

Save Ocean: Development of a Mobile Game Application to Create Awareness on Ocean Pollution

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Abstract: In recent years, ocean pollution incidents have occurred frequently. This is not only a challenge faced by regions and countries only but also a problem that the global society needs to cope with. Every year, human abandoned eight million tons of plastic in the ocean. At this rate, the number of fish will be estimated less than plastic in the oceans during 2050. Next, ocean pollution is an environmental topic that has neglected by the majority of Malaysian. Thus, instilling an awareness of this issue should begin from the younger generation to improve their attitude. Hence, Save Ocean is a mobile game application developed to raise awareness of ocean pollution among children aged 6 to 12. This application is an adventure game which consists of 3 main levels and 15 sub-levels. Game Development Life Cycle has been applied as the methodology in designing and developing Save Ocean. There are 6 phases in this model, which are initiation phase, pre-production phase, production phase, testing phase, beta phase, and lastly, release phase. The game application is developed using Unity, Blender, Nomad Sculpt, Procreate, and CapCut. The overall result of user acceptance test on Save Ocean game application has achieved a favourable result with 87.6%. Hence, the target users can increase their knowledge about marine organisms after playing this game. Indirectly, it can create environmental awareness of ocean pollution to the users.

Keywords: Ocean pollution, awareness, mobile game, application

1. Introduction

The ocean covers nearly three-quarters of the Earth's surface, and the livelihoods of more than 3 billion people depend on marine organisms [1]. However, human discards 8 million tons of plastic in the ocean every year, which is comparable to a truckload of plastic being thrown into the ocean every minute [2]. Based on a ranking among the top 20 countries, Malaysia's ocean is the eighth global largest plastic pollution [3]. Every year, plastic pollution caused the death of one million sea birds and 100,000 marine animals [4]. A documentary or film on ocean pollution or plastic pollution might have availed to build awareness. However, ocean pollution is still getting more serious due to the indifference and incomprehension of many people. These people tend to neglect the issue on ocean pollution entirely as

they assumed this big issue is still under control. Hence, developing a game that promotes awareness is required to enlighten the users on the seriousness of ocean pollution.

Moreover, the project's first objective is to design a mobile game application entitled Save Ocean using the third-person view based on adventure gaming approach. The next objective is to develop the Save Ocean mobile game application on Android platform. Finally, the last objective is to test the mobile game application to target users.

Save Ocean is an offline gaming application developed in English. It provides a platform for children from 6 to 12 years old to know more about the difference between a clean and polluted ocean from a third-person perspective. At the same time, the users can learn and understand more about the marine animals in a virtual style from this game's design.

In the 21st century, the digital world is the most effective method to reach out to the masses. Thus, this mobile application with a gaming approach can be an effective way to educate children about the seriousness and effects of ocean pollution. This is due to playing mobile games is much more interesting and attractive than watching a documentary or an awareness campaign. Hence, Save Ocean application is built to increase awareness on the environmental issue that the world is currently suffering.

The rest of the paper is organized as follows. Related Work is explained in the Section 2, consisting of the technique used and the study of the existing applications. Next, Section 3 details the methodology of this project, which is the game development life cycle (GDLC). Moreover, Section 4 presents the application results and covers the testing phase involving children aged 6 to 12. Last but not least, Section 5 is the last part of this report concludes the paper. This section sums up the overall achievement of objectives, its benefits and weaknesses together with future enhancements.

2. Related Work

2.1 Ocean Pollution

The issue of ocean pollution is getting worse and imperceptible affects our daily life. World Wide Fund for Nature (WWF) recently surveyed “Asia’s most serious marine polluters” and the report revealed that Malaysians are the largest individual consumers of plastic packaging [5].

In recent years, plastic pollution in the ocean has become more severe. Thus, the pollution will threaten marine organisms' survival and health. The death of aquatic species, especially turtles and marine animals such as dolphins, whales, and dugongs, is caused by discarding plastic-based solid waste. Malaysian Marine Fisheries Mammals Network’s National Task Force reported that most necropsy carried on marine mammals found plastic in their stomach and caused their deaths [6]. Hence, an ocean adventure game tense developed to create environmental awareness of ocean pollution to the children.

2.2 Development of Game Application

A simple understanding of gameplay is that games are often categorized in similar ways, including similar challenges and similar rules for winning or defeating game challenges [7]. Adventure games aim to permit players to travel around the different parts in the game's world at their own speed, find treasures, solve puzzles, and enjoy the story's development [7]. Thus, players are able to notice the surroundings in the game due to this more leisurely speed. Save Ocean utilizes adventure gameplay style which the player needs to navigate the movement of a character at his own pace by using a virtual joystick. The player will notice changes in the surroundings from a clean ocean to a polluted ocean based on different game's levels.

Next, after determining the gameplay, the graphics of the game is also important. 3D graphics can be interpreted as the graphics that use a three-dimensional illustration of geometric data stored in the

computer to execute calculations and perform rendering on 2D images [8]. Thus, 3D graphics are quintessential for several kinds of mobile applications because it provides opportunities to interact and navigate in a 3D environment. Hence, 3D graphics are applied in this proposed application to deliver a more understandable and more definite visual. As a result, the target users can easily connect the virtual scenes in the proposed game with real-life circumstances.

