives	10/21	6	10/22	2	2	100%
Define impact, significance and contribution	10/23	8	10/24	2	2	100%
Define background information	10/25	10	10/26	2	2	100%
Literature review	10/27	12	10/28	2	2	100%
Critical remark of previous work	10/29	14	10/31	3	3	100%
Design Phase						
Select develop tools	11/1	17	11/2	2	2	100%
Design User Requirement	11/3	19	11/4	2	2	100%
Develop verification plan	11/5	21	11/6	2	2	100%
Develop system flow diagram	11/7	23	11/8	2	2	100%
Develop storyboards	11/9	25	11/11	3	3	100%
Development Phase						
Collect elements	11/12	28	11/13	2	2	100%
Develop system prototype	11/14	30	11/16	3	3	100%
Intergrate prototype	11/17	33	11/19	3	3	100%
Prototype testing	11/20	36	11/21	2	2	100%
Review prototype	11/22	38	11/22	1	1	100%
FYP 1 report submission	11/23	39	11/23	1	1	100%
FYP 1 presentation	11/28	44	11/28	1	1	100%

Figure 3.21: Timeline of FYP1

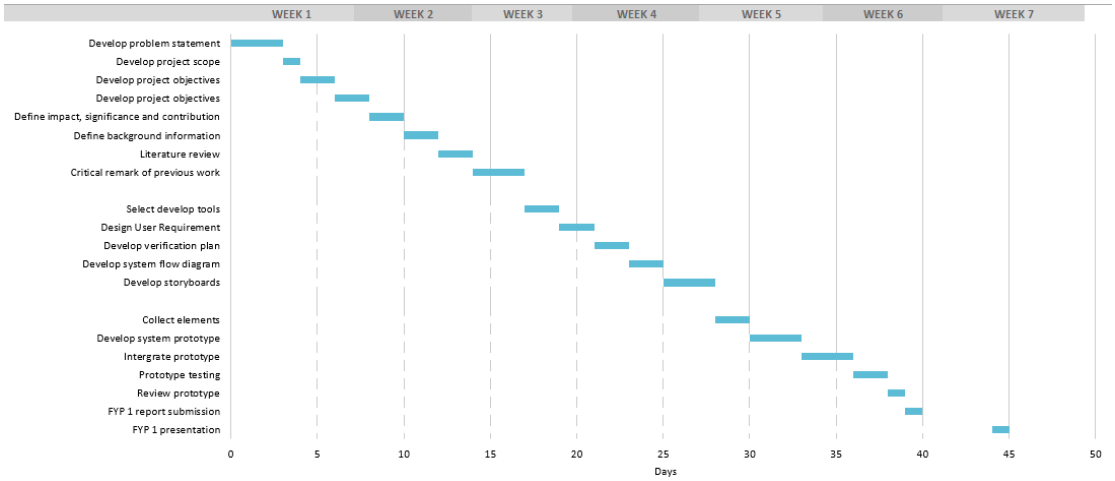


Figure 3.22: Gantt chart of FYP1

TASK NAME	START DATE	DAYS	END DATE	DURATION* (WORK DAYS)	DAYS COMPLETE*	PERCENT COMPLETE
Development Phase						
Develop each module	1/14	0	1/25	12	12	100%
Write the code for module needed	1/28	12	2/4	8	8	100%
Testing each module	2/5	20	2/7	3	3	100%
Fix bugs	2/8	23	2/13	6	6	100%
Intergrate all modules	2/18	29	2/25	8	8	100%
Testing the prototype	2/26	37	2/27	2	2	100%
Fix bugs	2/28	39	3/4	5	5	100%
Review prototype	3/5	44	3/6	2	2	100%
Implementation Phase						
Design Black-box testing	3/7	46	3/12	6	6	100%
Integrate black-box testing	3/14	52	3/15	2	2	100%
Record the test result	3/18	54	3/20	3	3	100%
Fix bugs and further enhancement	3/21	57	3/25	5	5	100%
Test the application	3/26	62	3/29	4	4	100%
Evaluation Phase						
Evaluate application	4/1	66	4/2	2	2	100%
Further enhancement	4/3	68	4/5	3	3	100%
Submission of the FYP2	4/8	71	4/8	1	1	100%
FYP2 presentation	4/17	72	4/17	1	1	100%

Figure 3.23: Timeline of FYP2

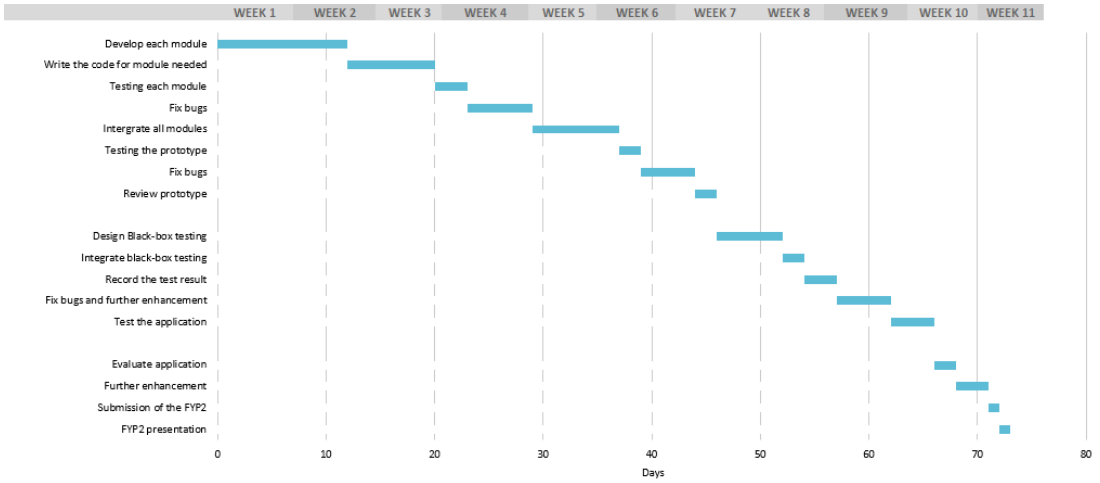


Figure 3.24: Gantt chart of FYP2

CHAPTER 4: SYSTEM METHODOLOGY AND REQUIREMENTS

4.1 Methodology

Prototyping model is chosen to be the software development model of this project. A prototype will be constructed, examined and reworked as necessary until a best prototype is eventually completed. Trial-and-error process will be taken place in order to complete the prototype. The prototype in this project will be developed based on presently known requirements. Design, coding and testing phrases will be done during the development of the prototype.

