

**PURIFICATION: A SERIOUS GAME OF
ENVIRONMENTAL ISSUES**

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**Bachelor of Computer Science (Graphics &
Multimedia Technology) with Honors**

UNIVERSITI MALAYSIA PAHANG

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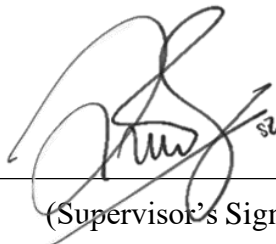
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PURIFICATION: A SERIOUS GAME OF ENVIRONMENTAL ISSUES

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ABSTRAK

Dalam beberapa dekad terakhir, masalah lingkungan baru muncul dan sejumlah masalah lingkungan membinasakan seluruh planet kita. Selain membangun perekonomian dan meningkatkan kualitas hidup, orang tidak peduli tentang pentingnya perlindungan lingkungan. Meskipun pemerintah dan kelompok lingkungan sedang mempromosikan pentingnya perlindungan lingkungan melalui poster, iklan, dan ceramah, masih ada kekurangan tindakan untuk melindungi lingkungan. Terutama remaja saat ini, mereka akan menemukan aktivitas ini membosankan. Oleh karena itu, proyek ini adalah untuk mengembangkan sebuah game serius bernama "Purifikasi", yang berfokus pada meningkatkan kesadaran masalah lingkungan di antara grup usia remaja. Dalam proyek ini, masalah lingkungan dapat dikategorikan ke dalam lima kategori: polusi udara, polusi air, deforestasi, perubahan iklim, dan pengelolaan sampah. Tujuan dari proyek ini adalah untuk meneliti mekanisme game dari game serius platform 2D yang dikembangkan, untuk merancang dan mengembangkan sebuah game serius platform 2D dengan cerita dan gameplay yang terpadu, dan mengevaluasi fungsionalitas game serius platform 2D yang dikembangkan. Proyek ini dikembangkan dengan menggunakan metodologi Rapid Application Development (RAD), yang ditujukan untuk pengembang individu yang perlu menyelesaikan proyek dalam waktu singkat. Game ini dikembangkan menggunakan mesin Unity, dirancang menggunakan Clip Studio Paint dan Photoshop, dan menggunakan audio bebas royalti dari internet. Produk akhir diterapkan pada platform PC dan di Itch.io, sebuah halaman web di mana orang bisa mengunggah atau memainkan game. Hasil yang diharapkan dari proyek ini adalah bahwa pengguna bisa memainkan game dan mencapai tujuan proyek yang ditetapkan.

ABSTRACT

Over the past few decades, new environmental problems have emerged, and a series of environmental problems have devastated our entire planet. Apart from developing the economy and improving the quality of life, people do not care about the importance of environmental protection. Although the government and environmental groups are promoting the importance of environmental protection through posters, advertisements and lectures, there is still a lack of action to protect the environment. Especially young people these days, they will find these activities boring. So, this project is to develop a serious game called "Purification", which focuses on raising awareness of environmental issues among the youth age group. In this project, the environmental issues can be categorized into five categories: air pollution, water pollution, deforestation, climate change, and waste management. The objective of this project is to study the game mechanics of the developed 2D platform serious game, to design and develop a 2D platform serious game with a combined storyline and gameplay and evaluate the functionality of the developed 2D platform serious game. This project is developed by using the methodology of Rapid Application Development (RAD), which is intended for individual developers who need to complete projects within a short period of time. The game is developed using the Unity engine, designed using Clip Studio Paint and Photoshop, and uses royalty-free audio from the internet. The final product is deployed on PC platforms and on Itch.io, a web page where people can upload or play games. The expected outcome of this project is that users can play the game and achieve the stated project goals.

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LIST OF SYMBOLS

LIST OF ABBREVIATIONS

GDD	Graphic Design Document
RAD	Rapid Application Development
SDLC	Software Development Life Cycle

CHAPTER 1

INTRODUCTION

1.1 Introduction

Over the last several decades, new environmental issues have piled on top of existing ones, and a range of environmental issues have impacted our whole planet. In this project, there are several of the world's most pressing environmental issues may be classified into five categories: air pollution, water pollution, deforestation, climate change, and waste management. The fast urbanization or industrialization in emerging economies, along with the public's desire of a luxury contemporary lifestyle, but it have resulted in a gradual degradation of the environment, it is affecting every person, animal, and country on the world. For developing countries, the basis of economic growth is to accomplish the industrialization of the country, which is also an essential point endorsed by many economists [1]. The deterioration of the environment and the depletion of resources, as well as the absence of sufficient public awareness and consciousness of the issue of environmental degradation, make attempts to protect the environment seem weak and insignificant. Although there are various public awareness programs about these environmental issues, the current epidemic is still raging, which has kept the public from participating in these programs, and these programs are not effective because they are unattractive. One strategy to raise public's attention to environment-related issues during a pandemic is using the technology.

With the advancement of science and technology and the progress of the times, activities to enhance public awareness are no longer restricted to the organizing of conferences or different large-scale events. The development of serious games is precisely one of the effective methods in which public awareness can be improved. Moreover, innovative approaches such as game - based learning are more conducive to generating public awareness than traditional ways [2]. According to a study, the serious

games keep the primitive gaming skills techniques but consistently to achieve goals and spread awareness (D. Gupta and K. Gupta, 2019). Beyond that, the awareness of environmental issues should not stop at the stage where children learn to connect with the world around them but should raise awareness and responsible attitudes towards environmental issues for all. Serious games can do that. This is all because the essence of serious games is not entertainment, but it is a combination of learning strategies, knowledge, simulation, and structure.

The educational value of serious games and their potential to engage people make serious games a potential tool for raising public awareness (Sayers, 2006). This project is to develop a serious game called "Purification" which aimed to raise the public awareness on the importance of environmental awareness in creating a healthier living environment. By introducing serious games, the project also hopes that the public can pay attention to the large and small environmental problems that occur on the earth and guide them to explore the joy of learning through serious games.

1.2 Problem Statement

With the development of economy and society, environmental pollution has become significantly since the 19th century, and it is become even more serious now. Although environmental issues and risks have received more attention from academia and the media, in the absence of legal and economic frameworks for environmental protection, many countries and ordinary people still lack efforts to protect environmental behaviours. [5]

Besides, the rural areas are frequently assumed to be less affected by modern environmental challenges. However, in a globalized world, most rural areas have encountered increasing environmental threats in recent years that threaten the sustainability and resilience of many rural systems. And the categorized four major environmental issues of air pollution, water pollution, waste management and deforestation are seriously affecting human health and living environment. The environmental pollution has become a serious problem that threatens human existence [6], which can cause at least 9 million deaths every year.

According to a study, the environment has changed somewhat since the outbreak of COVID-19, with improvements in air quality in many regions due to movement restrictions and a sharp slowdown, and reductions in water pollution in different parts of the world in social and economic activities (Rume & Islam, 2020). Obviously, whether the quality of the environment declines or improves depends on human behaviour. However, there is a low level of attention in environmental issues and the awareness of the consequences of protecting environmental issues is very weak. As the Health Minister of Malaysia, Datuk Seri Dr Dzulkefly Ahmad said, Malaysians' awareness of environmental protection is still at a low level, and many people are unaware of what is happening in the environment, including that health and the environment are closely related, and environmental pollution can also cause disease and become a global burden. (New Straits Times, 2019)

Traditional methods of raising environmental awareness, such as leaflets and posters, are becoming increasingly ineffective in today's society. With the rise of digital media, people are less likely to pay attention to physical materials, and they are more likely to rely on the Internet for information. Additionally, the one-way nature of traditional methods, where information is merely presented to the public, is inadequate in creating real change. These methods do not provide opportunities for active engagement and dialogue between the public and environmental organizations, which is essential for creating a more effective and lasting impact. Therefore, traditional methods of raising environmental awareness are limited in their ability to create meaningful change and it is important for organizations to explore more innovative and interactive methods to reach and engage with their target audiences.

In conclusion, in order to effectively deliver environmental awareness to the public, there is a need for a method that is suitable for public implementation, and serious games which based on game-based learning is a perfect choice. Serious games are effective teaching and training tools for people of all ages because they are highly motivating and purposeful, so they can effectively convey concepts and facts about current issues from the game content, thus allowing players to raise awareness. So, this project decided to develop a 2D platformer serious game about the environmental issues and it is aimed to be able to evaluate its functionality and impact.

1.3 Objectives

- 1) To study the game mechanism of the developed 2D platformer serious game.
- 2) To design and develop a 2D platformer serious game that combines storytelling with gameplay.
- 3) To evaluate the functionality of the developed 2D platformer serious game.

1.4 Scope

Target User : Users in youth age range (15 – 24 years old)

Themes : A 2D platformer serious game with categorized 5 main environmental issues.

Software/Tools Used : Unity, Clip Studio Paint and Photoshop.

- 1) The 2D platformer serious game developed in this project categorized 4 main environmental issues into game themes.
- 2) The game environment of this serious game is start from rural area to urban and then to global.
- 3) This serious game does not available on mobile platform.
- 4) To create a minimum of 5 levels which representing the environmental issues that facing by different regions.
- 5) To convey the storyline of the serious game which provide better understanding.

1.5 Significance of the project

The serious game to be developed in this project is significant from the point of view of public awareness application or education. This project is focused on developing a 2D platformer serious game about the environmental issues which could raise public awareness and compose a positive impact on human or the environment.

1.6 Report Organization

This thesis report consists of five chapters. Chapter 1 is the introduction of the proposed application. Chapter 1 discusses about the problem statement, objectives, and the scopes of project.

Chapter 2 is discussed about the literature review. The research is focused on the discussion of 3 existing applications that available in the market which could having a comparison with the proposed application.

Chapter 3 is discussed on the methodology that used to develop the proposed application. This chapter covers the proposed game interface design of the proposed application.

Chapter 4 discusses the implementation, results, and discussion of the project. It delves into the steps taken during the project's creation and execution and presents the findings and their analysis.

In the final chapter, Chapter 5, a summary of the project is provided, highlighting any limitations and potential areas for improvement in future iterations of the project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this project, several games have been selected for literature review. Due to the scarcity of serious games focused on environmental issues, this project will select some other platformer games with some same details as this project for literature review.

2.2 Environmental Issues

Air pollution, water pollution, deforestation, climate change and waste management are categorized as few of the world's most significant environmental challenges within this project. The rapid urbanization or industrialization in growing countries, coupled with the public's desire for a modern lifestyle, has resulted a gradual environmental degradation, which affects every person, animal, and country on Earth. However, whether it is the government, educational institutions, or environmental protection departments, they are all trying to raise people's awareness of environmental protection, and the traditional methods are nothing more than holding rallies, parades, publishing articles, and placing advertisements or posters.

This project has conducted a survey to understand the respondent's awareness of environmental issues and their views or requirements on this project as shown in the section 3.4.2.2 and appendix 1. In the survey results of question 6 and 7, there is only 11 respondents found the environmental protection advertisements and posters and only 8 respondents participated in related environmental protection activities. Therefore, it is obviously show that these traditional methods have been unable to effectively convey environmental information and raise public awareness.

So, to spread the awareness for environmental issues in a modern and interesting way, a 2D platform serious game developed in this project categorized 4 major environmental issues into game themes, namely water pollution, air pollution, waste management and deforestation. In this game, environmental issues for each theme will be shown in the game levels how they affect the environment and what the consequences have made. And the game environment of this serious game will be designed to be from rural to urban to global.

2.3 Existing System

There are 3 existing system that are available on the market that will be analysed and discussed here. There are Plasticity, Hollow Knight, and Sky: Children of the Light. The details and information of these games are discussed on its core gameplay, storyline, graphic or music that relevant with the proposed project.

2.3.1 Plasticity

Plasticity is a puzzled 2.5D platformer game, and this is a free game which developed by students at USC's renowned Games Program and offers between 20 and 40 minutes of gameplay. The available platform is on Steam for Microsoft Windows on May 24, 2019.



Figure 2.1 The cover photo of Plasticity

Figure 2.1 above shows the cover photo of Plasticity game. Plasticity is a beautiful puzzle platformer in which players explore a world filled with plastic. Along the way, players will travel through flooded cities and ravaged lands, and the choices players make in the game will profoundly change the gameplay and the future.



Figure 2.2 Plasticity in-game screenshot-1



Figure 2.3 Plasticity in-game screenshot-2

Plasticity is a 2.5D single-player game, so its game controls are relatively simple. The figure 2.2 and 2.3 shows the tutorial part of the game, the in-game controls is using up, down, left, and right key to move forward, backward, left, and right. And the CTRL key is for grabbing something in the game. Because it is 2.5D, players could not move freely like in the 3D open world, it only allows players move in platformer route.

In Plasticity, players need to solve the puzzle to continue the journey, sometimes need to push the box to climb the wall, find the electric door to open the door, do somethings that related to protect environment and so on.



Figure 2.4 Plasticity in-game screenshot-3

Figure 2.4 shows the Plasticity in-game screenshots 3 which is one of a puzzle part in the game, the player should help the villagers clean the beach. Players make own choices that might help or harm the world in Plasticity, so it comes to different ending.



Figure 2.5 Plasticity in-game screenshot-4

The Figure 2.5 shows another in-game screenshot of Plasticity, the ending part of the game which will ask player to restart the game. The aim of the game is "it's never too late to make a change" and each ending will allow the player to reopen the interface, allowing the player to replay the game and make different choices to save the world. The

developers of Plasticity also showed that the game's intention is that small changes can join a broad wave of metamorphosis, no matter how bad the environment looks [9]. It encourages a positive attitude towards environmental issues. It uses a soft soundtrack to iterate the game's narrative rhythm and emotional progression, allowing the player to empathize more even facing of harsh reality in the game.

2.3.2 Hollow Knight

The second existing application is Hollow Knight which is a very famous 2D platformer game. Hollow Knight is a 2D side-scrolling action-adventure video game in the Metroidvania style. It was developed by Team Cherry and initially published for Microsoft Windows on the February 24, 2017, then is it subsequently released on macOS, Linux. It was ported in 2018 to the Nintendo Switch, Xbox One and PlayStation 4 by Jump Shark Studios.



Figure 2.6 The cover photo of Hollow Knight

The Figure 2.6 shows the cover photo of Hollow Knight. The game's player is the Knight, a nameless warrior who is unsure of his or her identity or origin. The Knight journeys to Hallownest, a once-thriving country whose citizens have been brainwashed. The game is set in a variety of places and involves both friendly and hostile bug-like characters as well as a large number of bosses. Players may earn new skills as they explore each site, as well as discover pieces of lore scattered around the universe.

In classic Metroidvania style, knights cannot explore specific regions of the world unless they have obtained equipment or skills. Numerous locations contain a "boss" adversary that the knight must defeat to progress on, and there are many sub-bosses that drop valuable rewards or upgrades.



Figure 2.7 Hollow Knight in-game screenshot-1

According to the Figure 2.7 shows the Hollow Knight in-game screenshot. By defeated the enemies, the currency Geo dropped, the knights may use the Geo to purchase items from merchants. If the knights are dead, they respawn where they last rested and lose all geography. Then they have to travel back to where they died and battle their shadows to recover the currency. Knights also collect souls by attacking enemies, which they may later utilize to replenish lost health or trigger special powers. Health can also be restored at hot springs distributed across the world or resting on a bench.

According to the development team of Hollow Knight, they decided to use the capabilities of Unity's built-in development tools and extensions available on the Asset Store to accomplish their technical aims(*Hollow Knight - An Adventure Game | Made with Unity*, n.d.).



Figure 2.8 Hollow Knight in-game screenshot-2

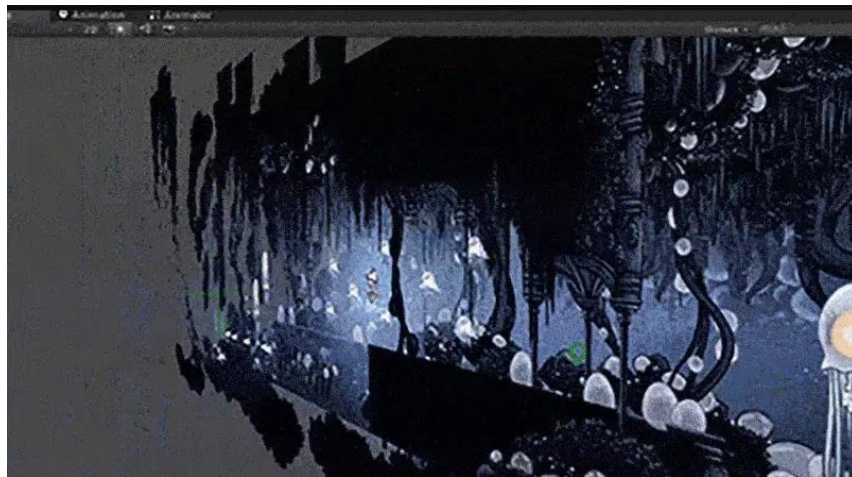


Figure 2.9 Parallax view of 2D game assets for Hollow Knight game environment

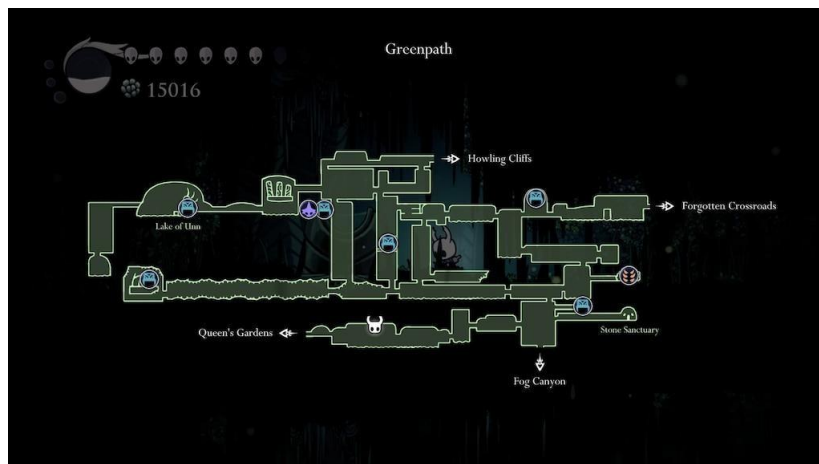


Figure 2.10 The game map of Hollow Knight

They create eye-catching visual styles with hand-drawn graphics and classic animations generated in Photoshop and save them as basic PNGs. They are using parallax views and layered 2D game assets which is showed on figure 2.9. Rather of relying on a complicated 3D lighting system, game scenery and actors are lit using soft, translucent forms. The team leveraged Unity's several out-of-the-box 2D technologies, including as 2D Physics, Sprite Packer, and Particle Systems, to create levels using layered 2D assets in a 3D environment, utilizing the Asset Store's 2D Toolkit.