Moreover, a game will become useless if not publish after completion. Google and Open Handset Alliance developed an open-source mobile operating system called Android and published it in 2007 [9]. According to the statistics reported by Kielty, Android devices' market was astonishing and manifestly compared to iOS devices in most countries, including Malaysia [10]. Based on the statistics, Android is one of the believable platforms for publishing games about ocean pollution because it consists of a large number of potential users [10].

2.3 Comparison of Similar Existing Mobile Game Applications

Comparison between several similar existing applications and the proposed application was conducted to review their strengths and weaknesses. Table 1 shows details of the comparison between three existing applications, which includes Trashman Underwater, Story of A Fish, Deep Blue Dump and the application, Save Ocean.

Table 1: Comparison between the similar existing games with the proposed game

Item	Trashman Underwater	Story of A Fish	Deep Blue Dump	Save Ocean
Developer	Docommit oy	Solutions Skovde AB	Stories Studio W.L.L	Natalie Wee Sung Yuan
Platform	iOS and Android	iOS and Android	iOS and Android	Android
Category	Adventure	Action	Casual	Adventure
Purchasing	In-app purchases	Free to use	In-app purchases	Free to use
Module	Learn and Game	Game	Learn and Game	Learn and Game
Boosters	Available	Not available	Available	Available
Graphic	2D	2D	2D	3D
Local content	No	No	No	Yes
Weaknesses	-Not free to use. -Unable to adjust the volume. - Unable to exit the game by press the Exit button.	-This application did not provide Setting and Pause interfaces. -All levels are not shown in the menu interface.	- Not free to use for Android. - This application did not provide Setting interface. - Inconsistent design.	-Only operate on the Android platform. -Only provide one language. -Only cover game module.
Strengths	-This application provides Setting and Pause interfaces. -Ocean pollution as the game content.	-Free to use. -Ocean pollution as the game content.	-This application provides Pause interfaces. -Ocean pollution as the game content.	-Free to use -Provides Setting and Pause interfaces. -Ocean pollution as the game content.

Table 1: (continued)

Item	Trashman Underwater	Story of A Fish	Deep Blue Dump	Save Ocean
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-All levels are shown in the menu interface.	-All levels are shown in the menu interface.	-The game background based on local content.
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Based on Table 1, the comparison made has accentuated the weaknesses and strengths of the existing applications. Hence, the design of Save Ocean has combined the strengths of the existing applications and enhanced the defects of the existing applications. As a result, the game application, Save Ocean is designed in a 3D graphic based on local content, as compared to the existing applications, which are designed in a 2D graphic based on overseas content. Besides, the content of the game is ocean pollution and it consists of 15 levels.

3. Methodology

The game development life cycle (GDLC) is a particular method applied to guide game development [11]. The GDLC model principally includes 6 phases as displayed in Figure 1.

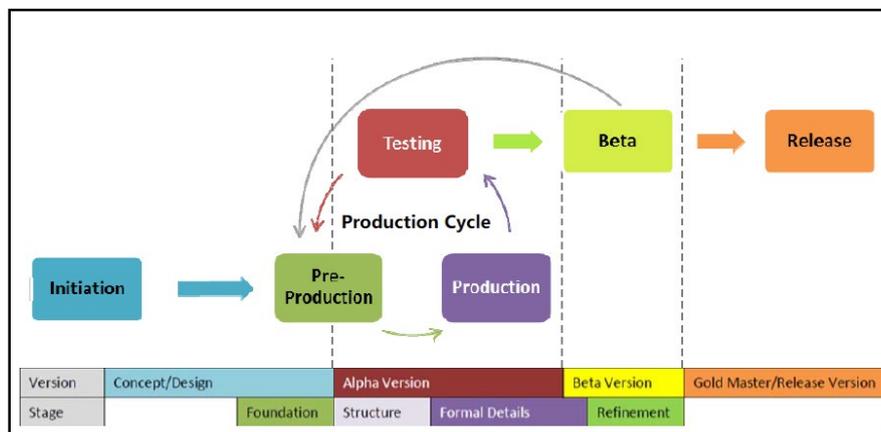


Figure 1: GDLC model [11]

3.1 Initiation Phase

The first step in developing a game is creating and drafting a rough idea of the game concept that will be designed [11]. Next, an overview of the project's introduction, problem statements, objectives, project scope, project significant, and the expected result are determined in this phase.

3.2 Pre-Production Phase

The creation of the game design and its prototype is included in this phase [11]. The game pitch requirements are defined in the game design, such as game title, game logline, game lore, gameplay style, intended audience, concept art, flowchart, and storyboard. Three flowcharts had been created to explain the application main flow and the subprocesses in the application can be referred to in Appendix A. Besides, Figure 2 displays the ocean metaphor used on the home interface.