Diagram of Prototype model:

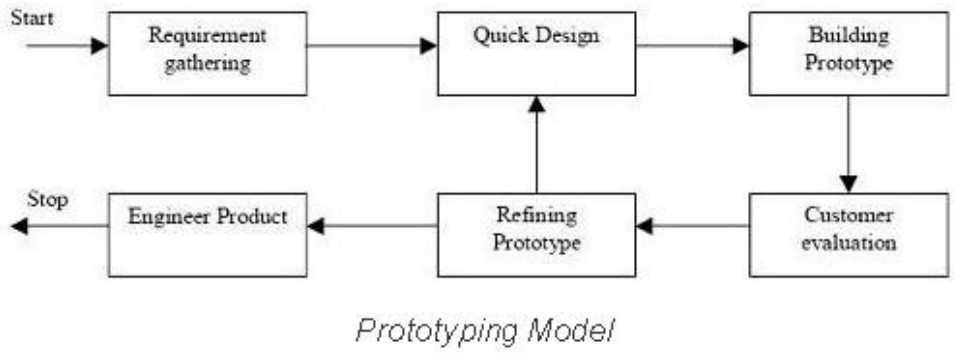


Figure 4.1: Prototyping Model

A prototyping model will start with identifying and analysing requirements of the system. The requirements are defined as detail as possible for example the genre of game to be developed and the platform of the system. Research on similar background of the system will be done in order to have more knowledge and understanding regarding to the background of the project especially in term of story, contents and gameplay.

After identifying the requirements in the requirements analysis phrase, the project will undergo design phrase. A preliminary design for the system will be created and will be used to construct the first prototype. The system might still likely to change and unclear in details in this stage (Dinesh n.d.). Storyboard will be used to draw and

plan the design flow of the application. Some of the graphics and sounds have to be draw or get on the internet which without copyright.

Implementation phrase is where the coding phrase of the project takes place. Android Studio has been chose to help me in the creation of this project. The graphical images and music that has prepared will be included in the application. The first prototype will be created as the preliminary work in this phrase of project.

In the testing phrase, black box testing is used to detect errors and bugs. Any errors and bugs found in the prototype will be fixed to improve until the best version of prototype has been made. Review from users of the prototype will be collected and analysed to be used in the phrase of refining of the prototype. This stage will be repeated until a complete product has been developed by adding new function and requirements each time. Black-box testing consists of several techniques such as equivalence partitioning, boundary value analysis, state transition test, decision table tests and use case testing. Use case testing is a form of black box testing technique based on the input of flows but not the data. Therefore, use case testing is applied in this project because no data is needed to be input by user in this project.

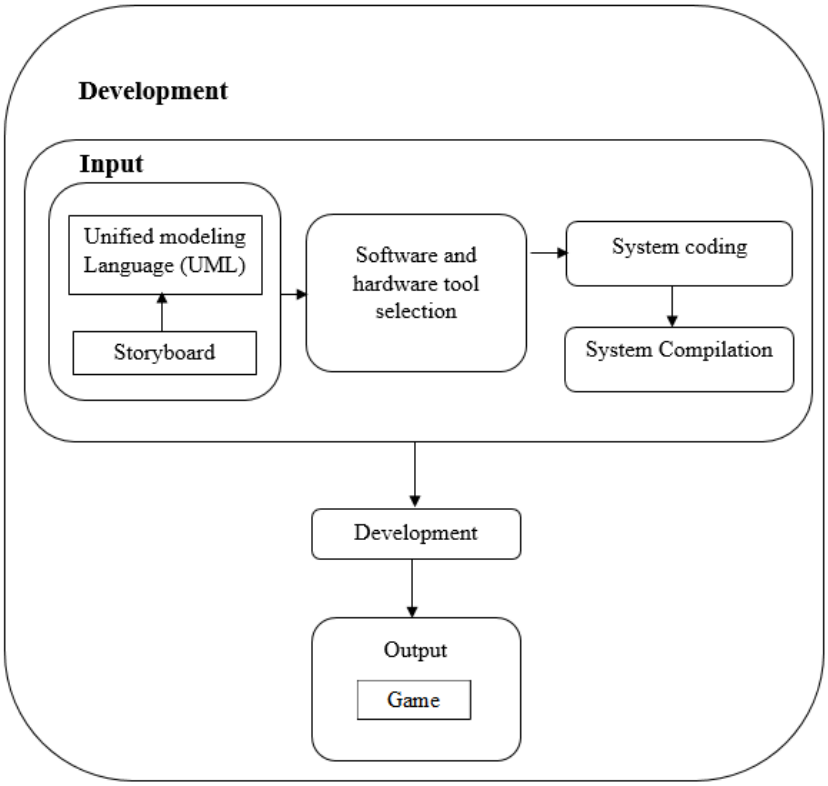


Figure 4.2: Development Flow Diagram

4.2 Tools and Technology involved

Platform:

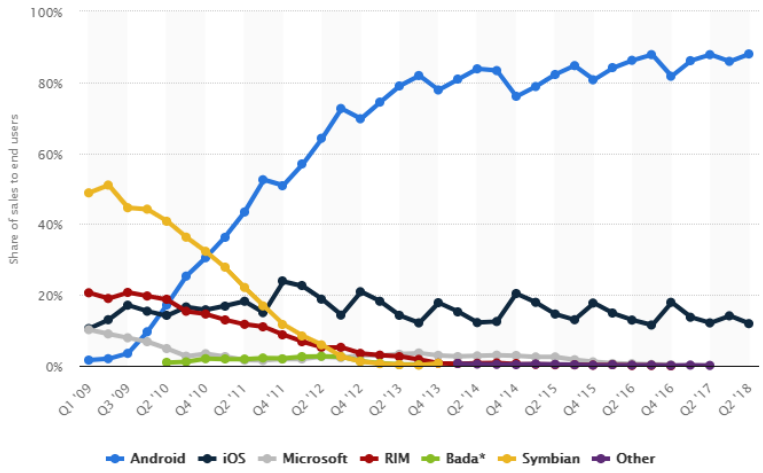


Figure 4.3: Global market share held by leading smartphone OS (Sales of end user) from 2009 to 2018 (Statista, 2018)

Android: Android is chosen to be the platform of the application in this project because of there is higher population of users using smartphone with android platform (Statista, 2018). The mobile game application is developed with a minimum SDK of API level 15 (Android 4.0 - Ice Cream Sandwich). The application targeting mobile devices with API 28 and later.

Programming Language:

Java: It is an object-oriented programming language and one of the most famous language in use. LibGDX as a game development application framework and also written primarily in Java is also implemented in the mobile application.

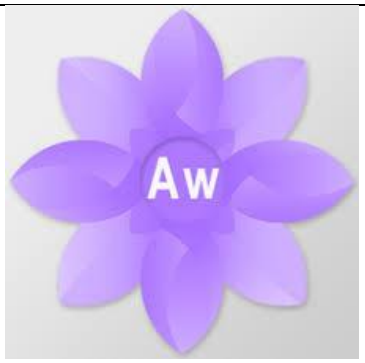
XML: Extensible markup language (XML) is a lightweight markup language used to describe data. It is scalable and easy to use in designing Android layouts.

JSON: JavaScript Object Notation (JSON) is a lightweight data-interchange format used to parse and generate data. It is a text format that easy to use in storing and exchanging data.

Storage:

Local Phone Storage (Shared Preferences): The mobile application only required a small collection of key-values to store the game progress and user preference options. Thus the local storage is selected to be used to store and retrieve application's values.

Software:

	• Android Studio - Official integrated development environment (IDE) for Google's Android OS, built on JetBrains' IntelliJ IDEA software and designed especially for Android development.
	• LibGDX - Java game development framework that supports a unified API that are able to be used across all supported platforms.
	• Artweaver - Painting tool with a large set of predefined genuine brushes for users to paint creatively.
	• Texture Packer - A sprite sheet creation editor that organizes and optimizes sprite sheets for game. It supports many game engines including LibGDX and Unity.