2.3.3 Sky: Children of the Light

Sky: Children of the Light (short form to Sky in game) is a mobile game which is designed as an open world social indie adventure game developed and published by Thatgamecompany and the designer is Jenova Chen. The first globally released for iOS on 18 July 2019. An Android version was later released on 7 April 2020 and a Nintendo Switch version is planned to release in 2021. The main game genres of this game are adventure, art, role-playing and indie.



Figure 2.11 The cover photo of Sky: Children of the Light

The figure 2.11 shows the cover photo of Sky: Children of the Light. The story begins in a kingdom where in its sky was filled with stars and constellations, but all the nights are gone missing in one night. Time has passed and player wake up as the child of

light. And player's mission is seeking fallen stars which is the ancestral spirits of the realms and restore them to the sky.



Figure 2.12 Example of one of the light creatures



Figure 2.13 Example of the dark creatures

In the world of Sky, there are a variety of animals or plants, they are beneficial or dangerous. There are two types of creatures in the sky: light creatures and dark creatures. Bright creatures will have their own light and allow the player to regenerate energy which shown on Figure 2.12 the example of one of the light creatures in Sky. The Figure 2.13 shows the example of dark creatures that will threaten the player's life, and when the player is attacked by these dark creatures, their energy is reduced. These creatures bring players a different experience and gameplay, and these light creatures will also help players on their journeys. For example, when the player is attacked by the dark creature, player can return to the position of the light creature to rest and replenish energy, so that the player can go farther and fly higher. Some of the light creatures are trapped by the dark creatures, the player could clear the darkness to save and release the light creatures.

2.4 Comparison of Existing System

2.4.1 Analysis of comparison on existing system

Table 2.1 below is a comparative analysis of the three existing related games. This table discusses and analyses the game specifications of the three existing games, such as the comparison of game platforms, game types, game engines, game modes, prices, in-app purchases, and game advantages and disadvantages.

Table 2.1 Comparison between the existing games

Specification	Existing System		
	Plasticity	Hollow Knight	Sky: Children of Light
Platform	<ul style="list-style-type: none"> • PC 	<ul style="list-style-type: none"> • Microsoft Windows • MacOS • Linux • Nintendo Switch • PlayStation 4 • Xbox One 	<ul style="list-style-type: none"> • iOS • Android • Nintendo Switch
Game Genre	<ul style="list-style-type: none"> • Puzzle platformer 	<ul style="list-style-type: none"> • Action-adventure, Metroidvania 	<ul style="list-style-type: none"> • Open world social indie adventure game
Game Engine	<ul style="list-style-type: none"> • In-house engine 	<ul style="list-style-type: none"> • Unity 	<ul style="list-style-type: none"> • Phyre Engine
Graphic	<ul style="list-style-type: none"> • 2.5 D 	<ul style="list-style-type: none"> • 2D 	<ul style="list-style-type: none"> • 3D
Game Mode	<ul style="list-style-type: none"> • Single player 	<ul style="list-style-type: none"> • Single player 	<ul style="list-style-type: none"> • Multiplayer
Price	<ul style="list-style-type: none"> • Free 	<ul style="list-style-type: none"> • RM31 (Steam) 	<ul style="list-style-type: none"> • Free

In-app purchase	<ul style="list-style-type: none"> • No 	<ul style="list-style-type: none"> • Yes 	<ul style="list-style-type: none"> • Yes
Advantages	<ul style="list-style-type: none"> • Free of charge • Game control is user friendly • Clear storyline to deliver message to player • Suitable for all ages 	<ul style="list-style-type: none"> • Creative and artistic design of game environment • Game control is user friendly • A variety of game mechanics but easy to understand • The soundtrack is amazing 	<ul style="list-style-type: none"> • Easy to control • Unique storyline, realms, and music. • Solo player can also complete missions and expeditions on their own. • Suitable for all ages.
Disadvantages	<ul style="list-style-type: none"> • Lack of game contents • Only available in one platform 	<ul style="list-style-type: none"> • Need more hand- eye coordination controls • Some things need to be done repeatedly, like attack the enemies to collect currency 	<ul style="list-style-type: none"> • Might get lost in the game at the beginning. • Lack of game instructions.

2.4.2 Relevance of comparison with project title

By reviewing and analyzing 2D and 3D games related to environmental issues, serious games, puzzle or story-based games, there are three existing games are related to the proposed project were also selected for review in subsection 2.3 and performed the comparative analysis in subsection 2.4.1. The three existing games that analysed above were all selected for the literature review because they have some relevance to what the project will launch.

According to the analysis in subsection 2.3.1 of the first existing game, Plasticity contributed to the theme and story setting of this proposed project. By reviewing from the subsection 2.4.1, the theme of Plasticity is same as the proposed project (Purification),

both are based on environment theme. But Plasticity as a puzzle platformer game which is focuses more on letting players solve the puzzles in game. Purification will also have some puzzle-solving components, but it only as a mechanic for minor difficulty for the player. There is also a little similarity in both storylines, both designed to bring positive change to the environment.

The relevance between Hollow Knight and Purification is the graphic. Reviewing from the subsection of 2.3.2, Hollow Knight is using hand-drawn graphic as game assets and Purification does so. The game environment design of Purification is inspired from Hollow Knight, the layered game assets arrangement. This brings the feel of a 3D environment with 2D game assets. In Hollow Knight, the game level map is large, and players can walk up and down the map and take time to get where they want to go. The game level environment of "Purification" is designed with rural and urban backgrounds. The size of the level map is proportional to the difficulty of the level. The higher the difficulty of the level, the larger the size of the level map. Players can explore the map to complete the level tasks.

In Sky: Children of the Light, the relevance point is the two types of creatures which are the light and dark creatures which shown in the Figures 2.12 and 2.13, they are relevant to Purification. In Purification, light creatures will be butterflies and healing bloom zones while the dark creatures refer to creatures that have been mutated by environmental pollution, such as fish, corrosive plants, and so on.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This section is to discuss the methodology in game development. There are many types of software development life cycle (SDLC) that can be chosen. Each SDLC model has its own benefits and drawbacks that need to consider. Rapid application development is a term used to describe the iterative process of software development. These approaches are all designed to overcome difficulties that are prone to emerge with traditional development methodologies such as waterfall. Due to the project size is smaller, and there is only a single developer, so the methodology of Rapid Application Development (RAD) is chosen. The reason RAD was chosen is that one of the project's objectives is to provide a viable solution within the allocated timeframe, it can use prototypes to provide users to evaluate and give effective feedback during the development and testing process, and to make changes and clear potential problems early.

3.2 Project Management Framework

The methodology selected for this project is Rapid Application Development (RAD). Rapid Application Development (RAD) commonly referred to as Rapid Application Creation (RA), is an adaptive software development process designed to rapidly generate software prototypes and make frequent modifications based on continuous evaluation (*Rad Methodology - All You Need to Know - InApps*, 23 July 2022.). RAD is a development strategy for enhancing rapid prototyping and immediate feedback over long-drawn-out development and testing cycles. With fast application development, developer may make several iterations and modifications to a product

quickly without starting from scratch each time. This helps guarantee that the final output is more quality-focused and is in alignment with the end-user's objectives.



Figure 3.1 The System Development Life Cycle (SDLC) details stages of RAD

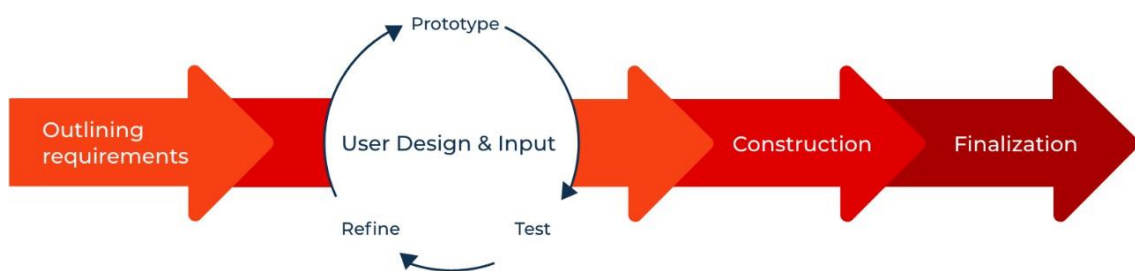


Figure 3.2 The condensed version of SDLC model of RAD

The Figure 3.1 shows the System Development Life Cycle (SDLC) details stages of RAD. And the Figure 3.2 shows the condensed version of SDLC model of RAD (*Rapid Application Development (RAD): Full Guide | Creatio, 2022.*). The planning and analysis process is in the outline requirements stage, the design, implementation, and testing are in the user design and input stage, the evaluation process is in the finalization stage.

Rapid application development (RAD) emphasizes speed and agility and is great for gaming development. This speedy pace is guided by RAD's skill and concentration on reducing effort during the planning phase, increasing and speeding prototyping, and consequently helping to expedite project release timelines. During the game creation phase, the needs of the game may be frequently updated feedback and testing.

3.3 Gantt Chart

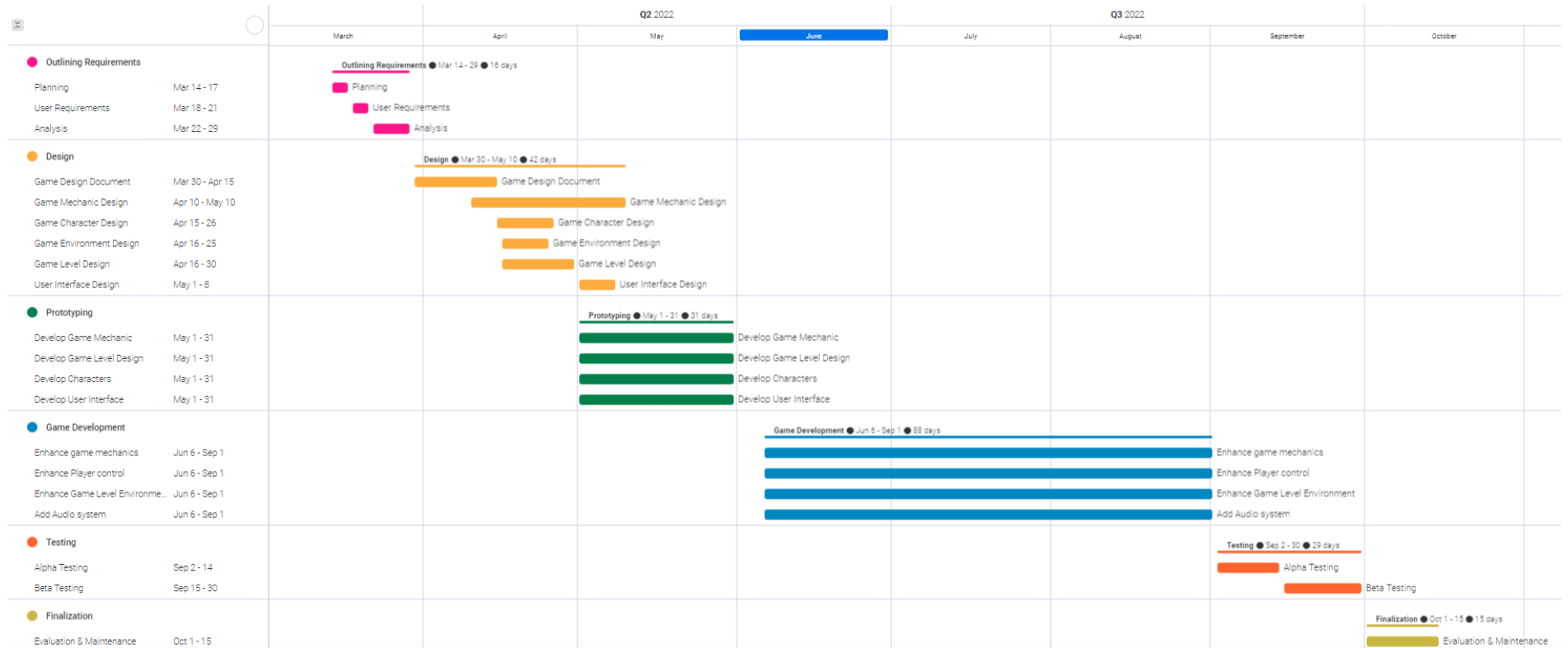


Figure 3.3 Gantt Chart of Purification

3.4 Phase 1 - Outlining Requirements

3.4.1 Planning

This planning phase is also known as the requirements planning phase. This phase corresponds to the determination of the project scope and use requirements. During this phase, developers, clients, and team members communicate to determine the goals and expectations of the project, as well as current and potential issues that need to be addressed during the build. That is, when determining the development of a serious game, it is necessary to clarify the development scope and requirements of the project and discuss and reach a consensus with the project director.

3.4.2 User Requirements

3.4.2.1 Observation

Gathering user requirements is an important process prior to the design phase. There are many techniques for gathering requirements, observation is one of the techniques used in this proposed project. By looking at recent news and people discussing topics around environmental issues. By observing the news in recent years, lightning floods, climate change, and excess waste brought about by various environmental problems are affecting the habitats of humans, animals, and plants. The most concerned news recently is the lightning flood and flash flood in KL. And the public and government are just found that the main reason is that the drains are full of garbage, rotten tree roots and trunks and animal carcasses. (Nuradzimmah Daim, 2022). So, it is obviously that the public is lack of awareness on environmental issues. Therefore, the proposed project is themed around environmental issues and aims to raise public awareness, and the rise of serious games has also moved the proposed project in the direction of its goals.

3.4.2.2 Questionnaire

In addition to gather and collect the user requirements through the method of observation, but also using the questionnaire. After completing the game prototype and

uploading it to Unity Play as a website platform, the users could fill out the questionnaire after playing the game prototype. The questionnaire is done with Google Form because it could summarize the survey results immediately with charts and graphs. There are two sections in this questionnaire which are demographic profile and views on Purification. The questions in Section A are focusing on understanding the respondents' demographic profile. While in Section B, 8 questionnaires were asked to get the respondents' views and suggestions on Purification. The Appendix A show the contents of questionnaire of user requirements and the survey results. The subsections of i. and ii. below show the analysis of the sections.

i. Analysis of Section A: Demographic Profile

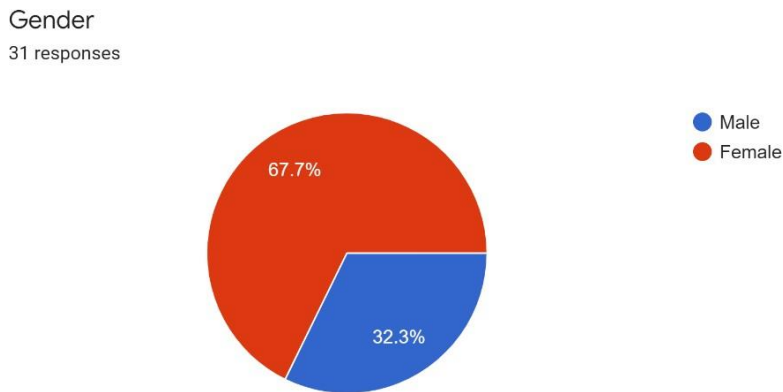


Figure 3.4 Gender of respondents in Pie Chart

Figure 3.4 above shows the survey result of gender of the respondents in Pie Chart. 67.7% of respondents are female and 32.3% of respondents are male.

Age
31 responses

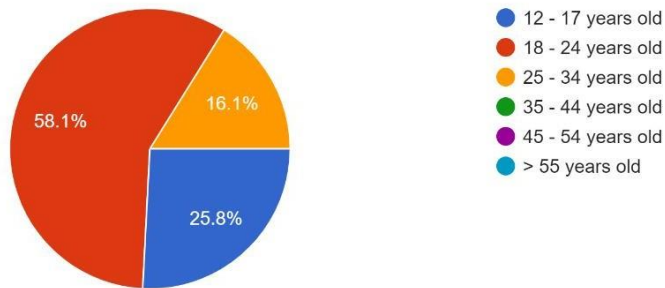


Figure 3.5 Age of respondents in Pie Chart

As seen in Figure 3.5 above, 58.1% of the respondents to this survey are between the ages of 18 to 24 years old, 25.8% of the respondents are from the age group of 12 to 17 years old and only 16.1% of the respondents are between ages of 25 to 34 years old.

Do you often play games?
31 responses

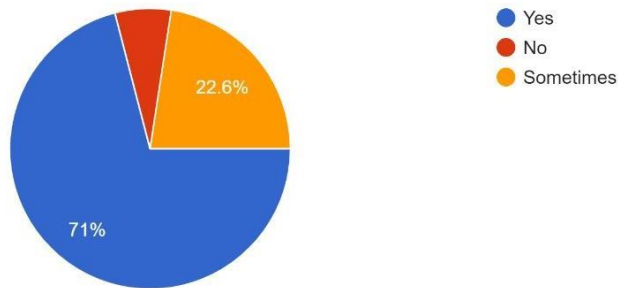


Figure 3.6 Survey result of Question “Do you often play games?”

The Figure 3.6 above shows the survey result of question “Do you often play games?”. There are 71% of respondents are often play games, whereas there are only 2 respondents do not often play games and 22.6% of respondents are playing games sometimes. So, most of the respondents are often play games.