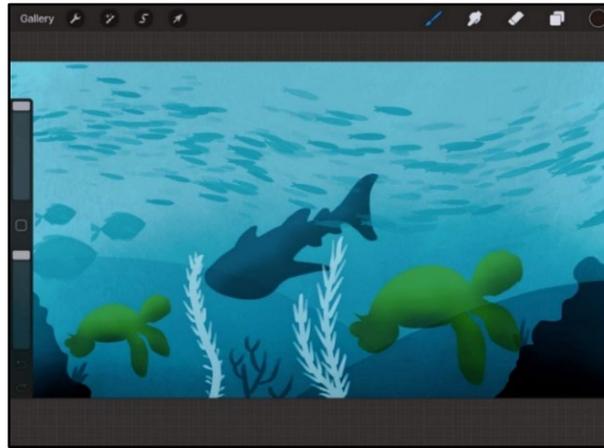


Figure 2: Ocean metaphor used on the home interface

3.3 Production Phase

The kernel process in the production phase focuses on creating the game assets, source codes and integrating these two components [11]. Firstly, Blender and Nomad Sculpt are applied to produce the game characters as depicted in Figure 3. Next, animation is an indispensable element in the game. By way of illustration, an animation of a fish is developed in Blender as detailed in Figure 4. Furthermore, Unity is used to develop the game by importing the assets and models. Unity's script is applying the C# programming language as the source codes in this project as described in Figure 5.

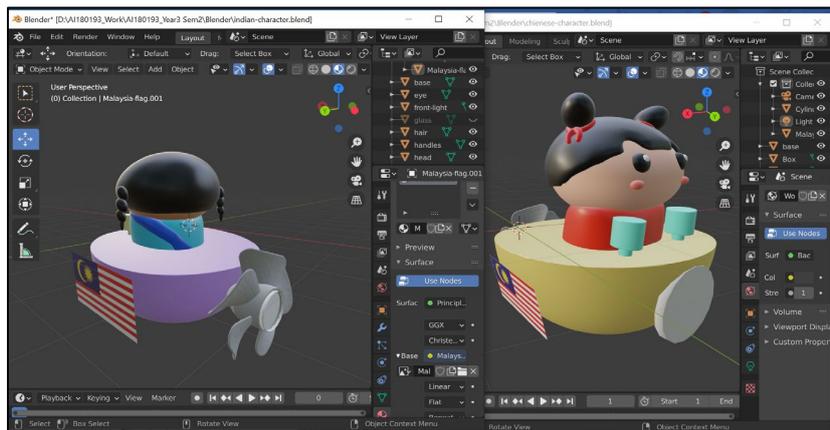


Figure 3: Modelling and colouring of the characters



Figure 4: Animation of a fish in Blender

```

public void buyLife()
{
    if (lovePrice <= PlayerPrefs.GetInt("Coin", GameControllerScript.moneyAmount))
    {
        PlayerPrefs.SetInt("Coin", PlayerPrefs.GetInt("Coin", GameControllerScript.moneyAmount) - lovePrice);
        gameOver.SetActive(false);
        HeartFYP.health += 1;
        Time.timeScale = 1f;
    }
}
    
```

Figure 5: Script snippet of purchasing the life booster

3.4 Testing Phase

The testing phase is carried out to test the playability and usability of a game [11]. Alpha testing is conducted to get the bug reports when the development process is nearly to finish. The functionality of the buttons is one of the elements that is tested during alpha testing. The result of alpha testing based on button functionality in Save Ocean reveals an issue and the appropriate actions have been taken to address this issue. Besides, the application utilised in the testing process is fully functional and has all of the planned features during the early stages of development. Table 2 displays some of the user interfaces of Save Ocean.

Table 2: User interfaces

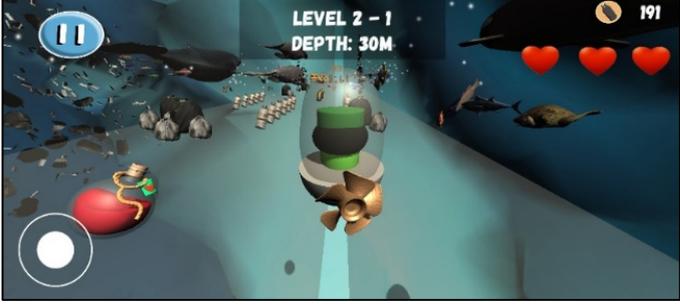
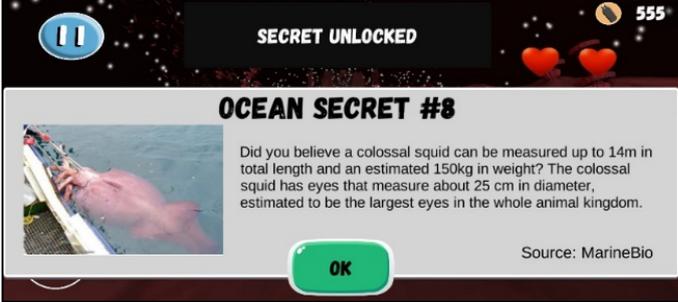
Scene	User Interface
Home	
Main Menu	
Game	

Table 2: (continued)

Scene	User Interface
Shop	
Ocean Secret's Panel	

3.5 Beta Phase

In this phase, the beta testing was conducted after Save Ocean is fully developed. Hence, Save Ocean was tested by the target users, children from the age of 6 until 12 years old. The results of beta testing are presented in Section 4.