	• Animaker - An online DIY animation video maker that provides user a large collection of animated resources including pre-built characters and templates to create animated video.

Table 4.1: Software used table

Hardware:

Mobile Device with Android OS for system application implementation and testing.

Operating System	Android v8.0 (Oreo)
Processor	Octa-core (4x2.4 GHz Cortex-A73 & 4x1.8 GHz Cortex-A53)
Graphics	Mali-G71 MP8
RAM	4 GB
Storage	64 GB
Display	5.9 inches (96.0 cm^2), 1080 x 1920 pixels (16:9 ratio)

Table 4.2: Mobile Device Requirements

Personal Computer for mobile application development.

Operating System	Microsoft Windows 10 Home
CPU	Intel® Core™ i5-5200U CPU @ 2.20GHz
GPU	NVIDIA GeForce GT 920M
RAM	4.00 GB

Table 4.3: Personal Computer Requirements

4.3 User Requirements

Functional requirements are determined by using use cases created in Chapter 3.2 which is based on the game design specification document. It illustrates the interaction between user and game system. It also allows the decomposition of game software functionality into small chunks of functionality.

User Perspective

- User shall be able to play the fruit catching game.
- User shall be able to choose the level they want to play after complete certain requirement.
- User shall be able to change the style of gameplay they preferred.
- User shall be able to check the collection of fruits after they complete certain level.
- User shall be able to check the way to play the game through “How to Play”.
- User shall be able to check the requirements of the stage before starting the game.
- User shall be able to control the game character to catch the fruits.
- User shall be able to check the time left of current stage.
- User shall be able to view the score they got in current stage.
- User shall be able to view the score they got after completion of stage.
- User shall be able to know whether they have passed current stage.
- User shall be able to continue the current stage progress after returning to the game from an interruption.

System Perspective

- System shall be able to spawn fruits for user to catch.
- System shall be able to record the user progression of the game.
- System shall be able to store the preference options of user.
- System shall be able to count the total score of user after completion of stage.

4.2 Non-Functional requirement

Non-functional requirements are established based on game design, game objectives and academic problem specification.

Environmental Requirements

- System shall be able to run on all Android OS mobile devices.
- System shall only be playable in landscape device orientation.
- System shall be able to support all kind of screen resolutions.

Performance Requirements

- System shall be able to respond to the requests of user with no or minor delay.
- System shall be able to retrieve the game state before pause if the game has been interrupted by incoming call and etc.
- System shall be able to response user request on skipping Splash Screen.

Usability Requirements

- System shall be easy and simple to understand and use.
- System shall use simple English while giving instruction on the gameplay since the users are targeting post-school children.

CHAPTER 5: SYSTEM IMPLEMENTATION AND TESTING

5.1 Game Scenes Concept and Description

As fruits fall from the top of the screen, user can try to catch as many fruits as possible. At the same time, user is recommended to get in-season fruits that shown on the top of the screen. When fruits are falling, touch the mobile device with finger to move the character with the basket and catch fruits. Alternatively, user can tilt the mobile device to control where the user want the character to move. An out of season fruit is worth 1 point. In-season fruits are worth double. Try to catch falling stars for bonus points. Avoid bomb, which will decrease the score.

The game consists of three levels. In every level the user needs to beat 8 challenges - one challenge for every season and conditions. At the beginning of the challenge user can see the fruits the season prefer and the number of points the user needs to collect. If user is manage to reach or exceed the goal, user can advance to the next level. Otherwise user will lose and the game is over. The difficulty increases with every new challenge and level. The first time user beats all challenges in Level 1 and user will unlock the next level. Next time user can start from that level and not from the beginning. Try to collect as many points in total as possible. When user leave the application the game the state of the game before quitting will be stored. User can come back at a later time to continue to catch the fruits needed.

```
GameModel[] games1 = new GameModel[CHALLENGE_COUNT];
games1[0] = new GameModel( duration: 20000,  fruitPeriod: 900,  badObjectsPeriod: 3000,  bonusObjectsPeriod: 5000,  difficulty: 60);
games1[1] = new GameModel( duration: 20000,  fruitPeriod: 900,  badObjectsPeriod: 3000,  bonusObjectsPeriod: 5000,  difficulty: 60);
games1[2] = new GameModel( duration: 20000,  fruitPeriod: 900,  badObjectsPeriod: 3000,  bonusObjectsPeriod: 5000,  difficulty: 60);
games1[3] = new GameModel( duration: 20000,  fruitPeriod: 900,  badObjectsPeriod: 3000,  bonusObjectsPeriod: 5000,  difficulty: 60);
games1[4] = new GameModel( duration: 20000,  fruitPeriod: 900,  badObjectsPeriod: 3000,  bonusObjectsPeriod: 5000,  difficulty: 60);
games1[5] = new GameModel( duration: 20000,  fruitPeriod: 900,  badObjectsPeriod: 3000,  bonusObjectsPeriod: 5000,  difficulty: 60);
games1[6] = new GameModel( duration: 20000,  fruitPeriod: 900,  badObjectsPeriod: 3000,  bonusObjectsPeriod: 5000,  difficulty: 60);
games1[7] = new GameModel( duration: 20000,  fruitPeriod: 900,  badObjectsPeriod: 3000,  bonusObjectsPeriod: 5000,  difficulty: 60);
games1[8] = new GameModel( duration: 20000,  fruitPeriod: 900,  badObjectsPeriod: 3000,  bonusObjectsPeriod: 5000,  difficulty: 60);


GameModel[] games2 = new GameModel[CHALLENGE_COUNT];
games2[0] = new GameModel( duration: 20000,  fruitPeriod: 950,  badObjectsPeriod: 2500,  bonusObjectsPeriod: 5500,  difficulty: 70);
games2[1] = new GameModel( duration: 20000,  fruitPeriod: 950,  badObjectsPeriod: 2500,  bonusObjectsPeriod: 5500,  difficulty: 70);
games2[2] = new GameModel( duration: 20000,  fruitPeriod: 950,  badObjectsPeriod: 2500,  bonusObjectsPeriod: 5500,  difficulty: 70);
games2[3] = new GameModel( duration: 20000,  fruitPeriod: 950,  badObjectsPeriod: 2500,  bonusObjectsPeriod: 5500,  difficulty: 70);
games2[4] = new GameModel( duration: 20000,  fruitPeriod: 950,  badObjectsPeriod: 2500,  bonusObjectsPeriod: 5500,  difficulty: 70);
games2[5] = new GameModel( duration: 20000,  fruitPeriod: 950,  badObjectsPeriod: 2500,  bonusObjectsPeriod: 5500,  difficulty: 70);
games2[6] = new GameModel( duration: 20000,  fruitPeriod: 950,  badObjectsPeriod: 2500,  bonusObjectsPeriod: 5500,  difficulty: 70);
games2[7] = new GameModel( duration: 20000,  fruitPeriod: 950,  badObjectsPeriod: 2500,  bonusObjectsPeriod: 5500,  difficulty: 70);
games2[8] = new GameModel( duration: 20000,  fruitPeriod: 950,  badObjectsPeriod: 2500,  bonusObjectsPeriod: 5500,  difficulty: 70);
```