What type of games are you interested in?

31 responses

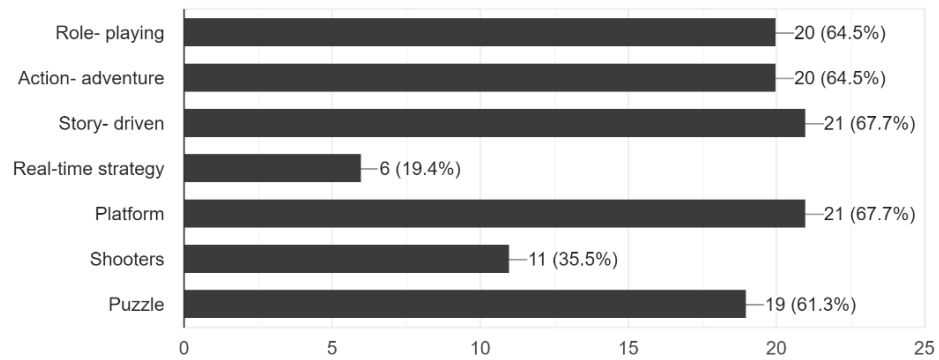


Figure 3.7 Survey result of Question “What type of games are you interested in?”

Based on the figure 3.7 above, story- driven and platform are the most interested game genres by respondents which accounted for the highest proportions at 64.5%. And 64.5% of respondents are interested in role-playing and action-adventure games.

Do you play serious game before?

31 responses

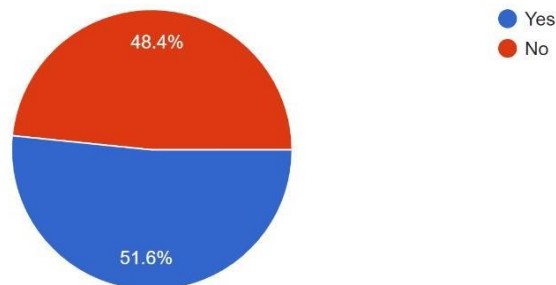


Figure 3.8 Survey result of Question “Do you play serious game before?”

The figure 3.8 above shows the pie chart of the survey results of question 5 in the questionnaire. 16 out of 31 respondents have played serious game before and 15 respondents do not play serious game before.

What environmental issues do you think are the most concern?

31 responses

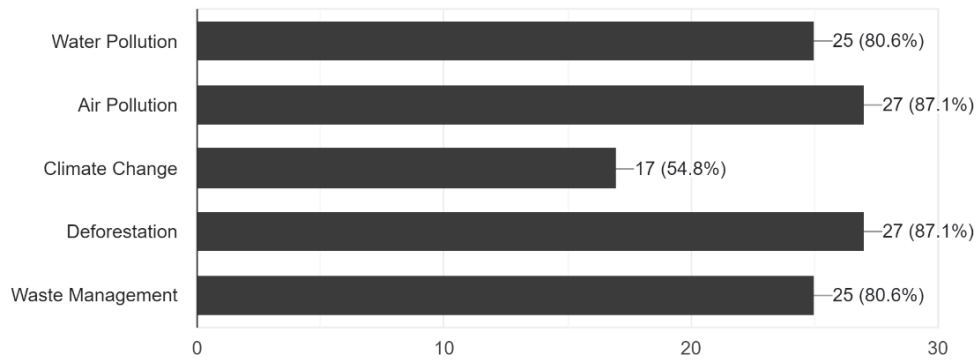


Figure 3.9 Survey result of Question “What environmental issues do you think are the most concern?”

Based on the figure 3.9 above, 87.1% of respondents think that air pollution and deforestation are the most concern environmental issues. Then, the second concern environmental issues are water pollution and waste management which are both accounted for the proportions at 80.6%. And there are 54.8% of respondents think that climate change is the most concern environmental issue.

Do you often see posters or advertisements about protecting the environment?

31 responses

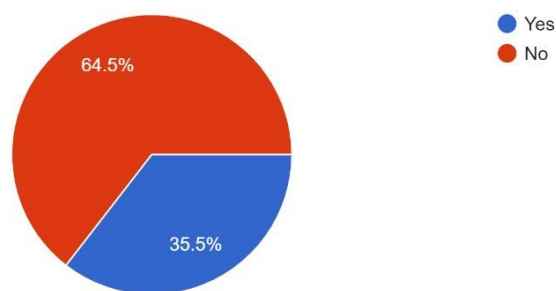


Figure 3.10 Survey result of Question “Do you often see posters or advertisements about protecting the environment?”

The figure 3.10 above shows the pie chart that there are 20 out of 31, 64.5% respondents do not see the posters or advertisements about protecting the environment

frequently and there are only 35.5% respondents do. So, there is a lack of action in disseminating environmental messages.

Have you participated in any online or offline activities with the theme of environmental protection?
31 responses

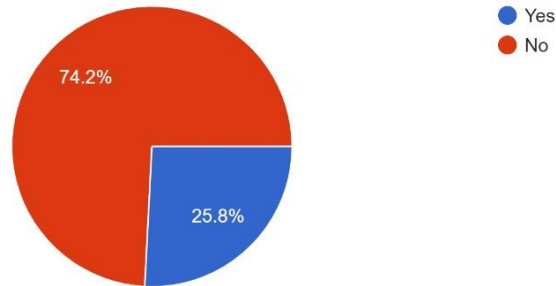


Figure 3.11 Survey result of Question “Have you participated in any online or offline activities with the theme of environmental protection?”

The figure 3.11 above shows the pie chart that most of the respondents are do not have participated in any online or offline activities with the theme of environmental protection which is accounted for the highest proportions at 74.2%. And only 25.8% have participated in.

ii. Analysis of Section B: Views on Purification

I can understand the story of this game through the dialogue between the Deer NPC and the player in the beginning.
31 responses

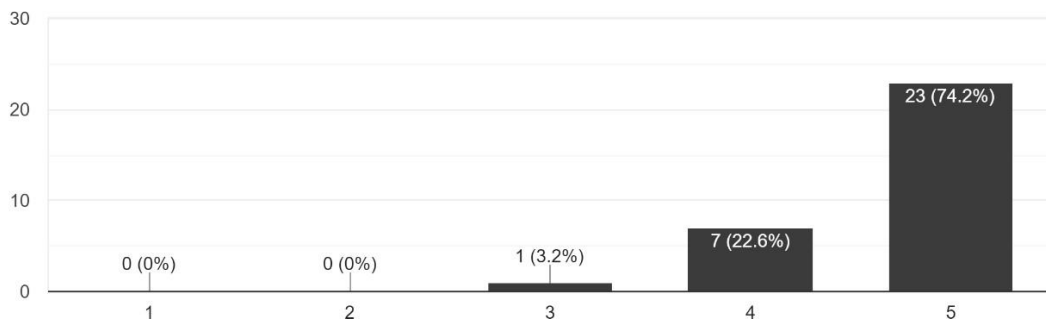


Figure 3.12 Survey result of “I can understand the story of this game through the dialogue between the Deer NPC and the player in the beginning.”

Based on the figure above, there are 23 out of 31 respondents are strongly agree that they could understand the story of this game through the dialogue between the Deer NPC and the player in the beginning whereas only 1 respondent is being neutral in this statement. Therefore, it can be concluded that the statement was understood by most respondents and that this way of conveying the story is acceptable and understandable.

I can understand the quest list and complete it.
31 responses

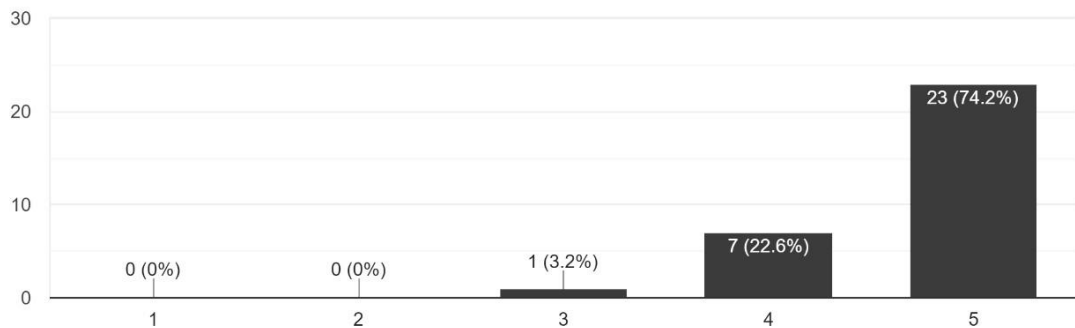


Figure 3.13 Survey result of “I can understand the quest list and complete it.”

Based on the figure 3.13 above, there are 23 out of 31 respondents which is accounted for the highest proportions at 74.2% are strongly agree that they could understand the quest list and complete it whereas only 1 respondent is being neutral in this statement. Therefore, it can be concluded that this game mechanics of quest list are understood by most of the respondents.

I can understand to use the picked up items to clear the trash.

31 responses

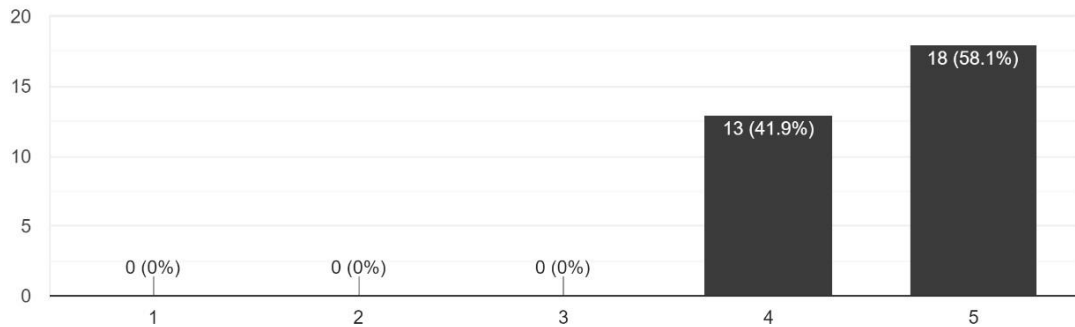


Figure 3.14 Survey result of “I can understand to use the picked up items to clear the trash.”

Based on the figure 3.14 above, there are 18 out of 31 respondents are strongly agree that they could understand to use the picked-up items to clear the trash in the game. And there are 13 out of 31 respondents are agree with this statement too. Therefore, it can be concluded that most of the respondents are agree that they understand this game mechanic.

The words and graphic are easy to understand the game content.

31 responses

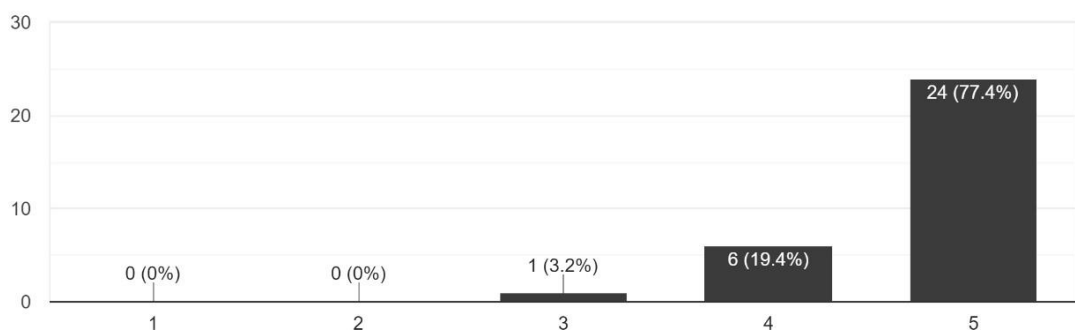


Figure 3.15 Survey result of “The words and graphic are easy to understand the game content.”

Based on the figure 3.15 above, there are 24 out of 31 respondents which is accounted for the highest proportions at 77.4% are strongly agree that they think that the words and graphic are easy to understand the game content whereas only 1 respondent is being neutral in this statement. Therefore, it can be concluded that the game contents are easy to understand.

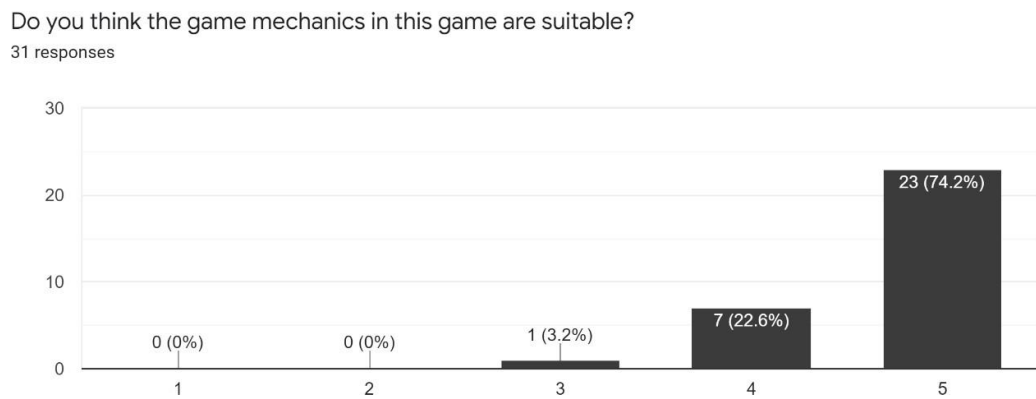


Figure 3.16 Survey result of Question “Do you think the game mechanics in this game are suitable?”

Based on the figure 3.16 above, there are 24 out of 31 respondents which is accounted for the highest proportions at 74.2% are strongly agree that they think that the game mechanics in this game is suitable whereas only 1 respondent is being neutral in this statement. And there are 22.8% respondents are agree with this statement. Therefore, it can be concluded that most of the respondents think the game mechanics used in the game are suitable.

Do you think it would be better that player could view the simple level map in game level?
31 responses

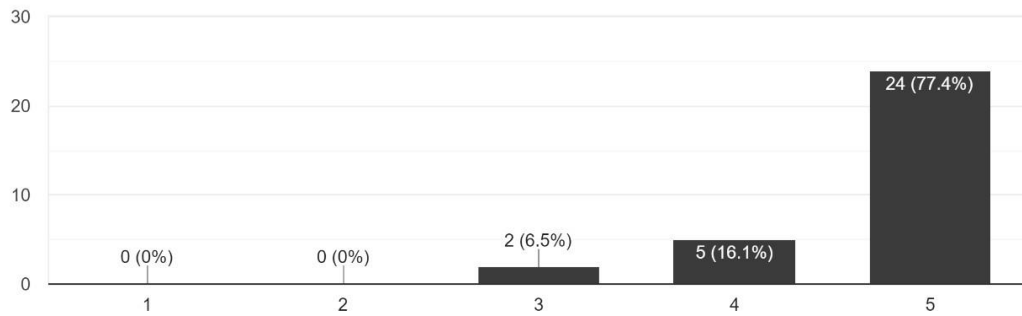


Figure 3.17 Survey result of Question “Do you think it would be better that player could view the simple level map in game level?”

Based on the figure 3.17 above, there are 24 out of 31 respondents which is accounted for the highest proportions at 77.4% are strongly agree that they think it would be better that player could view the simple level map in game level whereas only 2 respondent is being neutral in this statement. And there are 16.1% respondents agree with this statement. Therefore, it can be concluded that most of the respondents think a simple level map in game level is needed.

Do you think each level continues the storyline could makes people more understand the game content?
31 responses

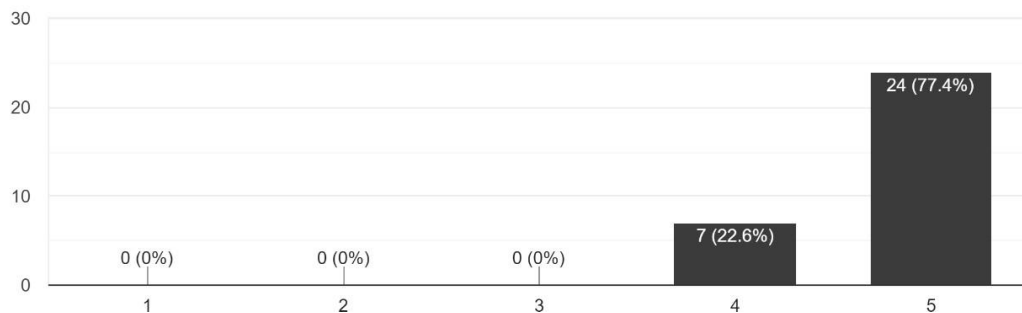


Figure 3.18 Survey result of Question “Do you think each level continues the storyline could makes people more understand the game content?”

Based on the figure 3.18 above, there are 24 out of 31 respondents are strongly agree that they think each level continues the storyline could makes people more understand the game content. And there are 7 out of 31 respondents are agree with this statement too. Therefore, it can be concluded that most of the respondents are agree that the game level continues with the storyline.