3.6 Release Phase

Finally, Save Ocean application is completely developed and released on the mobile with the operating system of Android. Besides, Save Ocean is also available as a free download from the Google Play Store as displayed in Appendix B.

4. Results and Discussion

Beta testing was carried out to assure that the final product is completely functional. It was implemented with the targeted users aged 6 to 12. Since the testing was conducted during movement control order (MCO), it only involves a small sample size, which is 10 children. The 10 respondents are 5 male children and 5 female children. Relatives of the developer and developer's friends were approached to test the beta version of the game application.

The testing is conducted with the target users by two methods. The first method is to download and install the APK file of Save Ocean on the developer's mobile phone and then the target users use the developer's phone to play the game. The second method is applied after Save Ocean is publishing on Google Play Store. The target users install Save Ocean on their own devices from Google Play Store and play it.

After playing Save Ocean, the developer asked the target users the prepared questions and filled in an online Google Forms. A set of questionnaires that consisting of four components is created using Google Forms. The four components comprised in the questionnaires are Demographic, User Acceptance Level, Level of Functionality and Learning Outcome Acquisition in Save Ocean.

Component 1, Demographic shows that one (10%) respondent is 7 years old, 10 years old and 11 years old respectively, 2 (20%) respondents are 8 years old, and the rest 5 (50%) respondents are all 12 years old.

Next, Figure 6 reveals the result of Component 2, which is the User Acceptance Level of Save Ocean. Based on Figure 6, there are five questions in Component 2 to determine the result of the User Acceptance Level. Question 1 is "Learning how to play the game is easy for me". 80% of users agree that the gameplay of Save Ocean is easy to learn while 20% of other users choose the option of neutral. Next, "I think that playing the game is fun" is Question 2. 60% of respondents agree that the game is fun and 40% of respondents strongly agree with this statement. Moreover, Question 3 shows that all users agree that the interface design is appealing. Furthermore, Question 4 is "I intend to complete all levels in Save Ocean". According to the bar chart, 30% of respondents choose neutral and strongly agree respectively, while 40% agree with the statement. As the game progresses to higher levels, it will be more challenging to complete causes some users to answer neutral. In addition, the result of Question 5 proves this reason is true. For Question 5, 60% of users agree that the game is challenging, while 30% choose neutral. However, one user finds that the game is not challenging enough. As a result, the user acceptability level results show good and positive feedback from the respondents.

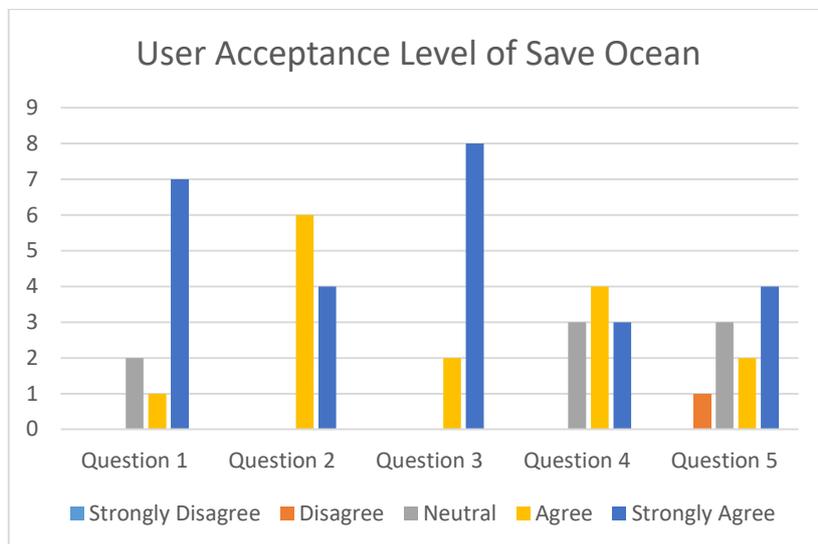


Figure 6: Result of Component 2

Based on Figure 7, Component 3 is the Level of Functionality of Save Ocean and it consisted of 4 questions. The first statement in Component 3 is "My interaction with the game is clear". The bar chart depicts all users agree that their interaction with the game is clear. Next, Question 2 depicts that only 10% of respondents choose neutral for this statement, while 90% of respondents agree that the interaction is understandable. For Question 3, "I understand the use of the buttons in Save Ocean", all users agree that the use of the buttons is understandable. Furthermore, Question 4 reveals that all respondents agree they can hear the background music during the game. Hence, it can be stated that the functionality of Save Ocean is in the range of above-average to high.