Figure 5.1: Partial Code from GameModelFactory class

```
public GameModel(int duration, int fruitPeriod, int badObjectsPeriod,
                 int bonusObjectsPeriod, int difficulty) {
    this.duration = duration;
    this.fruitPeriod = fruitPeriod;
    this.badObjectsPeriod = badObjectsPeriod;
    this.bonusObjectsPeriod = bonusObjectsPeriod;
    this.difficulty = difficulty;

    int fruits = (duration/fruitPeriod)-1;
    float r = FruitType.SEASONAL_FRUITS_RATIO;
    float fruitPoints = fruits*(
            ((1-r)*FallingObjectState.FRUIT_OUT_OF_SEASON_POINTS) +
            (r*FallingObjectState.FRUIT_IN_SEASON_POINTS)
           );


    goal = (((int) fruitPoints)*difficulty)/100;
}
```

Figure 5.2: Partial Code from GameModel class

```
//Spawn items randomly
if(st.isStarted && st.secondsRemaining > 0) {
    if (TimeUtils.millis() - st.lastFruitTime > fruitPeriod) {
        spawnFruit();
    }
    if (TimeUtils.millis() - st.lastBadObjectTime > badObjectsPeriod) {
        spawnBadApple();
    }
    if (TimeUtils.millis() - st.lastBonusItemTime > bonusObjectsPeriod) {
        spawnBonusItem();
    }
}
```

Figure 5.3: Partial Code from Game Screen

The difficulty in the game can be adjusted in GameModelFactory class by manipulate the values of time duration of the stage, spawn time period of falling objects and score goal that use difficulty value to calculate (shown in Figure 5.2). In harder difficulty of level, the spawn time period for fruit and bonus objects will be longer and spawn time period for bomb will be shorter. From Figure 5.3, it shows that the system will compare the time period of specific falling objects last spawned on the screen with the spawn time period to decide whether to spawn a new falling object. If the spawn time period sets in Figure 5.1 is longer, it takes more time to spawn the objects in the game scene.

5.2 Data Storing Technique

```xml
<?xml version='1.0' encoding='utf-8' standalone='yes' ?>
<map>
    <boolean name="Page1" value="true" />
    <boolean name="Level2" value="true" />
    <boolean name="TouchOn" value="true" />
    <boolean name="SoundOn" value="true" />
</map>
```

Figure 5.4: Shared Preferences – fruit-game-preferences.xml

```java
public class State {

    private static final String preferencesName = "fruit-game-preferences";

    public static boolean isSoundOn() {
        Preferences prefs = Gdx.app.getPreferences(preferencesName);
        return prefs.getBoolean( key: "SoundOn");
    }

    public static void setSoundOn(boolean on) {
        Preferences prefs = Gdx.app.getPreferences(preferencesName);
        prefs.putBoolean( key: "SoundOn", on);
        prefs.flush();
    }
```

Figure 5.5: Codes to implement storage of Shared Preferences

The proposed game in this project does not required database to store data because not much amount of data needed to be stored in this game. The data of option game state in OptionScreen that can be configured by user will be stored using Shared Preferences because the data are suitable to be stored in the form of key-value pair.

```
{gameScreenState:
{startGameTime:-4305, lastBadObjectTime:-1297, lastBonusItemTime:-4305, lastFruitTime:-686,
  isPaused:true, isStarted:true, basketX:188, score:3, secondsRemaining:16, isFinished:false,
  fallingObjects:
  [{posX:176, posY:158, type:0, points:1, index:33}, {posX:661, posY:216, type:2, points:-4, index:0},
    {posX:433, posY:339, type:0, points:1, index:26}],
  gameState: {active:true, challenge:0, level:0, totalScore:0}}
```

Figure 5.6: JSON data - gamestate.json

```
@Override
public void write(Json json) {
    json.writeValue( name: "posX", posX);
    json.writeValue( name: "posY", posY);
    json.writeValue( name: "type", type.getValue());
    json.writeValue( name: "points", points);
    json.writeValue( name: "index", index);
}

@Override
public void read(Json json, JsonValue jsonData) {
    posX = json.readValue( name: "posX", Integer.class, jsonData);
    posY = json.readValue( name: "posY", Integer.class, jsonData);
    index = json.readValue( name: "index", Integer.class, jsonData);
    points = json.readValue( name: "points", Integer.class, jsonData);
    int val = json.readValue( name: "type", Integer.class, jsonData);
    type = FallingObjectType.fromValue(val);
```

Figure 5.7: Codes to implement storage of JSON data

JSON is used in the proposed game because it is the best alternative for XML in data exchange. Since Shared Preferences only allows primitive values or strings to be stored, therefore, JSON is used in order to store custom Java objects. In this project, GameScreenState, FallingObjectState and GameState classes have implemented Serializable to write and read values in JSON format.

5.3 User Interface Design - Game Prototypes

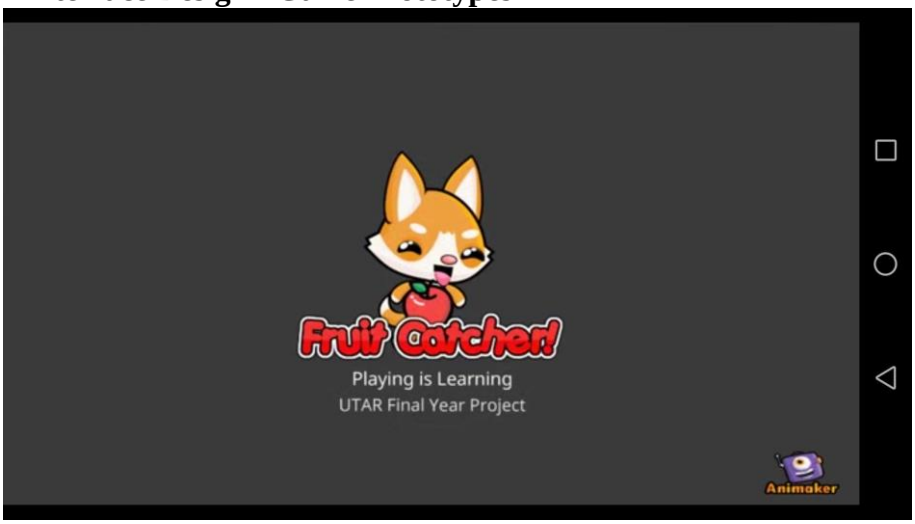


Figure 5.8: Splash Screen Interface

Before entering the main menu of the application, a splash screen will show up. User can choose to skip it by tapping the screen.

Figure 5.9: Main Menu Interface

In the main menu screen, there are several options for user to choose the action they wish to perform. To start the game, select “Start” button to enter the game level selection screen.

Figure 5.10: Level Selection Interface

In the level selection screen, only the first level is available for user to play by default. User has to unlock the following level by completing the previous level. Level 1 indicates the easiest difficulty while level 3 indicates the hardest. White color of text indicates the level has not been unlocked.

Figure 5.11: Start Game Message Interface

Before user enters the actual gameplay screen, a start game message will show up to tell the details of the current stage. User has to refer the in-season fruits displayed on the start game message and try to catch as many in-season fruit as possible to boost up the score.