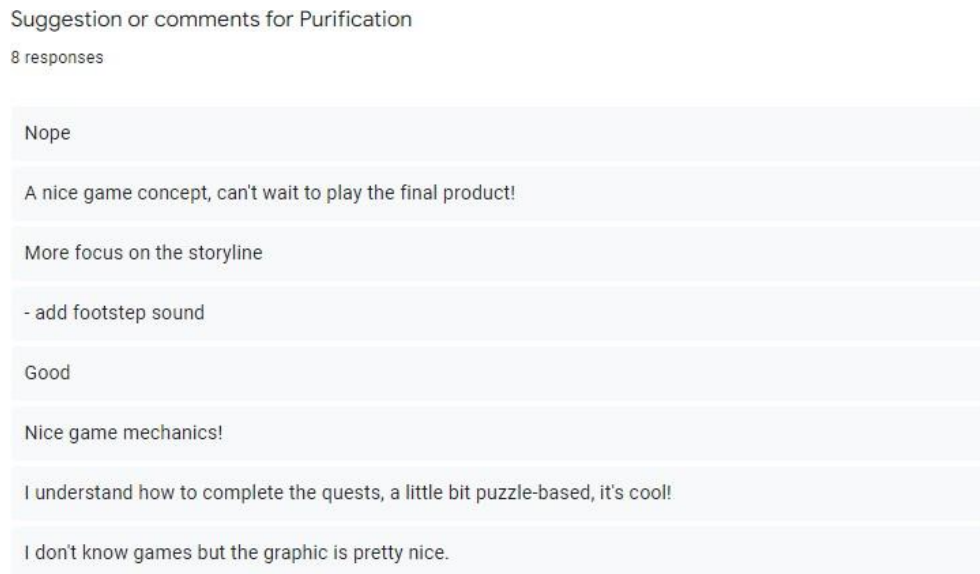


Figure 3.19 Suggestion or Comments from respondents

The figure 3.19 above shows the suggestion or comments from the respondents and this question is optional to answer. There are 8 respondents are giving the suggestion and comments. Most of the comments are positive and most of the suggestions will be added to the future development.

3.4.3 Analysis

After observed for a period, analyzing existing related systems can give project manager and developer an in-depth understanding of what the proposed project is all about. A critical analysis of this existing system was used to identify some needs and improvements for the proposed project through assessment and analysis. In Sections 2.3 and 2.4, three existing systems are analyzed and compared.

3.4.4 Functional and Non-Functional Requirement

System requirements can be classed as either functional requirements or non-functional requirements. Both criteria are helps to assure that developers will provide a programme that operates as planned. The table 3.1 below shows the functional requirements or non-functional requirements of the proposed project (Purification).

Table 3.1 The functional and non-functional requirements

Functional Requirements	Non-Functional Requirement
<ul style="list-style-type: none"> • The game will be controlled by a keyboard and mouse. • The game will have more than 5 levels. • The player could recharge wellness by resting around the bright creatures. • The player could pull or push the obstacles. • The player should decrease the wellness when touching the polluted creatures such as polluted toxic water, mutated animals, withered corrosive plants, and so on. • The interaction buttons on the game interface should be accessed by the player. 	<ul style="list-style-type: none"> • The game shall run on both Windows and Mac. • The game shall run on all browsers. • The system should be executed without bugs in a machine that fulfils the requirements of the #C runtime environment. • The basic artificial intelligence of NPCs must operate fast enough within 3 seconds. • The game should not store the personal information of players so there are no security requirements that need to be defined. • The brightness of the game environment is just right for the player’s view.

<ul style="list-style-type: none"> • The player could collect the dropped items and mission tool. • The player should complete to pass the level 	<ul style="list-style-type: none"> • The game's background music shall match the game environment and atmosphere.
--	--

3.4.5 Constraints and Limitations

The proposed project may face constraints and limitations due to difficulties in game levels, game rules, techniques, etc. The proposed project will make appropriate adjustments to these listed constraints and limitations, allowing players to complete the game and complete the level while having these restrictions. The table 3.2 below shows the constraints and limitations of the proposed project (Purification).

Table 3.2 The constraints and limitations

Constrain	Limitations
<ul style="list-style-type: none"> • When the player is corrupted by pollution, the health value will be reduced. • There are some puzzles solving part for completing the missions in the game levels, player should complete the missions given to pass the level. 	<ul style="list-style-type: none"> • The platform is limited which only available on PC. • Only some enemies drop items after defeat by player. • Only can restore wellness from the bright creatures.

3.5 Phase 2 - User Design and Input (Cycle)

3.5.1 Design

Once the scope of the project is determined, the process moves to the design and development phase. At this stage, developers first start designing everything needed in the game, such as game assets, game characters, game mechanics, level environments,

etc. The design phase of developing a game, also known as a Game Design Document (GDD), uses building blueprints for the game, defining the scope of the game and the overall direction of the project. Once in the development phase, user designs are iteratively built through various prototypes. At this stage, developers start designing prototypes and all bugs and issues are resolved in an iterative process.

3.5.2 Game Design Document (GDD)

3.5.2.1 Game Genre

Purification is a 2D platformer serious game that is also a game that combines puzzle contents in the game level design. The player not only can walk, run, and jump to pass through various obstacles but also control some of the obstacles which to jump around the platform. The game is aimed to improve public awareness of environmental issues by conveying the storyline to players in gameplay.

3.5.2.2 Game World

This game takes place in a 2D space world which is using the parallax design method like the game world of Hollow Knight. The game environment is about what polluted villages, cities and global pollution look like. The setting of the game is start from the rural area first, the player will keep travel to urban area and reach the end of the world. This is a 2D platformer game, so the perspective view of this game is side-on, which means the player is viewing the game from the side.

3.5.2.3 Storyline

The story of the game begins when the player character Alice's country and even the entire world is occupied by darkness, and the sun is eroded, which means pollution. Most people choose to turn a blind eye and move on with their lives. One day, Alice's friend, Lexie is corrupted by the darkness and lost its life in front of Alice. But Alice does not know what is happening. So, she decided find the omniscient elder to answer for her.

The elder told Alice to their world is surrounded by the darkness, and Alice have to find the scattered lights to purify the environment.

Alice will start from her hometown, that is, from the rural area. She will meet different people in the game. She will continue to explore from the rural area to the urban area. On the way to find the light ball, Alice will also be deducted from her wellness by the polluted substances. She must find bright creatures to recharge her wellness. She will experience severe consequences of air pollution, water pollution, poor waste management, climate change and deforestation.

3.5.2.4 Level Design

The game has 8 levels, which will be divided into different areas and different pollution themes. For example, the level of 1-3 are rural areas with air and river pollution themes, continue to the level of 4-7 are urban areas with poorer waste management, water pollution, air pollution, climate change and deforestation. The difficulty of each level will stack up little by little.

The game level design is a 2D platform design that allows players to move up, down, left, and right. Game level design is a two-dimensional platform design that allows players to move up, down, left, and right. The player completes the level missions to purify the environment in the level. Players need to explore by their own in the levels. The Figure 3.20 shows the draft design of game level 1 overview.

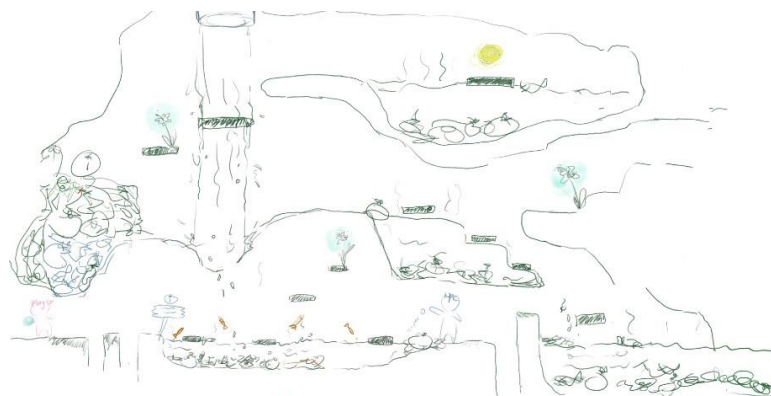


Figure 3.20 The draft design of game level 1 overview

3.5.2.5 Game Mechanics

In video games, game mechanics are the rules that regulate and direct the player's actions, as well as the game's response to them. A game's mechanics therefore basically determines how the game will operate for the individuals who play it. In Purification, currently there are planned some game mechanics are involved, and there are solve puzzles, watch the triggered animation, dialogue with NPCs, collecting light ball, purify the environment and recharging wellness. Players can achieve game goals by using game mechanics in the levels, and players advance strategies to pass the levels and complete the game.

3.5.2.6 Game Characters

Most of the game characters in the Purification are hand-painted, and only a few are assets found on the Internet. The game characters and assets shown are for current demonstration purposes only and do not represent the final product, which will be modified and upgraded later.

1. Main Character – Alice



Figure 3.21 Draft design of main character



Figure 3.22 Main Character in Prototype

The Figure 3.21 shows the draft design of main character. The main character in Purification is Alice, a mystery girl who is wearing headgear and cape. The player will control Alice in the game. The player could control the main character by using the “A”, “W”, “S” and “D” keys to move up, down, left, and right. Another key of “CTRL” is for the player to control the blocks which is grabbing, pushing, or pulling. Players have to explore the level to find the light ball and reach the portal and proceed to the next level.

2. Non – Player Character (NPC)

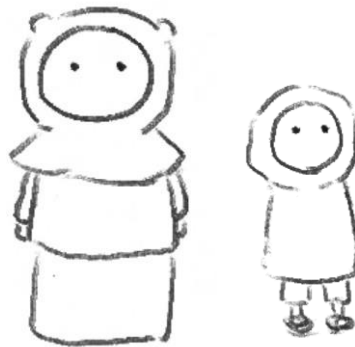


Figure 3.23 Draft design of a few NPCs’ looks

The Figure 3.23 shows the draft design of a few NPCs’ looks. The NPCs in Purification as the informant or the characters who convey the story to the player. NPCs will also give the tips on how to protect the environment, the way to find the light ball, what should

player be aware of in the level and so on. All NPCs have its own appearance. They might be kid, woman, businessmen and so on.



Figure 3.24 One of the animal victim NPCs – Deer

Another type of NPC in Purification is Animal Victims, who are injured and forced to flee due to environmental issues. The Figure 3.24 shows one of the animal victim NPCs – Deer. This type of NPC talks to the player and tells the player to convey the flow of the story to the player. There are some Animal Victim NPCs that will also be part of the quest, and the player will need to remove contaminants from the Animal Victims.

3. Enemies



Figure 3.25 Enemies in Purification – The mutated animals

The Figure 3.25 shows the current enemies in Purification, the mutated animals. These enemies are animals that have long lived in polluted environments, where they are mutated by chemicals, dirt, and viruses, so they attack the player. Some will patrol, fly, jump in poisonous water, etc. in the level. When the player gets close to them, player's health is deducted, and the player could attack them.

3.5.2.7 Game Creatures

1. Light Creatures



Figure 3.26 The light creatures in Purification – Healing Bloom



Figure 3.27 The light creatures in Purification – Flying Butterflies

The Figure 3.26 and 3.27 shows the light creatures in Purification, they are Healing Bloom and Flying Butterflies. The light creatures are glowing which appear in every level to let the player could recharge the wellness. The Healing Bloom only appear after player activate it by collecting a dropped glowing flower. The Flying Butterflies can be collected which will increase few points of the player's wellness.

2. Dark Creatures



Figure 3.28 The dark creatures in Purification – Corrosive Plants



Figure 3.29 The dark creatures in Purification – The mutated animals

The Figure 3.28 and 3.29 shows the dark creatures in the game, they are mutated animals and corrosive plants. The dark creatures appear in every level which threatens the wellness of the player. The mutated animals also known as the enemies in Purification, player could attack and defeat the enemies. Player could purify the corrosive plants by completing the level missions.

3.5.2.8 Reward

Physical reward in game:

- Unlock the level by fulfilling the requirements of the level.
- Purify the polluted environments and reach the end of the game to save the world.
- Recharge the health bar under the healing bloom zone.
- Increase few points of health by collecting the heal flower point.

Abstract reward in game:

- Gaining knowledge about environmental issues.
- Raise awareness about the environmental issues that facing by everyone in the world.

3.5.2.9 Punishment

- Lost the health and lose the game.
- If player touches the dark creatures, the wellness will decrease.
- Attack by the enemies in the game level.
- The lower the wellness, the darker the brightness of the player.

3.5.2.10 Victory Condition

In every level, the player should complete the level missions and purify the environment in the level to activate the portal and pass to the next level. Player needs to complete all the levels to reach the end of the world and make sure the wellness is in healthy condition.

3.5.3 Proposed Design

3.5.3.1 Flowchart

The Figure 3.30 below shows the flowchart of the proposed project, Purification. A simple flowchart showing the player's overall start and end game flow.

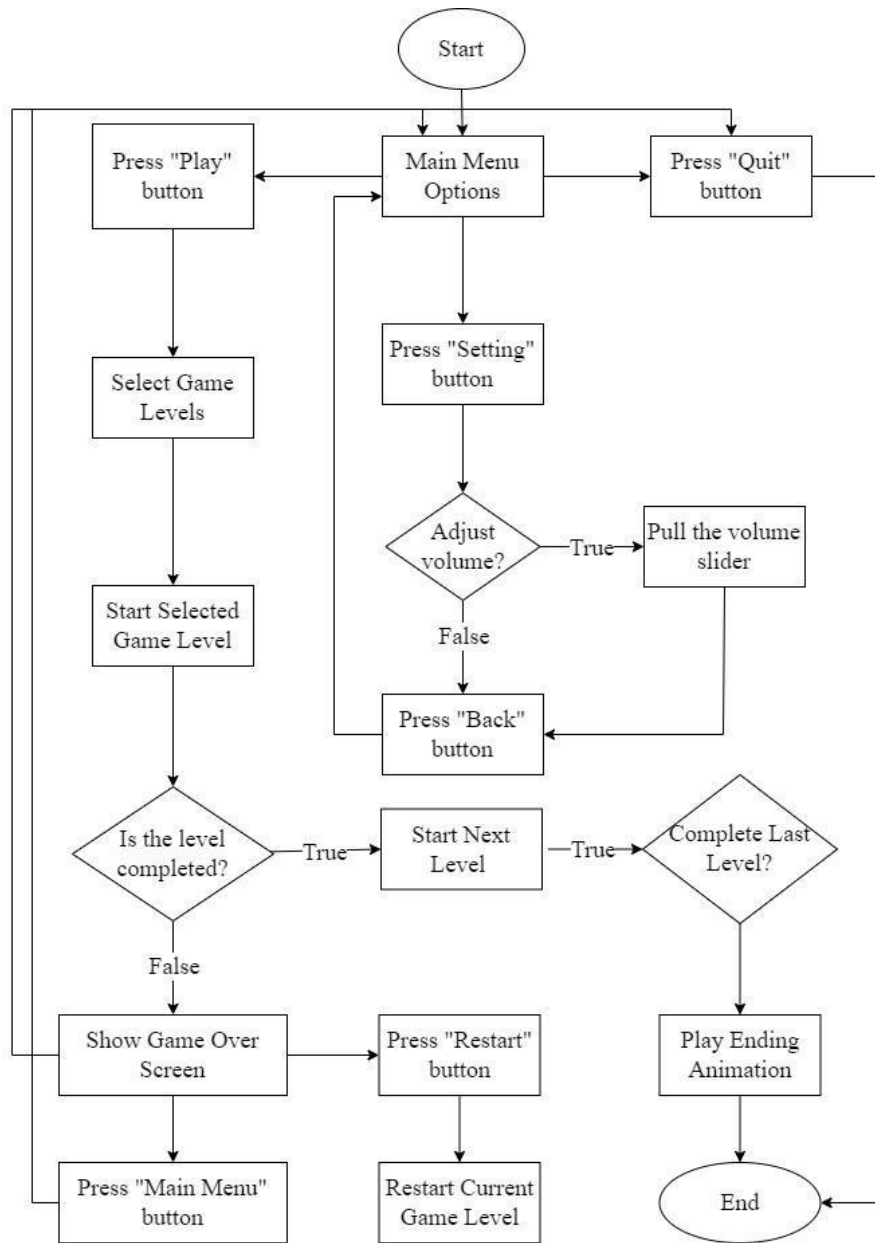


Figure 3.30 Flowchart of Purification

3.5.3.2 Context Diagram

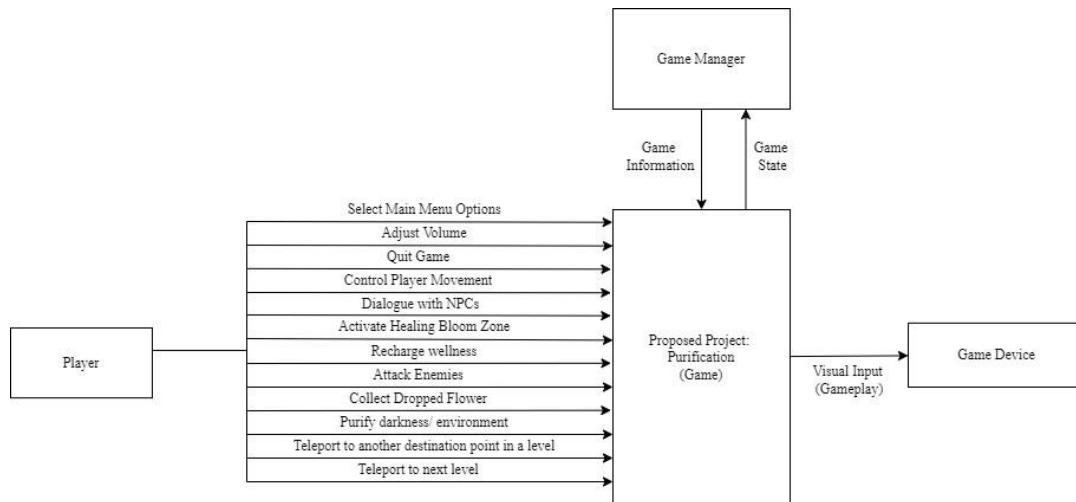


Figure 3.31 Context Diagram of Purification

The Figure 3.31 shows the context diagram of the proposed project, Purification. There are 3 major components or entities which are the player, game manager and game device. The arrows are to outline the data flow between the entities. The interaction that player can do in Purification are select options in main menu, adjust the volume in the setting and quit game. In game, player could control the player movement by pressing “A”, “W”, “S” and “D” keys. Other than that, player also could have dialogue with the NPCs, collect dropped items, activate healing bloom zone, recharge wellness, attack enemies, purify the environment and using the teleporter to teleport to another destination point in a level. The player could teleport to next level when reaching the next level portal.

The entity of game manager is abstractions of multiple managers in game, they are scene manager, user interface manager, input manager, event system manager and audio manager. The game manager is interacting with Purification which will process the game states and game information that generated by player to the game. The game device such as PCs or laptops are display devices for visual input to games.