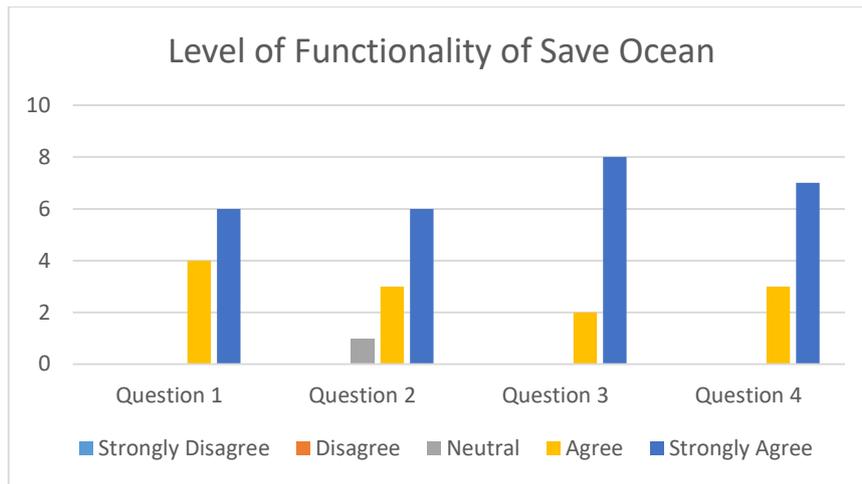


Figure 7: Result of Component 3

As presented in Figure 8, there are five questions in Component 4 to determine the result of Learning Outcome Acquisition. For Question 1, all respondents agree that they understand they should not pollute the ocean after playing some levels in the game. Besides, "I understand the seriousness of ocean pollution in 2020 after playing Level 3 in the game" is the statement of Question 2. From the result, 70% of users agree that they understood the seriousness of ocean pollution in 2020. However, 30% prefer neutral for this statement because they not intend to complete all levels in Save Ocean. Moreover, Question 3 is "I understand the effect of ocean pollution after playing some levels in the game". 10% of respondents disagree that they understand the effect of ocean pollution, while 20% are neutral with the statement. This is because some of the users only play until Level 2 and respond that the effect of ocean pollution is not obvious in Level 1 and Level 2. The rest 70% of respondents agree with the statement. Furthermore, "I know the sources that caused ocean pollution after playing some levels in the game" is the statement of Question 4. Based on the result, 80% of users agree that they know the causes of ocean pollution, while 20% of users choose neutral and disagree with the statement. Last but not least, Question 5 is "I understand more about marine organisms after playing the game". Based on the bar chart in Figure 8, 10% of users disagree that he understands more about marine organisms because he only focuses on completing the game and ignoring the Info Panels that introduce the marine organisms. The other 20% of users are neutrals with the statement, while 70% agree that they know more about marine animals after playing Save Ocean. According to the bar chart in Figure 8, all five questions were answered positively, meaning that the aim of the game to create awareness and enhance learning was met.

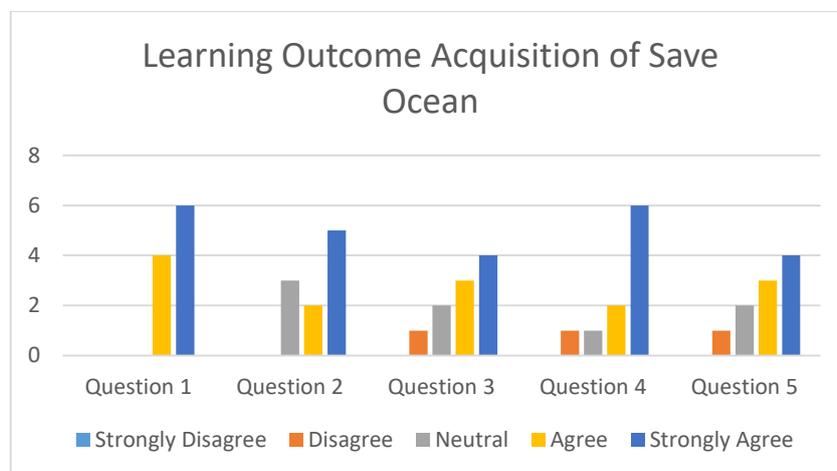


Figure 8: Result of Component 4

To conclude, Save Ocean's overall percentage of beta testing resulted in a positive outcome, with a percentage gain of 87.6%. The result indicates that the overall outcome is satisfactory since most of the criteria for user expectation and satisfaction have been reached.

5. Conclusion

In conclusion, Save Ocean is an application suitable for the target users to increase their awareness of ocean pollution through gamification. Save Ocean has some advantages, such as it has a high user acceptance level, which means that children find the game enjoyable to play, and it has a high level of functionality. In addition, Save Ocean can increase children's awareness on ocean pollution, which the world is currently suffering. Next, it has various multimedia elements such as textual information, graphical icons, animation, video, background music, and sound effects. Besides, the users can download Save Ocean from Google Play Store and play it offline.