Figure 5.12: Gameplay Interface

The game will start immediately after the user click the start button. At the same time, the clock will be started counting down to 0 and falling objects will be spawned on the top of the screen. User can control the game character by touching the screen by default.

Figure 5.13: End Game Message 1 Interface

Figure 5.14: End Game Message 2 Interface

Once the time is up, the end game message will pop out. If the user manages to score the targeted score mentioned in the start game message. “Success!” will be displayed on the top of the screen. However, if user fails to score the targeted score, “Try again!” will be displayed. The user can choose to play the next stage or play again the same stage if they failed the previous stage. If the user wishes to stop the game, they can click “Back” button to get back to the main menu.

Figure 5.15: Collection 1 Interface

Figure 5.16: Collection 2 Interface

If user clicks the Collection button in the main menu, the user is able to see the collection of fruits in every stage. The fruits will only be unlocked if the user has completed the specific stage. The fruits will be darken to indicate the user has not passed the stage yet. If the fruits is unlocked, user can click on the fruits icon to play the pronunciation of the fruits.

Figure 5.17: Option Interface

In the option screen, user can alter the type of gameplay and the setting of the sound. By choosing “Touch”, the user has to use finger to touch the screen in order to move the game character. Whereas by choosing “Tilt”, the user has to tilt the phone to left or right to control the movement of game character.

Figure 5.18: How To Play Interface

In the How to Play screen, it shows simple guidelines and rules on how the game works. User can exit the page once the user has understood the gameplay.

5.4 Black-box Testing

The testing phrase in this project involved in using the method of black-box testing model as it focuses on functionality and overall playability aspects of the game application. In this method, only the inputs and outputs of the application are tested, because black box testing does not required knowledge of how the internal system performs. After the game has been programmed, expected results and actual results are compared to verify the level of project completion.

Black box testing considers the software as a "Black Box" – without any knowledge of internal working. Black box testing only tests the fundamental aspects of the system. According to Khan (2012), black box testing is efficient for large code segment and is performing quicker compare to white box testing in test case development. Therefore, this project will be using black box testing to test the application.

Start Application		
Input	Expected Output	Actual Output
Click on the game icon	Display splash screen's animation.	Displayed.
Click on the splash screen to skip the animation	Main menu interface will be displayed instantly.	Displayed.

Table 5.1: Testing on starting application

Main Menu		
Input	Expected Results	Actual Results
Click on the "Start" button	Change from main menu screen to level selection screen.	Success.
Click on the "Collection" button	Change from main menu screen to collection screen.	Success.
Click on the "Option" button	Change from main menu screen to option screen.	Success.
Click on the "How To Play" button	Change from main menu screen to how to play screen.	Success.

Table 5.2: Testing on Main Menu

Level Selection		
Input	Expected Results	Actual Results
Click on "Level 1" button (that has been unlocked)	Change from level selection screen to gameplay screen.	Success.
Click on "Level 2" button (that has not been unlocked)	Send a toast message about level has not been unlocked.	Toast message did not show up.
Click on "Level 3" button (that has not been unlocked)	Send a toast message about level has not been unlocked.	Toast message did not show up.
Click on "Back" button	Change from level selection screen to back screen.	Success.

Table 5.3: Testing on Level Selection

Gameplay		
Input	Expected Results	Actual Results
Click on the "Start" button	Start Game Message will disappear.	Success.
	Time will start counting down.	Success.
	Falling objects will start to spawn.	Success.
	Game character will be displayed.	Success.
	Game details such as time remains, current score and in-season fruits will be displayed.	Success.
Detect user input on controlling character.	Game character will follow on user motions.	Success.
Detect the falling objects of user gets.	Score will add 1 point if out-of-season fruit is detected.	Success.
	Score will add 2 point if in-season fruit is detected.	Success.
	Score will add 3 point if bonus object is detected.	Success.
	Score will deduct 4 point if bomb is detected.	Success.

Table 5.4: Testing on Gameplay

Collection		
Input	Expected Results	Actual Results
Click on fruit icons. (that has been unlocked)	Pronunciation of fruit will be played.	Success.
Click on fruit icons. (that has not been unlocked)	Send a toast message about fruit has not been unlocked.	Toast message did not show up.
Click on the "Next" button.	Next collection of fruits will be displayed.	Success.
Click on the "Back" button	Change from collection screen to main menu screen.	Success.

Table 5.5: Testing on Collection

Option		
Input	Expected Results	Actual Results
Click on "Touch" or "Tilt" button.	Selected button will brighten up.	Success.
Click on "Sound On" or "Sound Off" button.	Selected on/off button will be displayed.	Success.
Click on the "Back" button	Change from collection screen to main menu screen.	Success.

Table 5.6: Testing on Option

How To Play		
Input	Expected Results	Actual Results
Click on the "Back" button	Change from collection screen to main menu screen.	Success.

Table 5.7: Testing on How To Play

5.5 User Acceptance Testing

The goal of this survey is to test the effect of different teaching methodologies on learning motivation and achievement in fruit recognition. In this survey, ARCS questionnaire and fruit recognition test are used to collect data which is then analyzed with SPSS for Windows. Pre-school children are randomly selected as the participants in this survey, then are separated into two groups, the experimental and control group, to study the effect on the learning achievement from the different teaching approaches, traditional classroom-based learning and game-based learning. A total of 60 pre-school children have participated in this survey, of which 44 are males and 16 females, with the average age of 4-6 years. There are 30 pre-school children (19 males and 11 females) in control group, using the traditional classroom-based learning approach; there are 30 pre-school children (25 males and 5 females) in experimental group which using the game-based teaching approach.

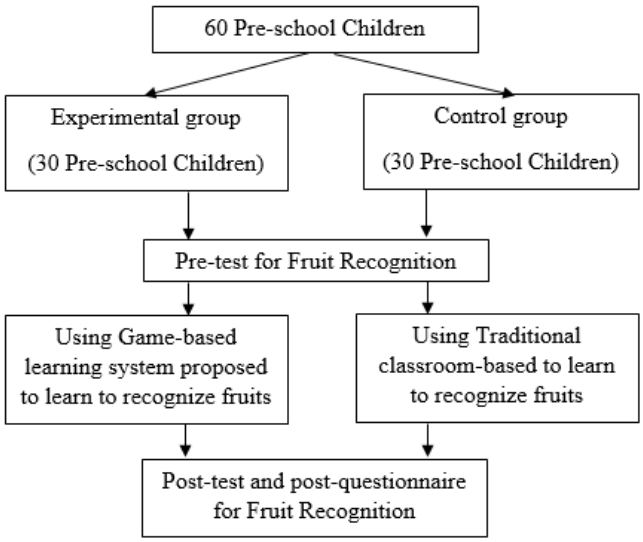


Figure 5.19: Experiment design for comparing the Game-based learning and the Traditional classroom-based learning

This survey analyzed the result scored in the pre-test and post-test, to check whether there are significance differences between the experimental group and control group before and after they try different type of learning approach. Eventually, according to the questionnaire results on pre-school children, an integrated view of the game proposed and teaching approach can be obtained.

The learning performance was taken from the experimental and control group children' test scores. In the pre-test and post-test, the pre-school children have been tested to

recognize 8 kinds of fruits. The sample of the test can be referred in Appendix I. The results scored by each pre-school children are recorded and analyzed with an independent sample T-test.