3.5.3.3 Use Case Diagram

The Figure 3.32 below shows the use case diagram of Purification. Use case diagrams are used to summarize the details of the interactions between the users of the system, the players in the game.

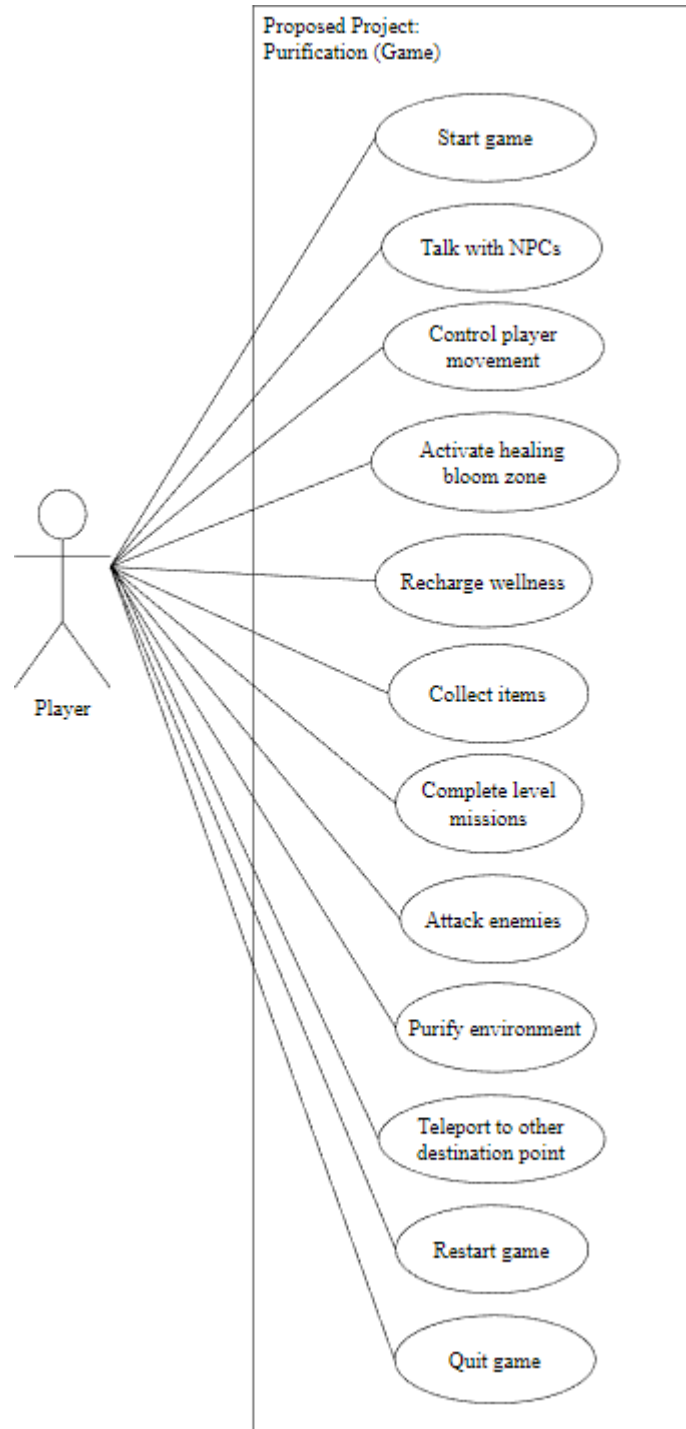


Figure 3.32 The use case diagram of Purification

3.5.4 Storyboard

Storyboarding and prototyping are done to demonstrate game flow and game mechanics. The storyboard and prototype screenshots below are presented in tabular form. ****Updated Storyboard**

Storyboard Number 1.0 – Main Menu



Elements

- **Buttons/ Controls:** Start, Setting, Credits, and Quit buttons.
- **Audio:** Soft natural background music.
- **Sound Effects:** Button click sound.

Description: This scene is when the player opens the game which shows the main menu of the game. There are 3 buttons in the interface, there are start, setting and quit buttons. By clicking the “START” button for start and play the game. By clicking the “SETTING” button, player could adjust the volume of the game. And by clicking the “CREDITS” button for view the developer information of Purification. By clicking “QUIT” button is to close the application.

Storyboard Number 1.1 – Main Menu (Level Select)



Elements:

- **Buttons Controls:** All the levels' button.
- **Audio:** Soft natural background music.
- **Sound Effects:** Button click sound.

Description: This is the setting menu of Purification when player has clicked on the setting button. In this menu user interface, player could adjust the volume by pulling the volume slider. Player can click “BACK” button to return the main menu page.

Storyboard Number 2.0 – Start Game (Story Scene)



Elements

- **Buttons/ Controls:** Skip button
- **Audio:** Video's audio.
- **Sound Effects:** Button click sound.
- **Animations:** The beginning story of the game

Description:

After pressing the "Skip" button, the player will start with the tutorial level.

Storyboard Number 3.0 – Start Tutorial Level



Elements

- **Game Mechanisms:** Task list, purify polluted place, attack enemy, recharge health, drop items, waterfall ladder
- **Buttons/ Controls:** Player movement
- **Audio:** Mystery background music
- **Sound Effects:** Player jump, attack, healing, poisoned river, purify
- **Animation:** Poisoned River, Waterfall, Pop out icon, healing zone, enemy

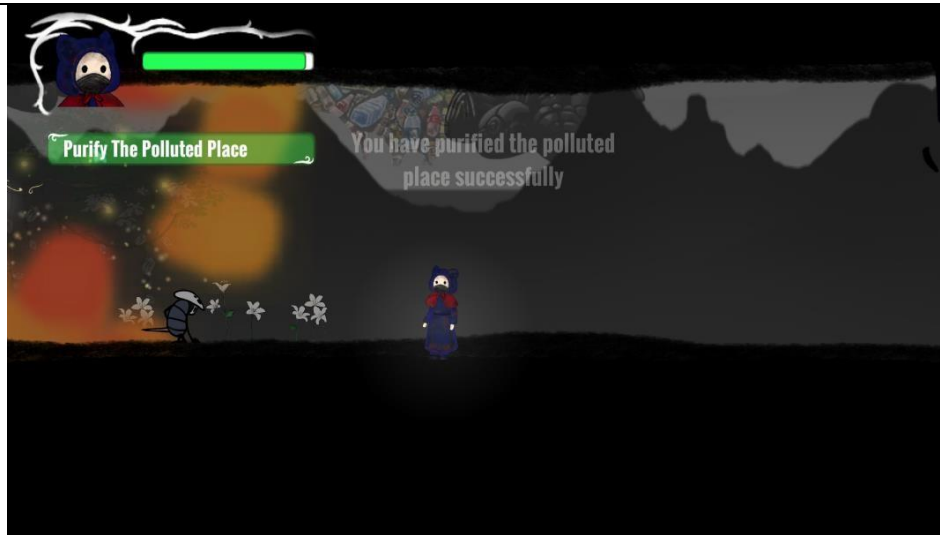
Description: In tutorial level, the level will guide the player the basic movement and some main game mechanics throughout the game.

Storyboard Number 3.1 – Game Level 1 (Ecological Imbalance)



Elements

- **Game Mechanisms:** Task list, purify polluted place, attack enemy, recharge health, drop items, waterfall ladder.
- **Buttons/ Controls:** Player movement
- **Audio:** Mystery background music
- **Sound Effects:** Player jump, attack, healing, poisoned river, purify
- **Animation:** Poisoned River, Waterfall, Pop out icon, healing zone, enemy



Description: The game level is in the rural area, Blooming Village. In this level, the story NPC will tell player that the environment is polluted which brings the effect of ecological imbalance, the animals become mutated and riled up. And the player has the task of purify the polluted place, the player is required to collect the scarted light of light ball to purify the environment. The player will find out the environmental issues of water pollution and air pollution.

Storyboard Number 3.2 – Game Level 2 (Elder’s Asylum/Protection)



Elements

- **Game Mechanisms:** Task list, purify polluted place, attack enemy, recharge health, drop items, waterfall ladder, open door, deduct zone.
- **Buttons/ Controls:** Player movement
- **Audio:** Mystery background music
- **Sound Effects:** Player jump, attack, healing, poisoned river, open door, purify
- **Animation:** Poisoned River, Waterfall, Pop out icon, healing zone, enemy



Description: In this level is called section 2: “Elder’s Asylum/Protection.” It is because of the story is continue with the Elder of the player will transform all his power to give player a feature to protect herself, the shooting mechanics. The player keep explore the game level, complete the task given and then find the Elder’s hidden place. The player will find out the environmental issues of water pollution and air pollution.

Storyboard Number 3.3 – Game Level 3 (What's Next?)



Elements

- **Game Mechanisms:** Task list, purify polluted place, attack enemy, recharge health, drop items, waterfall ladder, open door, deduct zone,
- **Buttons/ Controls:** Player movement
- **Audio:** Mystery background music
- **Sound Effects:** Player jump, attack, healing, poisoned river, open door, purify
- **Animation:** Poisoned River, Waterfall, Pop out icon, healing zone, enemy



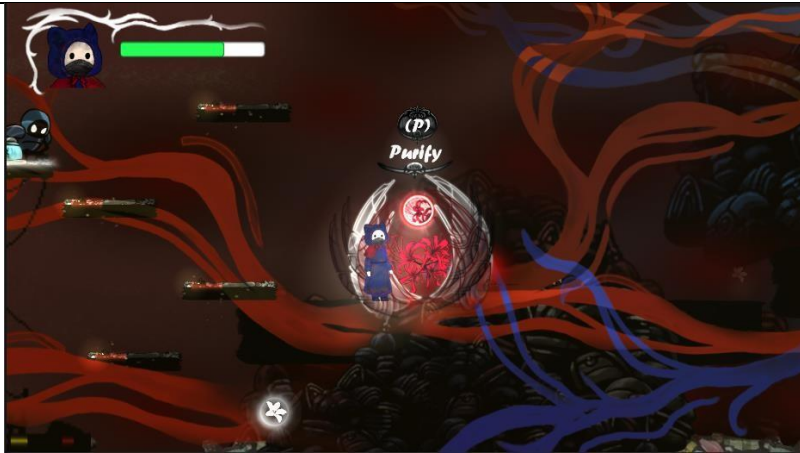
Description: Player keeps explore the game level environment. In this level is called section 3: “What’s Next?” The player receives the power from the Elder and the player character is able to shoot. Player could shoot the enemy to protect themselves from attacking by the enemies. And this is the last level in rural area, the player will go to the bus stop and take the bus to next destination, city. The player will find out the environmental issues of water pollution and air pollution.

Storyboard Number 3.4 – Game Level 4 (The Concrete Jungle)



Elements

- **Game Mechanisms:** Task list, purify polluted place, attack enemy, recharge health, drop items, waterfall ladder, open door, deduct zone, death zone, enemy follow the player, moving elevator
- **Buttons/ Controls:** Player movement
- **Audio:** City pop background music, campaign video, death zone background music
- **Sound Effects:** Player jump, attack, healing, purify
- **Animation:** Pop out icon, healing zone, enemy, purification of the death zone, death zone flower blooming





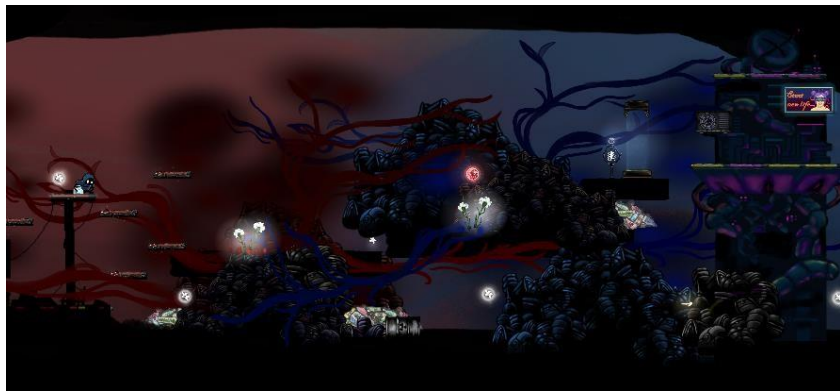
Description: The player reaches a new game environment, the darkness city. The player will meet different NPCs to convey the storyline and give some hints on how to pass the level. In this level, the player will encounter a new challenge, which is a death zone that caused by poor waste management. The death zone formed because no one manages the garbage or waste for a long time, the plant in that area is gradually wither, and a dead zone is form over time, and this will explain in the campaign video that inside the game. This dead zone creates a barrier and makes it impossible to pass through. The player should collect a Powerball key to activate the purification mechanism to purify the environment.

Storyboard Number 3.5 – Game Level 5 (The Price of Progress)



Elements

- **Game Mechanisms:** Task list, purify polluted place, attack enemy, recharge health, drop items, waterfall ladder, open door, deduct zone, death zone, enemy follow the player, moving elevator, teleporter, close waste water discharge tap
- **Buttons/ Controls:** Player movement
- **Audio:** City pop background music, death zone background music
- **Sound Effects:** Player jump, attack, healing, purify, river.
- **Animation:** Pop out icon, healing zone, enemy, purification of the death zone, death zone flower blooming



Description: In this level, the player reaches the industrial urban area which is more construction side and factory. The player will find out the environmental issues of air pollution, water pollution and poor waste management. There are 2 death zones in this level, they are red and blue death zone. The player has to find and collect the correct Powerball key type to purify the death zone. The blockage will only disappear after player is purified the environment. And the player have to turn off the waste water discharge tap because there are some platforms and are hidden under the poisoned water.

Storyboard Number 3.6 – Game Level 6 (The Climate Change)



Elements

- **Game Mechanisms:** Task list, purify polluted place, attack enemy, recharge health, drop items, waterfall ladder, open door, deduct zone, death zone, enemy follow the player, moving elevator, teleporter, close wastewater discharge tap, acid drops
- **Buttons/ Controls:** Player movement
- **Audio:** Mystery background music, death zone background music
- **Sound Effects:** Player jump, attack, healing, purify, rain drops sound, river.
- **Animation:** Pop out icon, healing zone, enemy, purification of the death zone, death zone flower blooming

Description: In this level, the player will be facing the environment issue of climate change. Acid rain is in the game environment, when the player exposed under the acid rain, the health will be continuously deducted. The player should hide under the buildings to avoid acid rain. The player has to purify the death zones to continue the journey.

Storyboard Number 3.7 – Game Level 7 (The Last Tree)



Elements

- **Game Mechanisms:** Task list, purify polluted place, attack enemy, recharge health, drop items, waterfall ladder, open door, deduct zone, death zone, enemy follow the player, moving elevator, teleporter, close wastewater discharge tap, acid drops, grow the last tree
- **Buttons/ Controls:** Player movement



- **Audio:** Mystery background music, death zone background music
- **Sound Effects:** Player jump, attack, healing, purify, rain drops sound, river.
- **Animation:** Pop out icon, healing zone, enemy, purification of the death zone, death zone flower blooming, growing tree

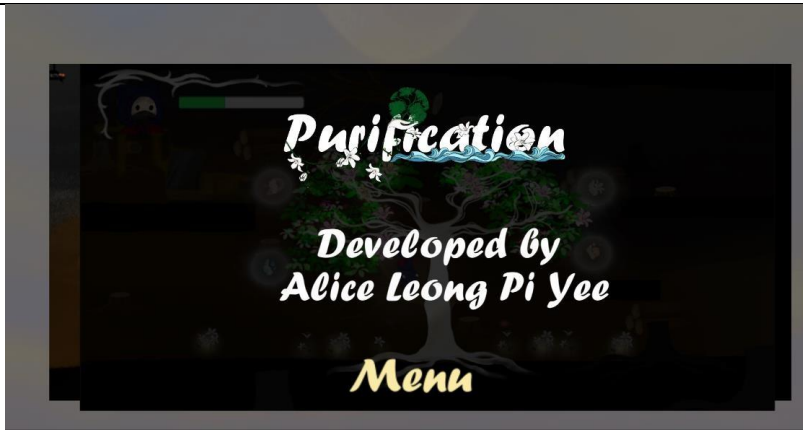
Description: In this last level of the game, the player arrives at a heavily polluted place. Players will discover environmental issues such as deforestation, climate change, and water pollution. The last tree in the level will ask the player for help, and the player needs to find and collect 4 power elements for the tree to grow again, carry out planting work. The 4 elements are purifying power, light, water and blooming booster. The player have to collect the elements step by step to grow the tree.

Storyboard Number 4.0 – The Ending Story of Game



Elements

- **Buttons/ Controls:** Back to Menu button
- **Audio:** Relax background music
- **Sound Effects:** Button click sound.
- **Animation:** The ending story



Description: After completing the last level of the game, an ending story of the game is play. This ending story is to call on players to observe the environment around them, feel the impact of environmental pollution. And ask for the players make changes together to save our environment and the earth. After the animation is ended, the Menu button is appeared for player to clicks on.

3.5.5 Prototyping

This is where the actual development takes place. Multiple prototypes for the in-game mechanics and features are constructed according to previously defined specifications to test out the concept of the game. The prototypes are comprising of systems that are featured in the game.

3.5.6 Implementation

i. Refine

Before refining the prototype of the game application, the developer gathers all the feedback from the testing result and the feedback from the supervisor. Based on the feedback obtained, the requirements will be updated, and the cycle continues. The prototypes are either scrapped or updated for the next gather input session.

ii. Implementation

Throughout this phase, the product undergoes various phases of development until it is ready for the end user. The preparation of this plan is to be outlining the activities that must be completed and develop in the game and put it into operational usage. Then rerun the unit tests for each aspect that needs to be tested.