However, a coin has two sides. There are some deficiencies found in Save Ocean after testing was conducted. By way of illustration, there are only 3 characters designed in the game. Therefore, the users can purchase all the characters in just a short time. In addition, only one booster is designed in the game. Besides, the purchased characters in the application are a bit hard to control. After discovering some of the flaws and gathering feedback from the tested users, some improvements can be made to Save Ocean, such as designing more characters that the users can purchase. In addition, develop different strength on each character to show their specialty. Next, provide more boosters in the game, such as a power that can automatically collect the plastic bottles and an acceleration that can increase the character's moving speed. Last but not least, the characters' movement can be adjusted from joystick control to UI buttons control. Therefore, the users can press the buttons to move forward, backward, left, and right.

To summarize, Save Ocean is a successful game developed using a well-planned Game Development Life Cycle methodology and received positive feedback from users during testing. Furthermore, all three project objectives have been met, and the application has potential to be further enhanced.

Acknowledgement

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Appendix A

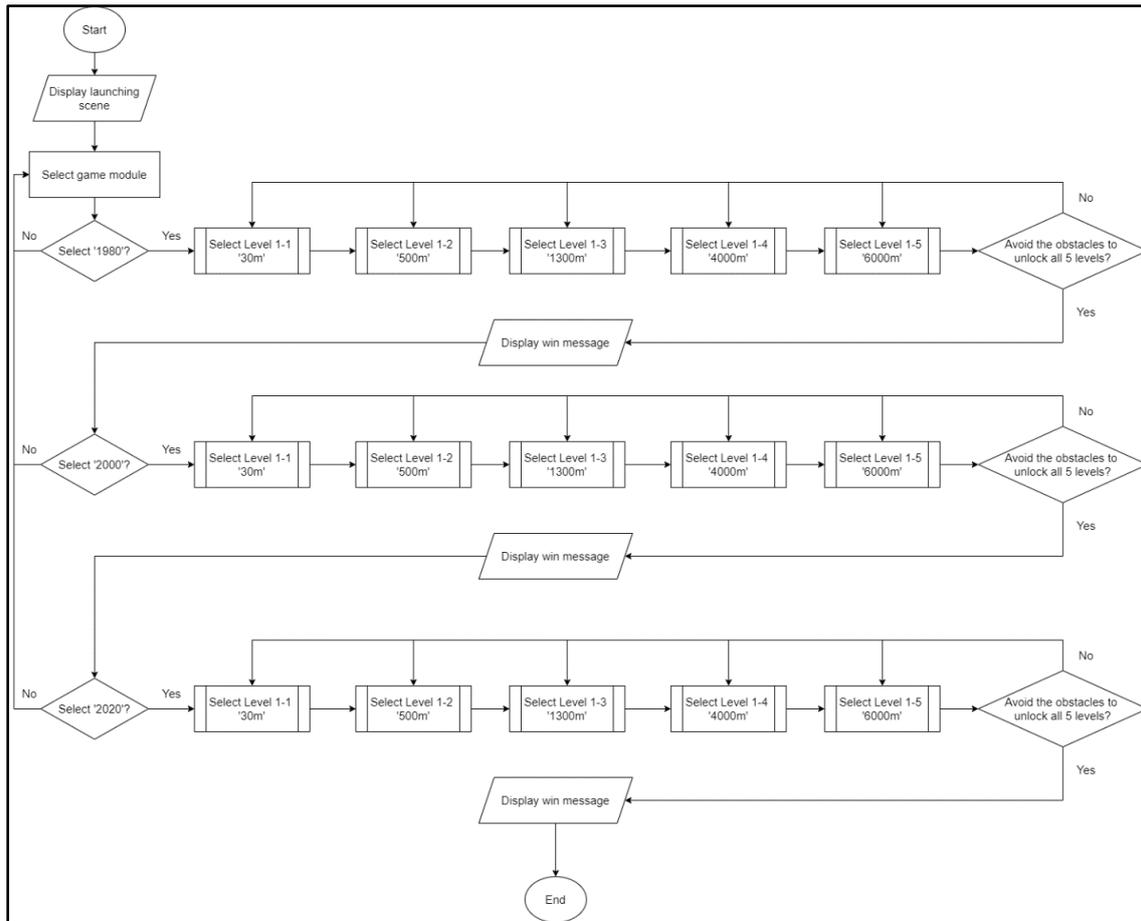


Figure 9: Main flowchart

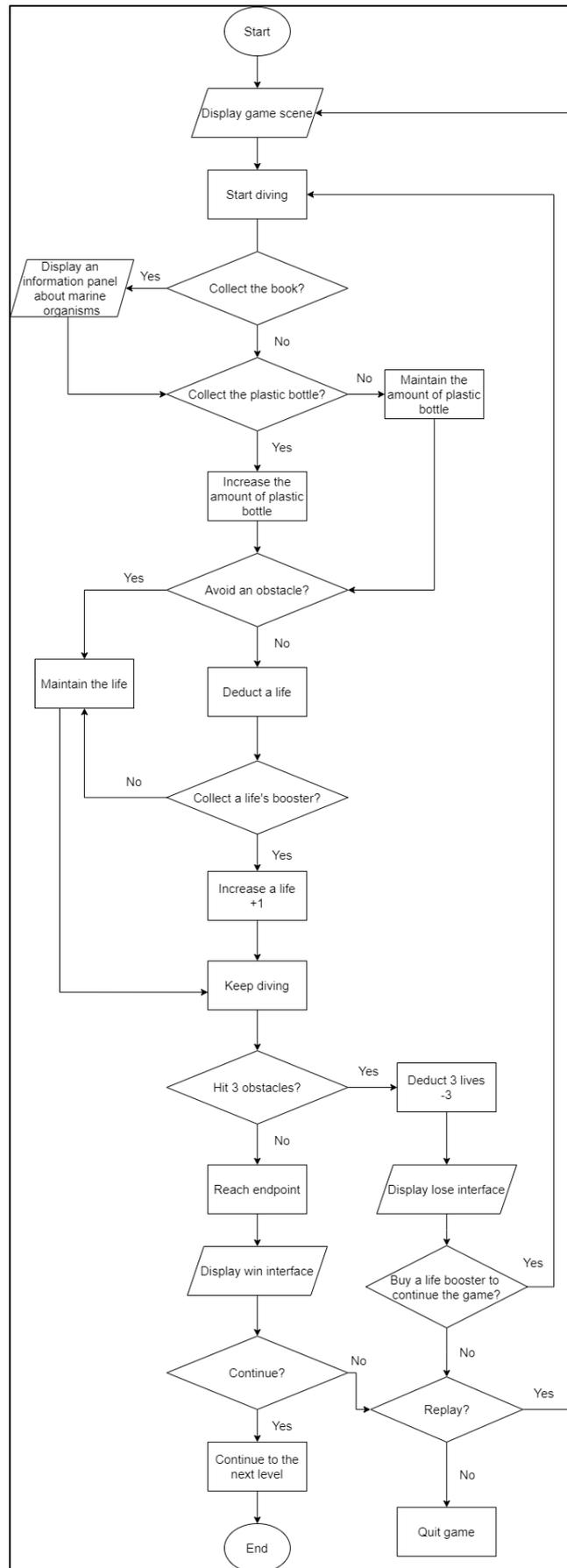


Figure 10: Sub-levels' flowchart

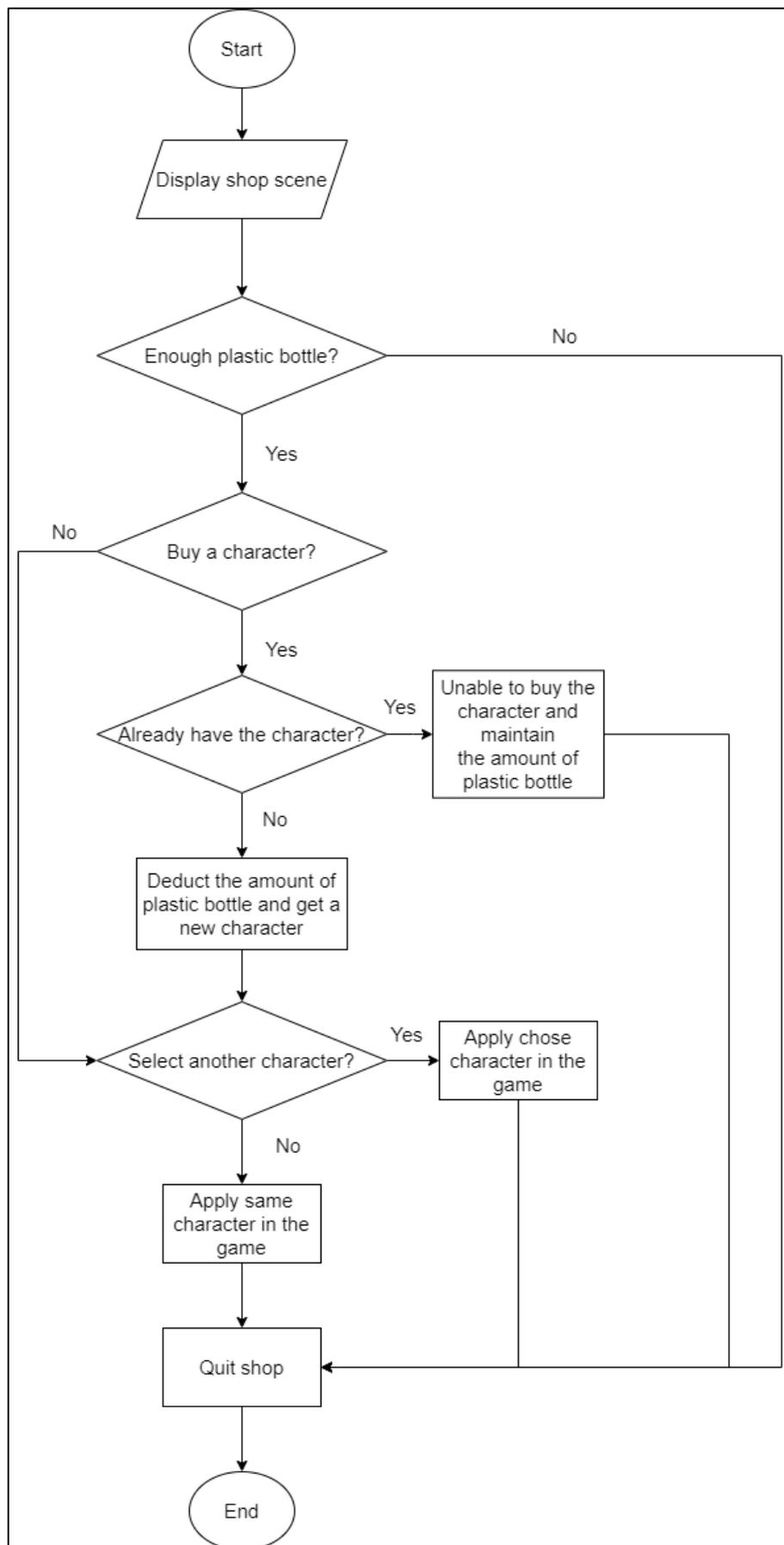


Figure 11: Shop's flowchart

Appendix B

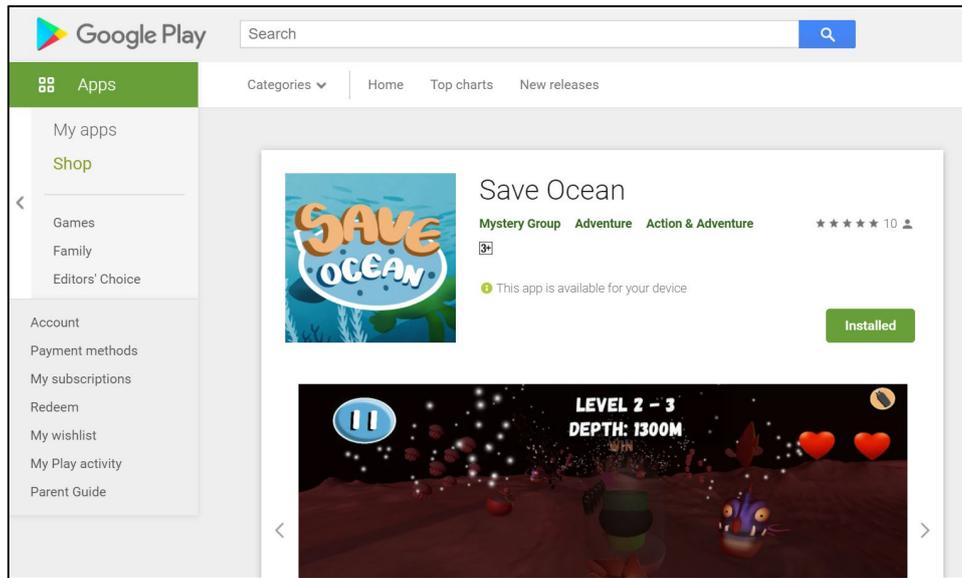


Figure 12: Save Ocean on Google Play Store

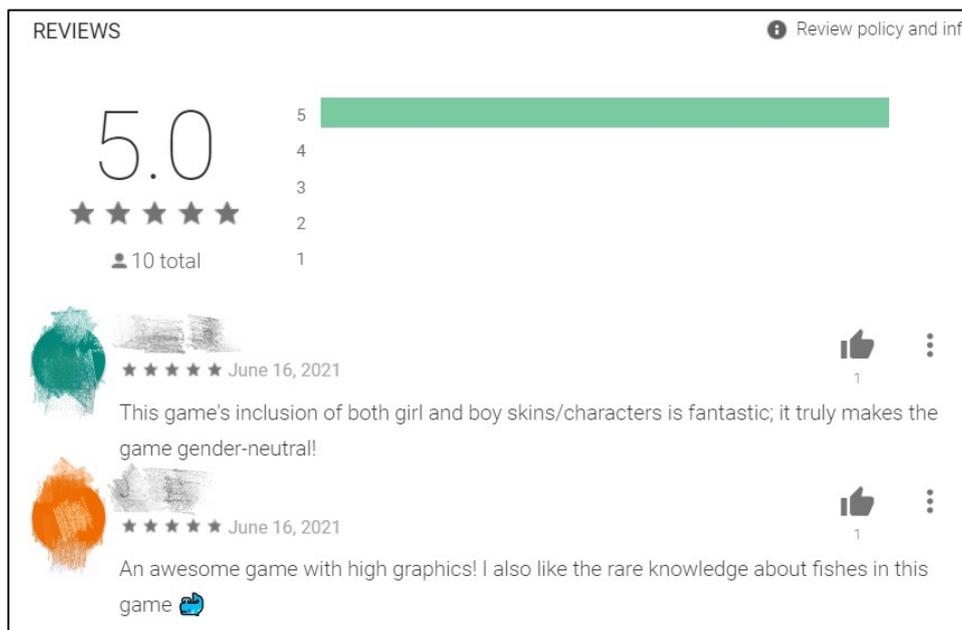


Figure 13: The reviews for Save Ocean on Google Play Store

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