	Group	Number	Mean	SD	t-test for Equality of Means		
					t	df	Sig. (2-tailed)
Pre-test	Experimental	30	74.26	8.267	-0.331	62	0.705
	Control	30	73.47	12.324			
Post-test	Experimental	30	80.20	9.423	3.023	62	0.004
	Control	30	75.34	12.03			

Table 5.8: The results for the learning achievement of different learning method

In pre-test comparison, t-test shows no difference in learning achievement between experimental group (Children who used the fruit catching game with game-based learning) and control group (Children who used traditional classroom-based learning) as shown in Table 5.8. However, the post-test comparison has a significant difference, Table 5.8 shows the average scores of children in experimental group who use the fruit catching game with game-based learning are Mean = 80.20 and SD = 9.423, which are higher than who use the traditional classroom-based learning (Mean = 75.34, SD = 12.030). Lastly, comparison with the scores of pre-test and post-test shows that, in the control group who use the traditional classroom-based learning does not have a significant difference on the scores of pre-test and post-test, but in the experimental group who use the fruit catching game with game-based learning have significant differences in the scores of pre-test (Mean = 74.26) and post-test (Mean = 80.20). From the data above, it can be concluded that the game proposed has increase children's academic performance as compare to traditional classroom-based learning. This proved that the first objective of this project which is to compensate the lack of interactivity of traditional classroom-based learning is achieved.

ARCS model was considered as the preferred theory and used in this survey to measure effect of games proposed in this project on learners' motivation along four attributes of Attention, Relevance, Confidence, and Satisfaction. The reason is because this model has been widely used to evaluate motivations of learners in a variety of learning settings including E-learning environments and web-based distance settings, hypermedia contexts, and classroom face-to-face setting (Kebritchi, 2018).

Factor	Definition
Attention	A student's attention has to be aroused and sustained.
Relevance	After the student's attention is gained, a student may wonder how the given material relates to their interests and goals. If the content is perceived to be helpful in accomplishing one's goals, then they are more likely to be motivated.
Confidence	Students have to know that they will probably be successful before completing a given task. They have to feel somewhat confident. Success is not guaranteed and people enjoy a challenge. However, the challenge can't be too difficult.
Satisfaction	If the outcomes of a learner's effort is consistent with their expectations and they feel relatively good about those outcomes, they will remain motivated.

Figure 5.20: The Four Factors in the ARCS Model (Ying and Yang, 2013)

Questionnaire results on the effectiveness of game proposed with implementation of game-based learning are collected. The procedure of questionnaire forming is based on the definition of measuring aspect and the items is based on literature and expert opinion, which are used to generate a formal questionnaire. The designed questionnaire adopted from the questionnaires of Su and Cheng (2013) and it is fairly high reliability, as all questions have been revised by experts, and therefore fit the needs of this survey.

The proposed questionnaire is based on Keller's ARCS motivation model with its four dimensions attention (Dimension A), relevance (Dimension R), confidence (Dimension C) and satisfaction (Dimension S) with a total of 17 questions. Responses to all questions were on a five point Likert-scale questionnaire: "5: Strongly agree" means absolute agreement with the given question; "4: Agree" means general agreement with the question; "3: Neither" stands for neither agree nor disagree with the question; "2: Disagree" represents general disagreement; "1: Strongly disagree" represents absolute disagreement with the question.

The narration of the questionnaire is as follows: this survey uses a game with game-based learning approach to improve the learning effect of fruit recognition, after the end of experiment, let the children participate the system test, conduct test and complete the questionnaire. This has been done to understand the degree of children' acceptance for this system. There are four parts: in the first part (Dimension A), children evaluate whether there is attraction in game content; in the second part (Dimension R), children assess whether the game content is helpful and worth learning; in the third part (Dimension C), children evaluate whether the game gave them self-control over the learning process and whether it was able to build confidence in children to finish whole activities; in the fourth part (Dimension S), children assess the their overall degree of satisfaction and acceptance for the system.

Item	Question
A1	The themes of the learning material draw my attention.
A2	The way in which the learning materials are presented helps me focus my attention.
A3	I can concentrate on the learning activities.
A4	The learning activities can stimulate my curiosity.
A5	The learning activities is interesting to me.
R1	I can link the content of the activities to the knowledge that I am already familiar with.
R2	The content of the activities is linked to my daily experiences.
R3	The content of the activities is worth learning.
R4	The content of the activities motivates me to put more effort in the activities.
C1	The progressing method of learning activities meets my expectations.
C2	I can control my progress in the learning activities.
C3	I am confident that I can accomplish all the learning activities.
C4	I am confident that I can apply what I learn from the learning activities to my daily life.
S1	I enjoy the learning activities.
S2	I am satisfied with my learning achievement in the learning activities.
S3	The content of the activities is worth my time and effort.
S4	Completing the activities gives me a satisfying feeling of accomplishment.

Table 5.9: Survey Questions

Item	Number of Item	Cronbach α
ARCS-A (Attention)	5	0.92
ARCS-R (Relevance)	4	0.88
ARCS-C (Confidence)	4	0.97
ARCS-S (Satisfaction)	4	0.86
	Average:	0.9075

Table 5.10: Cronbach's alpha of questionnaire

Table 5.9 lists the Cronbach's alpha of ARCS questionnaire that children done after using two difference types of learning approach. This survey uses Cronbach's alpha value to verify the reliability standard of the questionnaire. Cronbach's alpha coefficient is used to evaluate the internal consistency reliability of the tests. Cronbach's a coefficient ranges between 0 and 1, and Stephanie (2014) suggests that 0.7 is an acceptable minimum reliability coefficient. The Cronbach's alpha values of four dimension are all higher than .70, and the entire questionnaire is α = .91 which indicate the questionnaire is reliable. The reliability is the credibility and stability of the questionnaire result which stands for there are consistencies among every question.

ANOVA

		N	Mean			Sum of Squares	df	Mean Square	F	Sig.
A1	Experimental Group	30	4.10	A1	Between Groups	.017	1	.017	.044	.835
	Control group	30	4.13		Within Groups	22.167	58	.382		
	Total	60	4.12		Total	22.183	59			
A2	Experimental Group	30	4.13	A2	Between Groups	8.067	1	8.067	14.322	.000
	Control group	30	3.40		Within Groups	32.667	58	.563		
	Total	60	3.77		Total	40.733	59			
A3	Experimental Group	30	4.30	A3	Between Groups	11.267	1	11.267	25.460	.000
	Control group	30	3.43		Within Groups	25.667	58	.443		
	Total	60	3.87		Total	36.933	59			
A4	Experimental Group	30	4.27	A4	Between Groups	4.267	1	4.267	5.411	.024
	Control group	30	3.73		Within Groups	45.733	58	.789		
	Total	60	4.00		Total	50.000	59			
A5	Experimental Group	30	4.17	A5	Between Groups	13.067	1	13.067	32.204	.000
	Control group	30	3.23		Within Groups	23.533	58	.406		
	Total	60	3.70		Total	36.600	59			

Figure 5.21: ANOVA results in Dimension A (Attention)