3.5.7 Testing

Game testing is very necessary, and the testing process mainly revolves around alpha testing by internal testers, developers and related personnel conduct the testing first, and then find and list bugs that need to be fixed. Beta testing is also involved to provide a nearly completed product to a set of target consumers for real-world performance testing.

i. Alpha Testing

Alpha testing is to test user journey and confirm the works as intended and it done by internal team. And it is conducted in a controlled environment, all result recorded and analysed. In this project, the Alpha testing uses functional acceptance testing (FAT) to allow testers to provide feedback and upgrading the game. The test focuses on functional indicators such as game stability, game mechanics, game artificial intelligence, graphics, game level difficulty and so on. The figure 3.33 below shows the draft template of FAT. The template is used in the alpha testing phase later.

Test Case 1: Main Menu				
No.	Functionality	Pre-Condition	Expected Result	Pass/ Fail
1	Start the game from story opening scene	Click on the start button	The story opening scene is loaded and play automatically.	
2	Adjust the volume bar by sliding	Click on the settings button	The volume could be adjusted.	
3	Credits information show on scene	Click on the credits button	The credit information able to show out.	
4	Quit the game application.	Click on the quit button	The game will be closed.	
5	Back to the main menu	Click on the back button	The scene will back to the main menu.	

Figure 3.33 The draft template of FAT

ii. Beta Testing

Once all objects, environments, game systems, and user interface are complete, and evaluated by the target player base, and any issues are resolved, the game is ultimately close to completion. Then it comes to Beta for further testing especially finding the bugs. In this project, beta testing uses User Acceptance Testing (UAT) to test whether the game is meet the user's requirements, experience, and expectations. And the UAT will be carry out by using Google Form for testers to fill in the testing result. After the testing is completed, an analysis will be conducted. Data and comments from the survey will be considered for a future update. The table 3.3 below shows the draft template of UAT form.

This test is performed by:

Name	
Signature	
Date	

No	Module	Activity	Status		Comments
			Yes	No	
1.	Main Menu	Play Button			
2.		Setting Button			
3.		Adjust Volume			

4.		Credits Button			
5.		Quit Button			
6.		Back Button			
7.	Story Scene	Watch Cutscene			
8.		Having Dialogue with NPC			
9.		Continue Button			
10.	Tutorial Level	Player Movement			
11.		Attack Enemies			
12.		Teleporter			
13.		Waterfall Stairs			
14.		Collect Dropped Items (Flower)			
15.		Collect Dropped Items (Light Ball)			
16.		Recharge Wellness			

17.		Activate Healing Zone			
18.		Quest List Update			
19.		View Level Map Deck			
20.		Information Board			
21.		Pause Menu			
22.		Resume Button			
23.		Main Menu Button			
24.		Quit Button			
25.		Activate Portal			
26.		Proceed to Next Level			
27.	Story Scene	Watch Cutscene			
28.	Level 1 – 3 (Water Pollutions and Air Pollutions)	Player Movement			

29.		Toxic Water which will deducts the wellness of player when triggered			
30.		Toxic Air area which will deducts the wellness of player when triggered			
31.		Attack Enemies			
32.		Teleporter			
33.		Waterfall Stairs			
34.		Collect Dropped Items (Flower)			
35.		Collect Dropped Items (Light Ball)			
36.		Recharge Wellness			
37.		Activate Healing Zone			
38.		Quest List Update			

39.		Having Dialogue with NPC			
40.		Continue Button			
41.		View Level Map Deck			
42.		Information Board			
43.		Pause Menu			
44.		Resume Button			
45.		Main Menu Button			
46.		Quit Button			
47.		Activate Portal			
48.		Proceed to Next Level			
49.	Story Scene	Watch Cutscene			
50.	Level 4 – 6 (Deforestation, Air Pollutions)	Player Movement			

	and Waste Management)				
51.		Flame which will deducts the wellness of player when triggered			
52.		Trash Obstacles			
53.		Toxic Air area which will deducts the wellness of player when triggered			
54.		Attack Enemies			
55.		Teleporter			
56.		Trash Stairs			
57.		Collect Dropped Items			
58.		Collect Light Ball			
59.		Recharge Wellness			
60.		Activate Healing Zone			

61.		Quest List Update			
62.		Having Dialogue with NPC			
63.		Continue Button			
64.		View Level Map Deck			
65.		Information Board			
66.		Pause Menu			
67.		Resume Button			
68.		Main Menu Button			
69.		Quit Button			
70.		Activate Portal			
71.		Proceed to Next Level			
72.	Story Scene	Watch Cutscene			
73.	Level 7 – 8	Player Movement			

	(Climate Change and Deforestation)				
74.		Toxic Rain area which will deducts the wellness of player when triggered			
75.		Trash Obstacles			
76.		Attack Enemies			
77.		Teleporter			
78.		Waterfall Stairs			
79.		Collect Dropped Items			
80.		Collect Light Ball			
81.		Recharge Wellness			
82.		Activate Healing Zone			
83.		Quest List Update			
84.		Having Dialogue with NPC			

85.		Continue Button			
86.		View Level Map Deck			
87.		Information Board			
88.		Pause Menu			
89.		Resume Button			
90.		Main Menu Button			
91.		Quit Button			
92.		Activate Portal			
93.		Proceed to Next Level			
94.	Story Scene	Watch Cutscene			

Table 3.3 Table of template of UAT form of Purification

3.6 Phase 3 - Construction

This is another continuous stage; it is closely related to user input. This stage focuses on implementing user-provided input through coding, testing, and any other necessary development chores. The second and third stages complement each other till the user approves the product. So, the prototypes and test systems will be taken from the

design phase and turned into working models at this stage. Different changes and new ideas can still be received throughout the process to solve some problems.

3.7 Phase 4 - Finalization

i. Evaluation/ Maintenance

After the period of testing and transition, the game will need to be maintained and routinely examined for bugs and potential upgrades.

3.8 Potential Use of Proposed Solution

This proposed project can be used for education field as it is a 2D game about raising awareness of environmental issues. Education field can use Purification to allow the students to learn through games on how to protect the environment and the causes of environmental pollution. Compared with the existing 2D or 3D games in the market, the uniqueness of Purification is that the environmental issues that mentioned in this game is not only the urban environmental issues, but also the large and small environmental issues that faced by villages, cities and even the entire world. Purification tells players the importance of environmental protection and the main reasons for environmental pollution in the form of stories. Players need to explore the game map and the player could understand the environmental issues that are existed in reality by completing the quests in game.

In addition, the game levels in Purification are having some puzzle-solving elements to increase the difficulty of the game. So, it could also improve the player's problem-solving ability and logical thinking and enhance the player's cognitive ability. Purification is launched in the 2D platform game mode because the operation mode and 2D graphic are easy to understand by players of different ages. Purification is a serious game that suitable for players of all ages, so it has a lot of potential, and there will be more and different developments in the future.

3.9 Conclusion

In conclusion, the methodology used to develop the Purification is using Rapid Application Development (RAD). RAD was chosen because one of the project's objectives is to offer a viable solution within the allowed timeframe. It may employ prototypes to provide users with meaningful input throughout development and testing, and to make modifications and clarify possible problems early.

The game concept and design as proved by the game prototype, and it have been evaluated by users and evaluators. Therefore, the project is currently undergoing game development and refining user needs. In the stage of development is to design the game assets of the game environment and game levels. Other than that, development process also undergoes to design, develop and implement some new suitable game mechanics in the game level.

CHAPTER 4

IMPLEMENTATION, RESULT AND DISCUSSION

4.1 Introduction

In section 3.4, the SDLC process of implementation is discussed about the development and preparation of testing. So, chapter 4 will discuss about the development, implementation and preparation of Purification, the 2D platformer serious game for youth age group.

4.2 Game Design Document (GDD)

A Game Design Document (GDD) is a very important part of the game development process, serving as a blueprint for building a game. It helps the project define the scope and general direction of the game, keeping the overall development of the project consistent. In Section 3.5.2, the game scope and direction of the project have been sorted out, and the next implementation process is to develop and execute with the direction that proposed in GDD. GDD includes the proposed game type, game world, game storyline, level design, game mechanics, game character design, rewards, penalties, and victory conditions.

4.3 Implementation Process

4.3.1 Project Setup

Before starting the actual development and implementation, the project needs to be set up. This includes software installation, version control, and importing packages into projects. Software installation includes all software and tools used in this project. The software used in this project is shown in Table 4.1 below, and Table 4.2 is the package import list used in this project.

Table 4.1 Software/tools used in project




Software/ Tools	Description
 Unity Engine	Unity Engine is used as the game engine for project development. The game engine version used for this project is 2020.3.24f
 Clip Studio Paint	Clip Studio Paint is used for all the game asset design which include design the game characters and environment.
 Adobe Audition	Digital Audio Workstation that uses to fine tune the music or sound effect (SFX) for the game.

Table 4.2 Unity Packages installed

Packages	Description
Universal Render Pipeline (URP)	The Universal Render Pipeline (URP) is a prebuilt Scriptable Render Pipeline, made by Unity. URP provides to create optimized graphics across a range of platforms.
2D PSD Importer	An importer for importing Adobe Photoshop PSB (Photoshop Big) file format. Used to create multi-Sprite character animation using Unity 2D Animation Package.

Cinemachine	Provide smart camera tools that allow free transitions.
Timeline	Unity Timeline to create cinematic content, game-play sequences, audio sequences, and complex particle effects. And the animation of game story is using timeline to create the sequences.
Unity Recorder	The Unity Recorder allows to capture and save data from the Unity Editor during Play Mode: animations, videos, images, audio, and more.

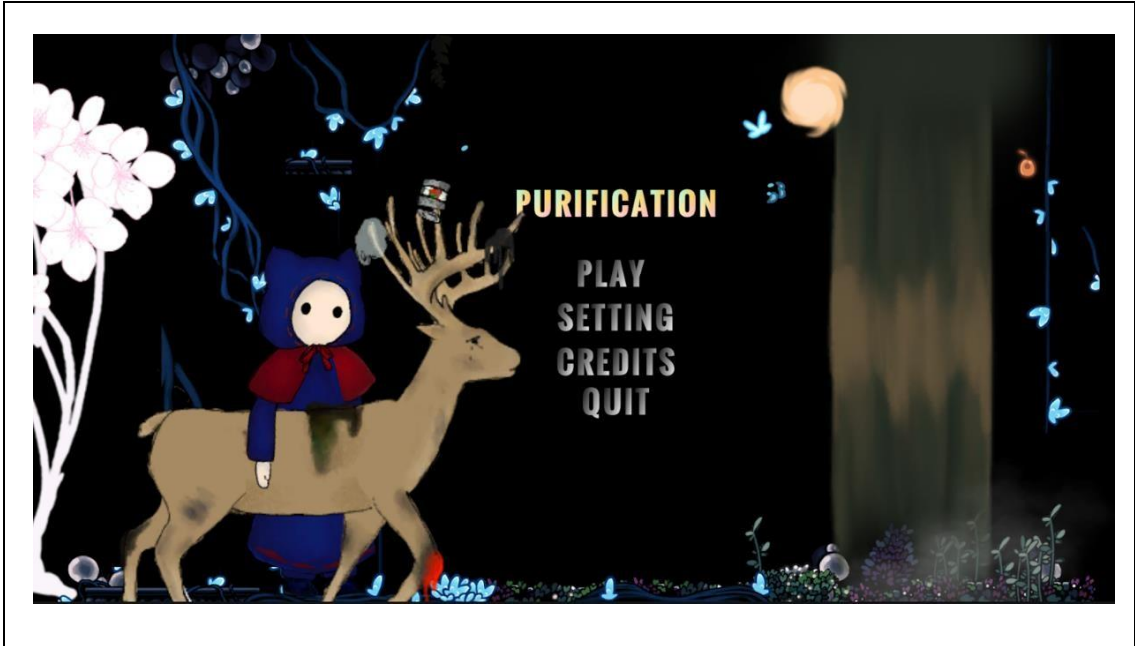
4.3.2 Game User Interface

4.3.2.1 Main Menu UI

The user interface of the game are self- design game assets that are also used in the game level. The main menu is the first page when player get in the game. The table 4.3 shows the comparison before and after implementation of the main menu. After implementation, the game logo and buttons have change to customized design. When player clicked on “Play” button, the UI is changed to Level Select UI for play to choose the level to start which shown in figure 4.1. When player clicked on “Setting” button can adjust the volume of the background music which shown in figure 4.2. When player clicked on “Credits” button, player can view the credits info of Purification and when the player clicked on “Quit” button, the game application will closed.

Table 4.3 Comparison before and after of Main Menu UI

Comparison before and after implementation
Before



After



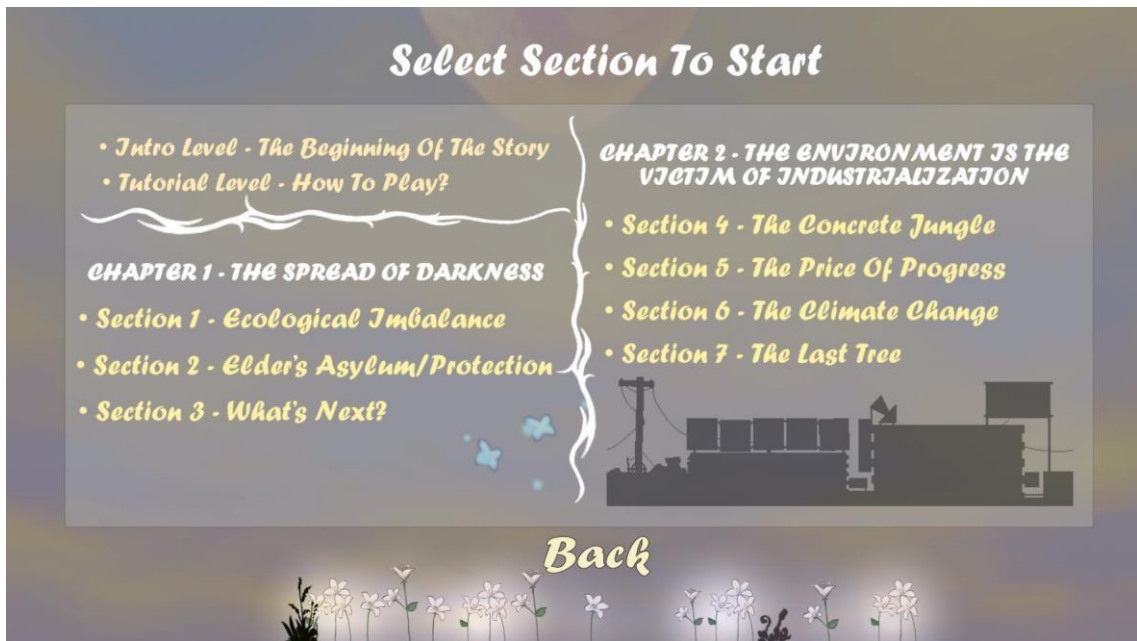


Figure 4.1 Level Select UI

The figure 4.1 shows the Level Select UI after the player clicked on “Play” button in the game main menu. Player is free to select the game level to start the game. The game levels are classified into their respective chapters, which also means that they are the same game environment, except the levels of “The Beginning of The Story” and “How to Play?”.

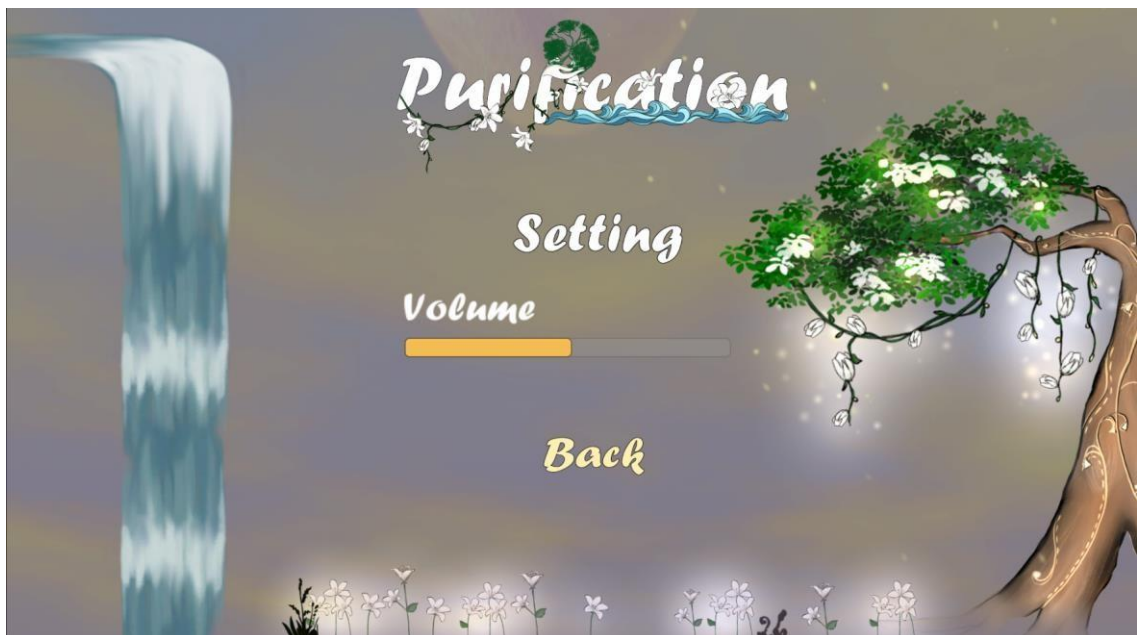


Figure 4.2 Volume Setting UI

The figure 4.2 shows the Volume Setting UI after the player clicked on “Setting” button in main menu. The player can adjust the volume of background music by sliding the bar.

4.3.2.2 Pause Menu UI

The 4.3 shows the user interface of pause menu scene when player press “Esc” key in game. The game will pause the activities in the game, and the game will only continue when player clicked “Resume” button.