The one-way analysis of variance (ANOVA) is used to determine whether there are any statistically significant differences between the means of experimental group and control group. Figure 5.21 shows that responses to item A1 indicated that there wasn't a significant difference in the attractiveness of contents of learning materials: F = 0.044, Sig. = 0.835 > 0.05. This might because traditional classroom-based learning are using

variety of learning materials that are colorful and beautiful while teaching. While the game proposed is also using attractive graphics that similar to materials used in traditional classroom-based learning. Responses to item A2 indicated that there was a significant difference in the attractiveness of the presentation of learning materials: F = 14.322, Sig. = 0.000 < 0.05. Responses to item A3 indicated that there was a significant difference in the attractiveness of the active nature of the learning activities: F = 25.460, Sig. = 0.000 < 0.05. Responses to item A4 indicated that there was a slight difference in children' curiosity toward the active nature of the learning activities: F = 5.411, Sig. = 0.024 < 0.05. Responses to item A5 indicated that there was a significant difference in children' interest in the learning activities: F = 32.204, Sig. = 0.000 < 0.05. The results of A2 – A5 have indicated that children in the experimental group who played fruit catching game believe that their concentration has been enhanced while playing the game and has been encouraged their learning through play, and therefore they thought the learning activities were interesting.

R1	Experimental Group	30	4.10	R1	Between Groups	.017	1	.017	.026	.871
	Control group	30	4.07		Within Groups	36.567	58	.630		
	Total	60	4.08		Total	36.583	59			
R2	Experimental Group	30	4.20	R2	Between Groups	.067	1	.067	.147	.703
	Control group	30	4.13		Within Groups	26.267	58	.453		
	Total	60	4.17		Total	26.333	59			
R3	Experimental Group	30	4.27	R3	Between Groups	.267	1	.267	.663	.419
	Control group	30	4.13		Within Groups	23.333	58	.402		
	Total	60	4.20		Total	23.600	59			
R4	Experimental Group	30	4.17	R4	Between Groups	12.150	1	12.150	31.983	.000
	Control group	30	3.27		Within Groups	22.033	58	.380		
	Total	60	3.72		Total	34.183	59			

Figure 5.22: ANOVA results in Dimension R (Relevance)

From Figure 5.22, responses to item R1 indicated that there wasn't a significant difference in the link between the learning activities and children' knowledge: F = 0.026, Sig. = 0.871 > 0.05. Responses to item R2 indicated that there wasn't a significant difference in the link between the learning activities and children' daily experiences: F = 0.147, Sig. = 0.703 > 0.05. Responses to item R3 indicated that there wasn't a significant difference in thinking that the contents in learning activities is worthy to learn: F = 0.663, Sig. = 0.419 > 0.05. Results of R1 – R3 indicate that children believed there is not much difference between fruit catching game and classroom-based learning in terms of Relevance aspect. Both learning activities have provided learning content that is helpful and worth learning. Responses to item R4 indicated that there was a

significant difference in thinking that the fruit catching game is helpful to children by motivates them putting more effort in the learning activities: F = 31.983, Sig. = 0.000 < 0.05. Many children in the experimental group thought that the fruit catching game could help their motor skill. The results show that children in the experimental group that completing levels in the game encouraged them to continue the learning activities than they did in the classroom.

C1	Experimental Group	30	4.13	C1	Between Groups	11.267	1	11.267	28.006	.000
	Control group	30	3.27		Within Groups	23.333	58	.402		
	Total	60	3.70		Total	34.600	59			
C2	Experimental Group	30	4.23	C2	Between Groups	2.817	1	2.817	5.415	.023
	Control group	30	3.80		Within Groups	30.167	58	.520		
	Total	60	4.02		Total	32.983	59			
C3	Experimental Group	30	4.23	C3	Between Groups	2.017	1	2.017	4.710	.034
	Control group	30	3.87		Within Groups	24.833	58	.428		
	Total	60	4.05		Total	26.850	59			
C4	Experimental Group	30	4.00	C4	Between Groups	.267	1	.267	.563	.456
	Control group	30	3.87		Within Groups	27.467	58	.474		
	Total	60	3.93		Total	27.733	59			

Figure 5.23: ANOVA results in Dimension C (Confidence)

Figure 5.23 shows the responses to item C1 indicated that there was a significant difference in believing that the progressing method of learning activities meets children' expectations: F = 28.006, Sig. = 0.000 < 0.05. Children in the experimental group indicated that the fruit catching game were a real learning experience which they could not possibly gain from textbooks and audio CDs. Responses to item C2 indicated that there was a slight difference in controlling the progress of learning activity: F = 5.415, Sig. = 0.023 < 0.05. They can choose to replay a level or continue to proceed to next level in the game, unlike in traditional classroom-based learning, it is hard for them to catch up if they missed what teacher said in the classroom. Responses to item C3 indicated that there was a slight difference in having the confidence to accomplish all activities: F = 4.710, Sig. = 0.034 < 0.05. As the game contains different levels of difficulties for them to choose, they can choose to replay easy difficulty's level until they get familiar with the gameplay. Responses to item C4 indicated that there wasn't a significant difference in having the confidence to apply what they learn from the learning activities to children' everyday life: F = 0.563, Sig. = 0.456 > 0.05. The results of C1-C3 indicates that the children feel confidence with the difficulty of the game as compared to classroom. This indicates that the difficulty of the game is appropriate for their level which proves that the second objective of this project has been achieved.

S1	Experimental Group	30	4.07	S1	Between Groups	8.067	1	8.067	13.548	.001
	Control group	30	3.33		Within Groups	34.533	58	.595		
	Total	60	3.70		Total	42.600	59			
S2	Experimental Group	30	4.27	S2	Between Groups	10.417	1	10.417	26.004	.000
	Control group	30	3.43		Within Groups	23.233	58	.401		
	Total	60	3.85		Total	33.650	59			
S3	Experimental Group	30	4.17	S3	Between Groups	6.017	1	6.017	13.614	.000
	Control group	30	3.53		Within Groups	25.633	58	.442		
	Total	60	3.85		Total	31.650	59			
S4	Experimental Group	30	4.17	S4	Between Groups	8.817	1	8.817	18.686	.000
	Control group	30	3.40		Within Groups	27.367	58	.472		
	Total	60	3.78		Total	36.183	59			

Figure 5.24: ANOVA results in Dimension S (Satisfaction)

Figure 5.24 shows the responses to item S1 indicated that there was a significant difference in children' enjoyment of the fruit catching game: F = 13.548, Sig. = 0.001 < 0.05. Children in the experimental group stated that the game was interesting compared with a textbook and they could have controlled the character in the game which give them choices to interact during learning. Responses to item S2 indicated that there was a significant difference in being satisfied by children' achievement in the fruit catching game: F = 26.004, Sig. = 0.000 < 0.05. Most of the children in experimental group enjoyed the fruit catching game because they could unlock the collection after complete a stage in the game, which act as a reward for them. Responses to item S3 indicated that there was a significant difference in thinking that the contents in learning activities is worthy to spend their time and effort to learn: F = 13.614, Sig. = 0.000 < 0.05. Most of the children in experimental group felt that the game was interesting, and they seemed to be immersed in the learning situation during the activity. Responses to item S4 indicated that there was a significant difference in having sense of satisfaction by children after completing the learning activities: F = 18.686, Sig. = 0.000 < 0.05. Many children in the experimental group mentioned that completing a level with several stages giving them sense of accomplishment because the score goal for each stage is not that easy to be achieved.