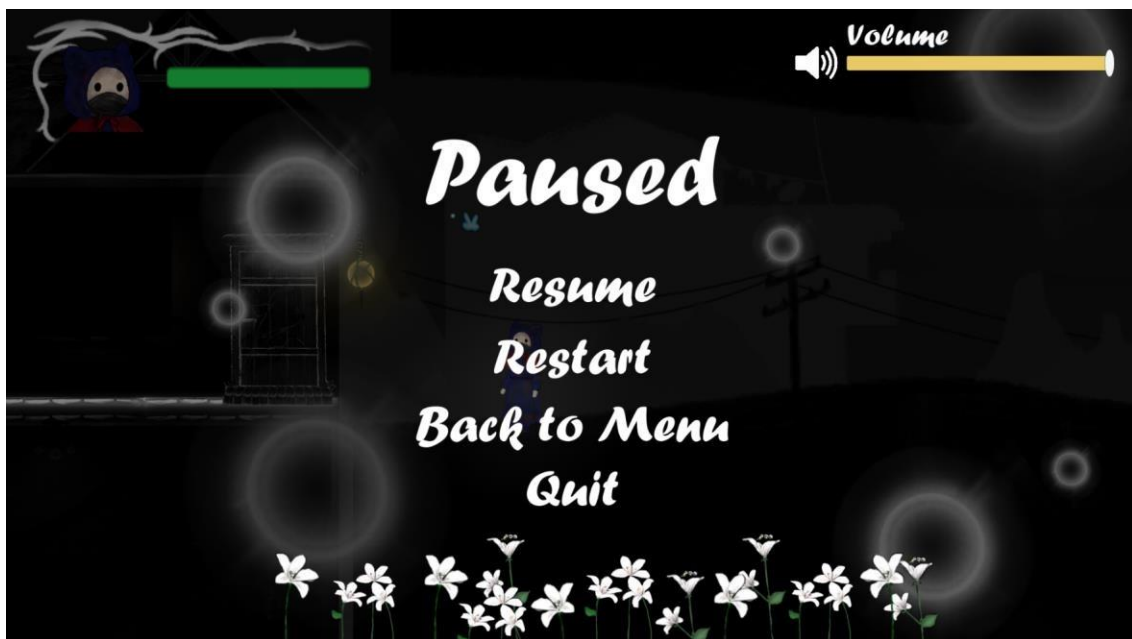


Figure 4.3 Pause Menu User Interface

When player clicked on “Restart” button, the game will restart the current level and player can get back to main menu page by clicking “Back to Menu” button. When player clicked on “Quit” button which means to exit the game application. There is a volume bar in the pause menu, player could adjust the volume by sliding the volume bar.

4.3.2.3 Game Over UI

Figure 4.4 shows the user interface of game over. This UI only shown when player’s health is reached zero which means player is corrupted by darkness in the game.



Figure 4.4 Game Over User Interface

When player clicked on “Restart” button, the current game level is restarted. Player can get back to main menu page by clicking “Main Menu” button. When player clicked on “Quit” button which means to exit the game application.

4.3.2.4 Game Completion UI

Figure 4.5 shows the game completion UI which is only shown after completing the last game level and ending animation. The ending animation is discussed under the subsection of 4.3.6 Animation Setup.



Figure 4.5 Game Completion User Interface

4.3.3 Game Environment Setup

4.3.3.1 Game Level Design

Game environment setup is all about designing and building a playable and story setting level or scene. This project has 1 tutorial level and 7 main gameplay levels, which will be divided into different areas with different environmental issues. Level 1-3 are rural areas with the environmental issues of air pollution, river pollution and poor waste management. And continue to level 4-7 are urban areas with the environmental issues of poor waste management, climate change, global warming, deforestation, air pollution and water pollution. The difficulty of each level will add up a little bit with new game mechanics added.

- i. Tutorial Game Level Design

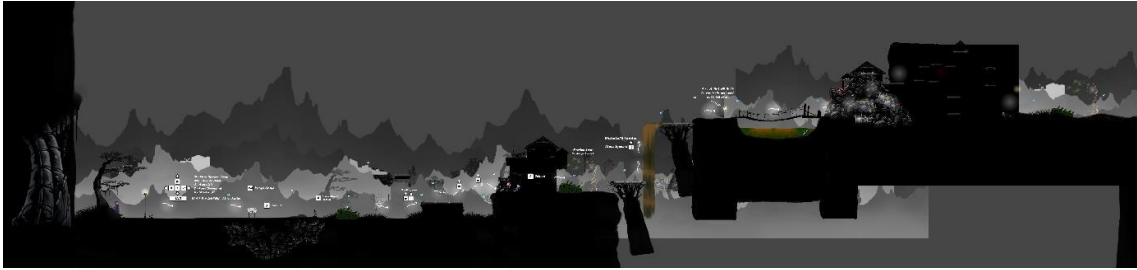


Figure 4.6 The Tutorial Level Design

The figure 4.6 shows the overall level design of the tutorial level, which is using the game environment 1, the rural area. The tutorial level is designed to be simple to guide player on character movement and the overall gameplay.

ii. Game Level 1 Design

Figure 4.7 shows the overall game level 1 design screenshot that captured in unity scene. The level 2 is under Chapter 1 of “The Spread of Darkness”, which named as “Section 1: Ecological Imbalance”.

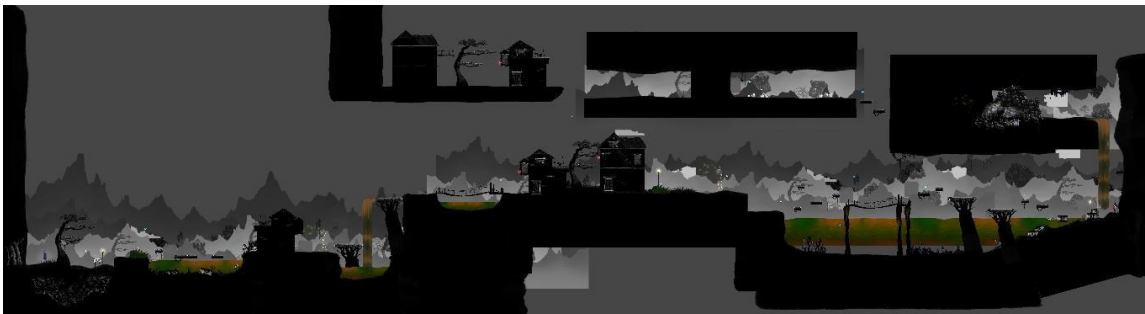


Figure 4.7 The overall game level 1 design screenshot

Level 1 will be the rural area with the theme of river pollution, and there will be polluted rivers in environmental design. Since Purification is a 2D platformer, so there are different types of platforms will be designed so that the player can move up, down, left, and right to explore the game environment.

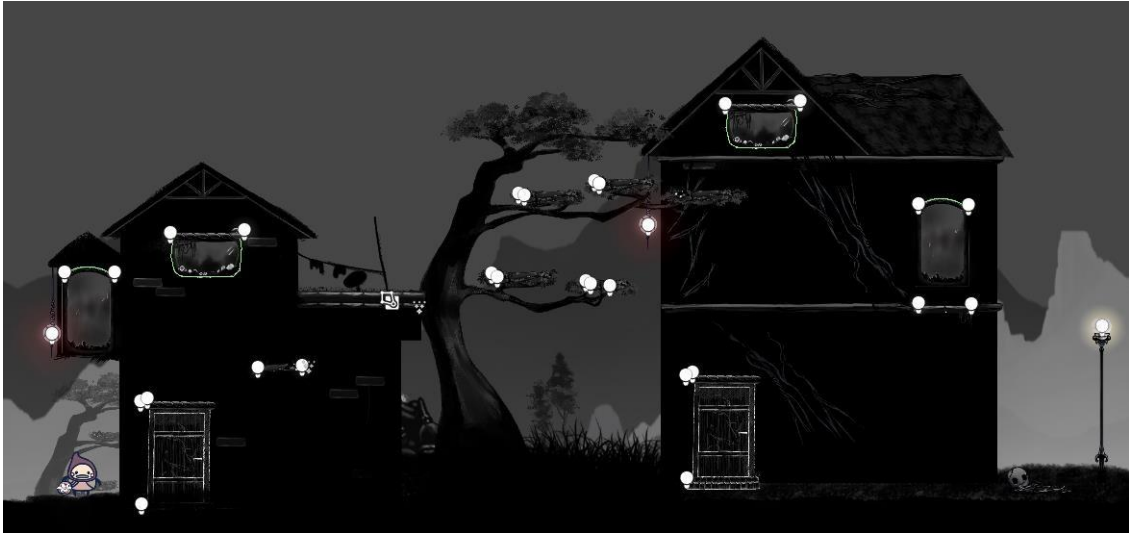


Figure 4.8 The screenshot- 1 of the platforms in game level 1

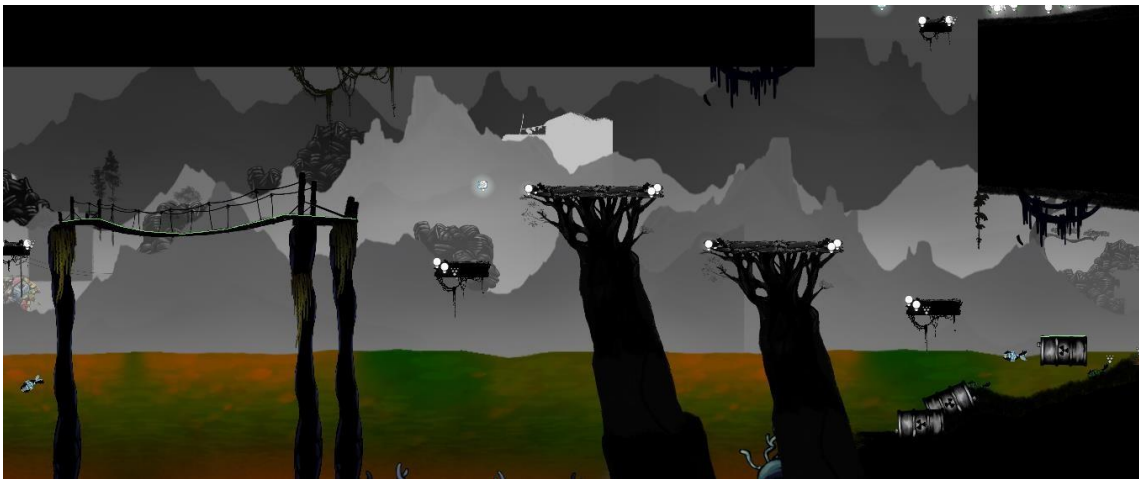


Figure 4.9 The screenshot-2 of the platforms in game level 1

And the figures 4.8 and 4.9 are shows the screenshot of the platforms in game level which are include the platforms of window, door, balcony, tree, bridge, and chemical bucket.

iii. Game Level 2 Design

The figure 4.10 shows the overall game level 2 design screenshot in Unity. The level 2 is under Chapter 1 of “The Spread of Darkness”, which named as “Section 2: Elder’s Asylum/Protection”.

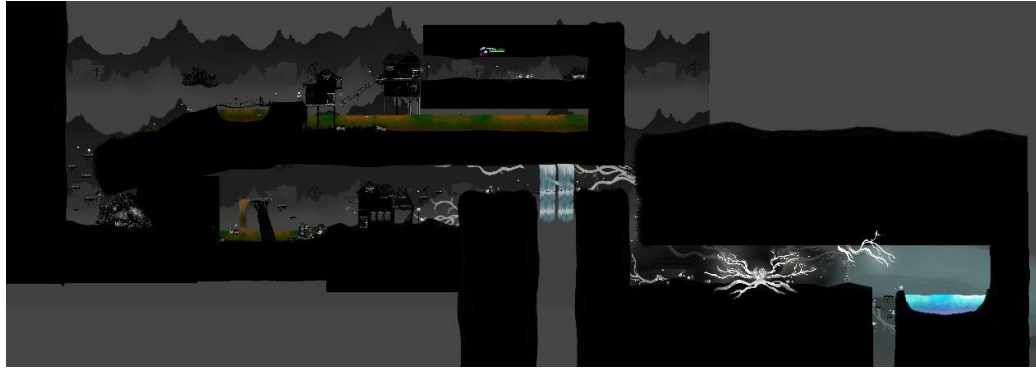


Figure 4.10 The overall game level 2 design screenshot

The level design is made up of 3 main big platform which to let the player to explore, follow the guideline and complete the task. In level 2 is mainly highlights the environmental issues of water pollution and air pollution and their causes.

iv. Game Level 3 Design

The figure 4.11 shows the overall game level 3 design screenshot in Unity. The level 3 is under Chapter 1 of “The Spread of Darkness”, which named as “Section 3: What’s Next?”.



Figure 4.11 The overall game level 3 design screenshot

Level 3 is the last level in rural area which is the Blooming Village. The level design is become bigger and more complicated for increasing the difficulties.

v. Game Level 4 Design

The figure 4.12 shows the overall game level 4 design screenshot in Unity. The level 4 is under Chapter 2 of “The Environment Is the Victim of Industrialization”, which named as “Section 4: The Concrete Jungle”.



Figure 4.12 The overall game level 4 design screenshot

This level design is mainly highlighting the environmental issue of poor waste management and air pollution. This level is design with more city buildings and few construction sides.

vi. Game Level 5 Design

This level design is designed in industrialized urban area which is more factories and construction sides. And this level is mainly highlighting the environmental issue of poor waste management and water pollution.

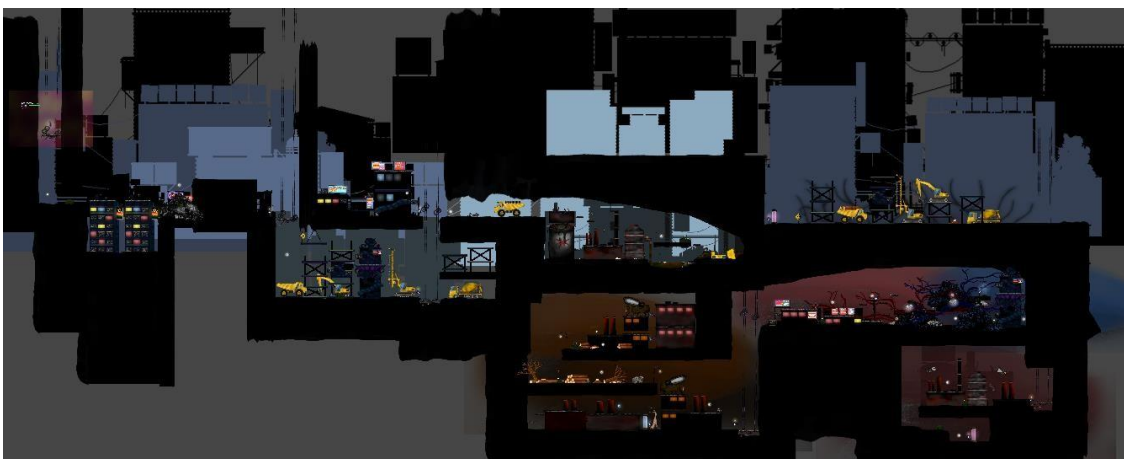


Figure 4.13 The overall game level 5 design screenshot

The figure 4.13 shows the overall game level 5 design screenshot in Unity. The level 5 is under Chapter 2 of “The Environment Is the Victim of Industrialization”, which named as “Section 5: The Price of Progress”.

vii. Game Level 6 Design

This level design is designed in industrialized urban area which is more factories and construction sides. And this level is mainly highlighting the environmental issue of climate change (acid rain), poor waste management and water pollution.

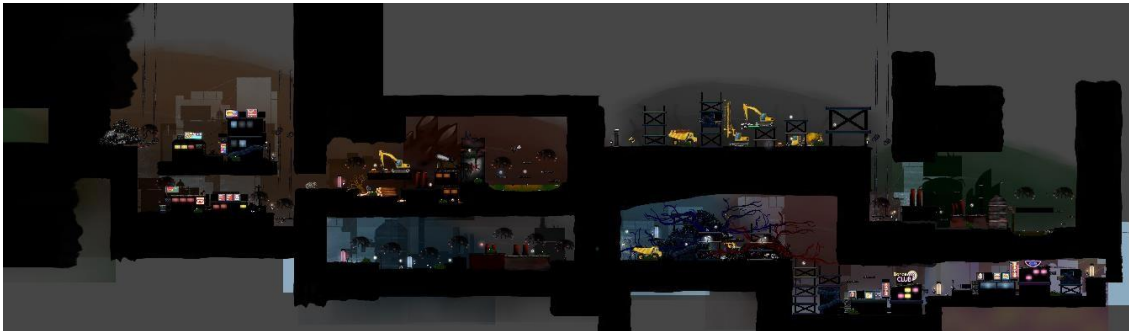


Figure 4.14 The overall game level 6 design screenshot

The figure 4.14 shows the overall game level 6 design screenshot in Unity. The level 5 is under Chapter 2 of “The Environment Is the Victim of Industrialization”, which named as “Section 6: The Climate Change”.

viii. Game Level 7 Design

This level design is designed in industrialized urban area which is more factories and construction sides. And this level is mainly highlighting the environmental issue of climate change (acid rain and global warming), poor waste management and deforestation.



Figure 4.15 The overall game level 7 design screenshot

The figure 4.15 shows the overall game level 7 design screenshot in Unity. The level 5 is under Chapter 2 of “The Environment Is the Victim of Industrialization”, which named as “Section 6: The Last Tree”.