The statistical results of the survey also demonstrate that for the experimental group, using fruit catching game with game-based learning approach in the learning process produced better learning outcomes and learning motivation than using the traditional classroom-based learning. Although children in the experimental group enjoyed the game in learning, they still recognized the value of non-gaming learning modules. They pointed out that game-based learning is motivating, but the non-gaming learning style

is still very important. They thought that games-based learning could not be used alone without traditional teaching, and hoped that game-based learning would be widely adopted in the future.

The evaluation results of learning outcomes in pre-test and post-test and learning motivation in questionnaire demonstrate that using interactive games in learning could achieve a better learning performance and motivation than traditional classroom-based learning. Through the results of this survey, it can be concluded that the objectives of this project in compensate the lack of interactivity and overcome the loss of motivation with appropriate learning module's difficulty is achieved.

CHAPTER 6: CONCLUSION

6.1 Discussion and Conclusion

Since the benefit of mobile devices has undoubtedly exploded, a vast amount of technological tools have been provided for people to use in anyway and anytime. Certain taboos about games must be overcome before the education field adopts it. Game-based learning should not be treated as a waste of time or a way that implicate students with a fun but worthless task. Game-based learning can be utilized in teaching where appropriate especially incorporating it into traditional instructional teaching to bring an enjoyable and captivating experience for students.

In this project, some deficiencies on current traditional teaching method and existing game have been found and analysed. To overcome these problems, a game with game-based learning approach is proposed in this project. By reviewing some existing applications, the advantages found from the existing system have been taken into consideration to be included in the project as well. On the other side, the disadvantages will be avoided to ensure the quality of the project outcome.

The objectives of this project is to develop an interactive game with adequate difficulty that tracks user learning progress. By playing the game, user can learn to differentiate the total of 30 fruits from different seasons, the name and pronunciation of them. User can retry the stages with different difficulties, which can train user fine motor skills that helps in cognitive development.

In conclusion, the main focus of this project is to develop a mobile game application that helps post-school children in differentiate different kinds of fruits with the concept of game-based learning.

6.2 Future Enhancements

- Set screen time limits

The application should implement a function that can detect the duration of game time user has played. At the same time, parents should be able to set a time limit for the duration of game time to limit the time their children spend on the mobile device. According to Time (2019), some studies found that weaker performance on developmental measure has shown on children who spent longer duration in using screen such as computers and phones. Other than that, this can prevent children from reducing physical activity which can cause obesity problem in children (Lee, 2019).

- Add competitive and collaborative element into the gameplay

Multiplayer mode can be implemented into the game to promote competitive and collaborative gameplay which could emotionally and cognitively encourage players and effect on their learning and motivation naturally (Jabbar and Felicia, 2015). However, including multiplayer mode in the game indicates internet connectivity is needed. Children may not have enough mature and knowledge to differentiate violent, false and inappropriate information on the internet.

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APPENDIX A - GAME PREPARATION AND PERFORMANCE TEST

Game Preparation and Performance Test (Administrated in the pre-tests and post-tests)

- Name: _____
- Link the fruits with their names

/8

	Mango
	Lime
	Blueberries
	Watermelon
	Fig
	Cherries
	Pineapple
	Strawberry

APPENDIX B - ARCS MODEL QUESTIONNAIRE

ARCS Model Questionnaire

Instruction:

1. There are 17 statements in this questionnaire. Please think about each statement in relation to the fruit catching game that you have played and indicate how true the statements are using the scale provided after each statement. Give the answer that truly applies to you and not what you would like to be true, or what you think others want to hear.

2. Circle the number that best indicates your response.

Scale for Your Responses

1 = Strongly disagree

2 = Disagree

3 = Neither

4 = Agree

5 = Strongly agree

No.		Strongly disagree	Disagree	Neither	Agree	Strongly Agree
	Attention					
1	The themes of the learning material draw my attention.	1	2	3	4	5
2	The way in which the learning materials are presented helps me focus my attention.	1	2	3	4	5
3	I can concentrate on the learning activities.	1	2	3	4	5
4	The learning activities can stimulate my curiosity.	1	2	3	4	5
5	The learning activities is interesting to me.	1	2	3	4	5
	Relevance					
6	I can link the content of the activities to the knowledge that I am already familiar with.	1	2	3	4	5
7	The content of the activities is worth learning.	1	2	3	4	5
8	The content of the activities is linked to my daily experiences.	1	2	3	4	5
9	The content of the activities motivates me to put more effort in the activities.	1	2	3	4	5
	Confidence					
10	The progressing method of learning activities meets my expectations.	1	2	3	4	5
11	I can control my progress in the learning activities.	1	2	3	4	5
12	I am confident that I can accomplish all the learning activities.	1	2	3	4	5
13	I am confident that I can apply what I learn from the learning activities to my daily life.	1	2	3	4	5
	Satisfaction					
14	I enjoy the learning activities.	1	2	3	4	5
15	I am satisfied with my learning achievement in the learning activities.	1	2	3	4	5
16	The content of the activities is worth my time and effort.	1	2	3	4	5
17	Completing the activities gives me a satisfying feeling of accomplishment.	1	2	3	4	5

GAME-BASED LEARNING APPROACH FOR LEARNING

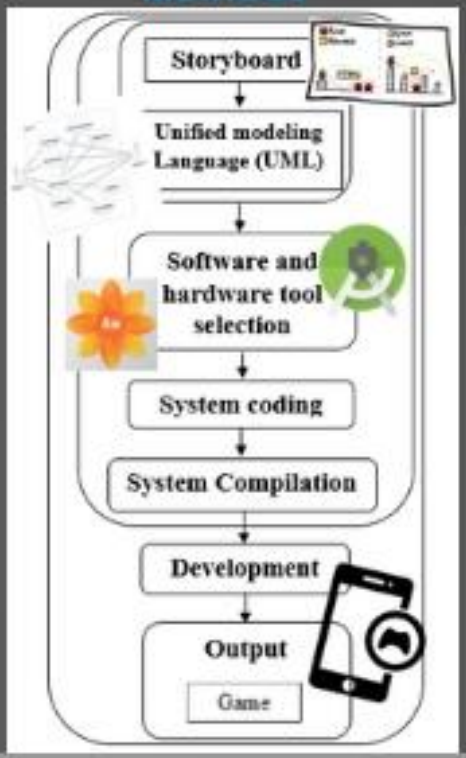
Introduction

Learning is always a painful process for certain people. What if there is a way to make learning fun? Game-based learning indicates the idea of using video games as education tools. A game which brings fun and enjoyment and at the same time assisting the players in education and learning is proposed in this project.

Objectives

- To compensate the lack of interactivity in traditional teaching method.
- To develop a game with appropriate difficulty.
- To develop a collection module to track learner activity in the game.

Methods



Conclusion

A game with game-based learning with well design in gameplay and difficulty can be utilized in teaching where appropriate especially incorporating it into traditional instructional teaching to bring an enjoyable and captivating experience for students.

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Bachelor of Computer Science (Hons)
Faculty of Information and Communication Technology

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