4.3.3.2 Game View

i. Player’s Game View



Figure 4.16 Player’s game view

ii. Player’s Game View with Dialogue Panel

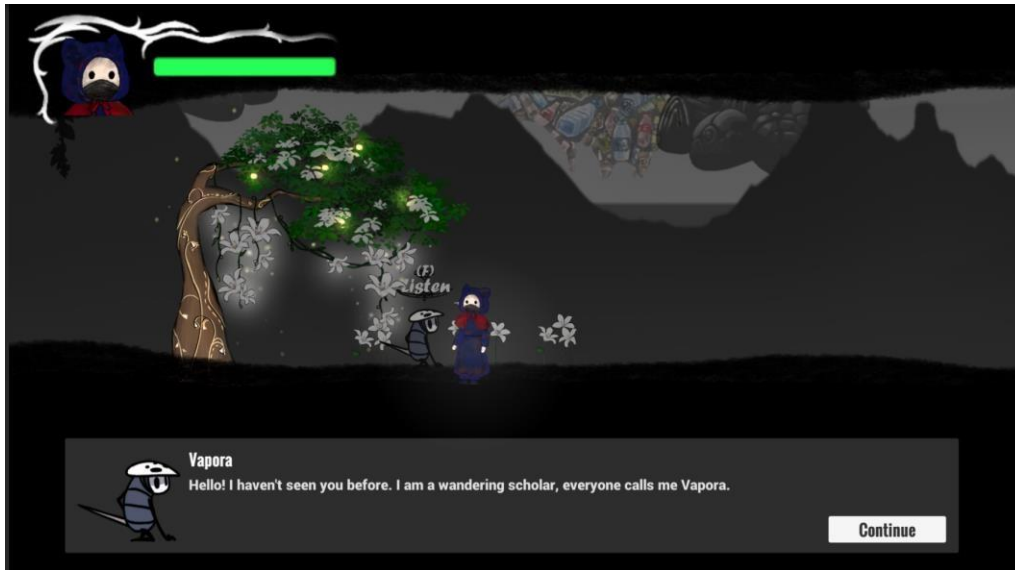


Figure 4.17 Player's game view with dialogue panel

The figure 4.16 shows the game view when the player starts the game. The player's health bar is designed in the upper right corner, and the player will be set in the middle of the game view. The dialogue panel is designed at the bottom of the game view, as shown in figure 4.17.

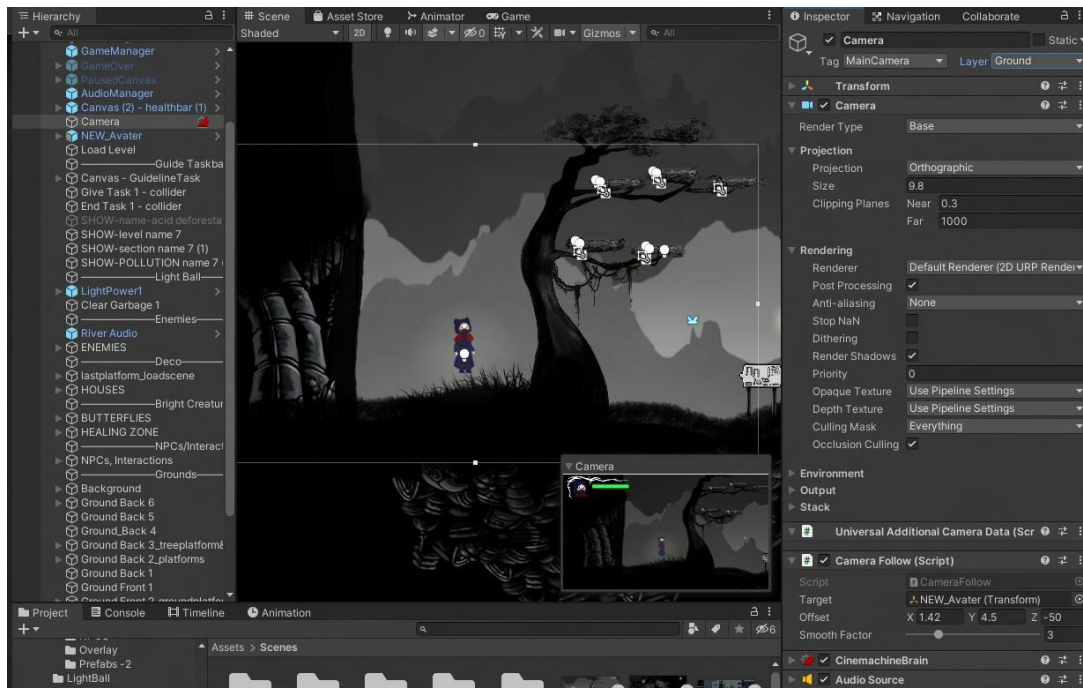


Figure 4.18 CameraFollow script applied

The camera used is the built-in camera package in Unity which is Cinemachine. It provides smart camera tools that allow free transitions, and it also can handle the complex

particles effects. There is only one camera used in this game. CameraFollow script is applied to control the camera is following the player's movement and to adjust the camera view as shown in figure 4.19.

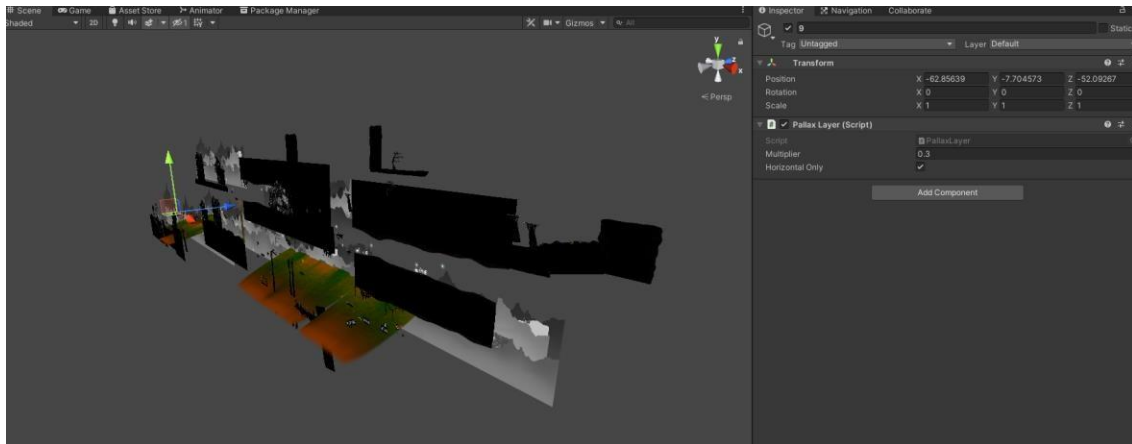


Figure 4.19 Parallax view of 2D game assets of the game environment

Parallax scrolling background is a technique that control the part of background and foreground move independently of the main screen. The figure 4.19 shows the parallax view of 2D game assets of the game environment. It is inspired from Hollow Knight which has discuss in the section 2.3.2. For Purification is using scripting to do the parallax scrolling background mechanics in game level. Purification uses a script to implement the parallax scrolling background mechanism in the game level, which is the ParallaxLayer script. The script will process the selected GameObject into a layer, and then let the layer move with the transition of the camera, and the filled multiplier indicates the moving speed of the layer.

4.3.4 Main Character Control

One of the most integral features of a game is the way players move their characters. The character's movement animation needs to be tidied up so that it looks logical. In the gaming world, the WASD or arrow keys are most used to move a character vertically or horizontally. The AD keys used to move left or right, while the W key acts as a jump key. The PlayerController script handle all functionality for manipulating the player.

4.3.4.1 Player Character Setup

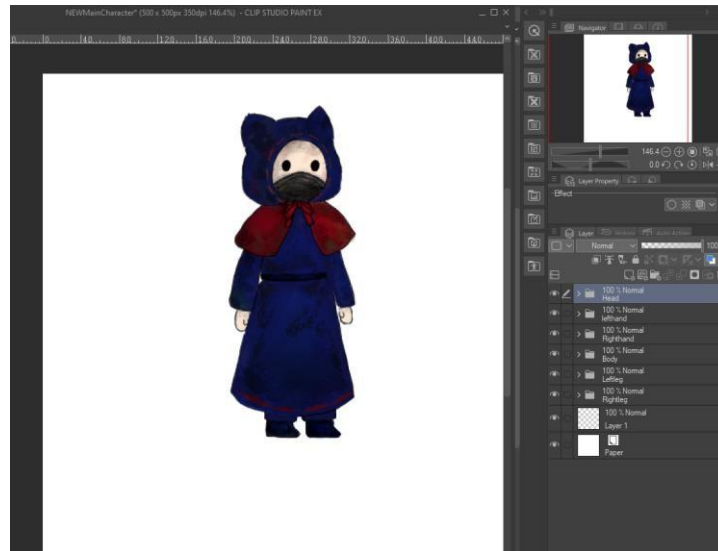


Figure 4.20 The design and development of character design in Clip Studio Paint

Table 4.4 Comparison before and after implementation of player character



Comparison before and after implementation	
Before	After
	

Figure 4.20 shows the main character design drawn and created in Clip Studio Paint. The various parts of the character will be separated into their own layers, the file can be exported as a PSD file format, and then imported into unity, using unity's sprite

editor and skinning editor to add bones to the character which are shown in figure 4.21 below. And the table 4.4 shows the comparison before and after implementation of player character.

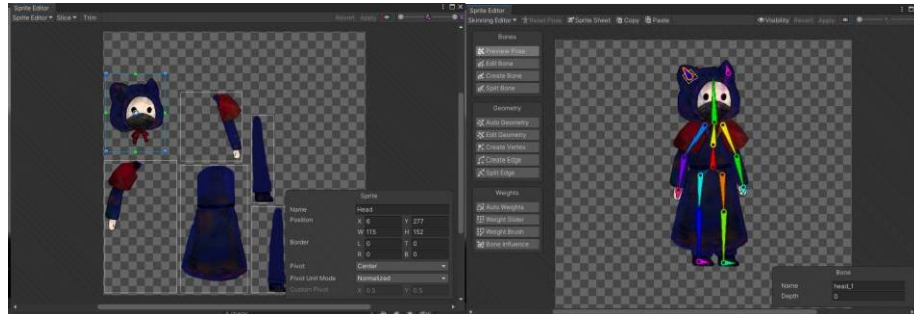


Figure 4.21 Sprite editor and skinning editor window of main character

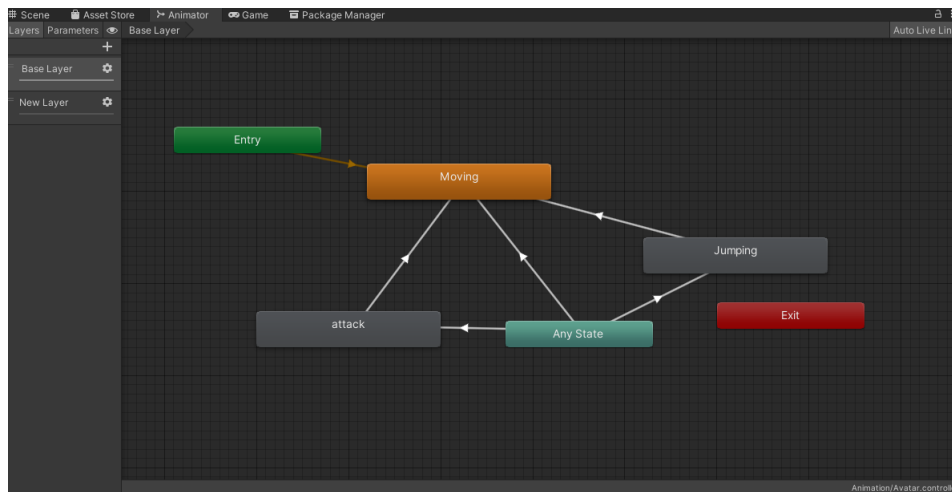


Figure 4.22 Animator of Main Character

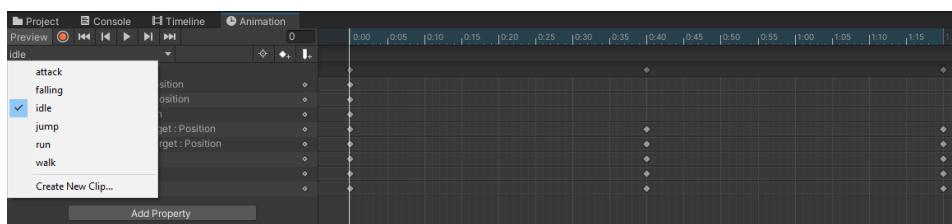


Figure 4.23 Animations of main character

Figure 4.3 shows an animator working on an animation transition. The main character has about 6 animation actions which are idle, walk, run, jump, fall and melee attack.

4.3.4.2 Player Controller

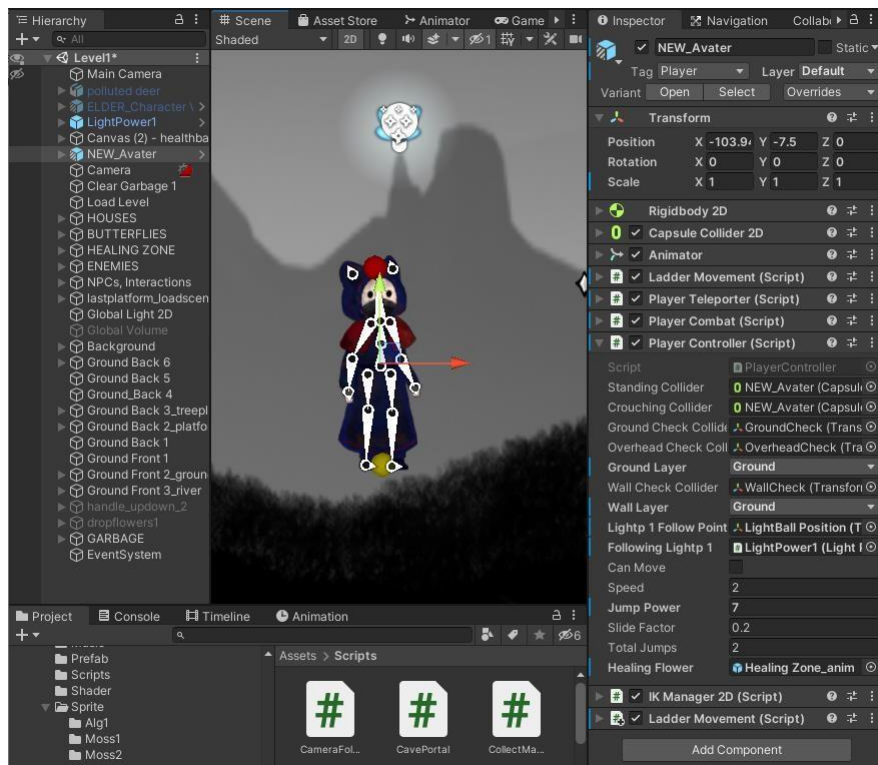


Figure 4.24 The PlayerController script attached in the inspector of player character

The script is attached on the game object where it is controlled by player to move. The figure 4.24 shows the PlayerController script that attached in the inspector of the player character. The full script is in the subsection 1 of Appendix D.

i. Idle



Figure 4.25 Idle State of Player Character

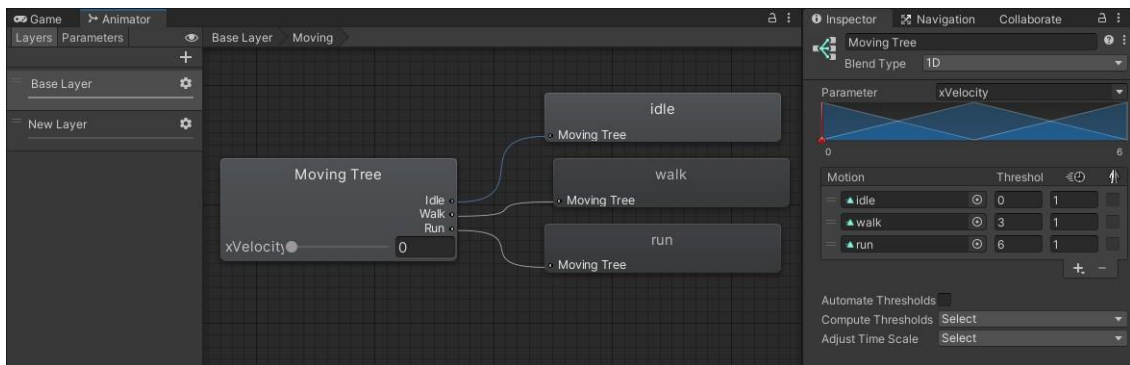


Figure 4.26 The Blend Tree of Moving of the player character

Figure 4.25 shows the idle state of the player character. The idle state is part of the Blend Tree of Moving. The blend tree is to manage the moving movement of the player, which is including idle, walk, and run. The idle state is working when the player do not move the character.

ii. Walking and Running



Figure 4.27 Walking and Running State of Player Character

The figure 4.27 shows the walking and running state of the player character. The player moves backwards and forwards by pressing the “A” and “D” key respectively. To move faster, the player needs to hold down the left shift key and the movement key at the same time.

```

void Update()
{
    if(!canMove)
    {
        rb.velocity = Vector2.zero;
        return;
    }

    horizontalValue = Input.GetAxisRaw("Horizontal");

    if (Input.GetKeyDown(KeyCode.LeftShift))
        isRunning = true;

    if (Input.GetKeyUp(KeyCode.LeftShift))
        isRunning = false;

    if (Input.GetButtonDown("Jump"))
        Jump();

    animator.SetFloat("yVelocity", rb.velocity.y);

    WallCheck();
}

void FixedUpdate()
{
    GroundCheck();
    Move(horizontalValue, crouchPressed);
}

void Move(float dir, bool crouchFlag)
{
    #region Move & Run
    float xVal = dir * speed * 100 * Time.fixedDeltaTime;
    if (isRunning)
        xVal *= runSpeedModifier;
    if (crouchFlag)
        xVal *= crouchSpeedModifier;
    Vector2 targetVelocity = new Vector2(xVal, rb.velocity.y);
    rb.velocity = targetVelocity;

    if (facingRight && dir < 0)
    {
        Flip();
    }
    else if (!facingRight && dir > 0)
    {
        Flip();
    }

    animator.SetFloat("xVelocity", Mathf.Abs(rb.velocity.x));
    #endregion
}

private void Flip()
{
    facingRight = !facingRight;
    transform.Rotate(0f, 180f, 0f);
}

```

Figure 4.28 The functions used in PlayerController script to control walk and run

The figure 4.28 shows the screenshot of the functions used in PlayerController script to control the player character's movement, walk, and run. In Update () is to control the key down to move the character. The function of void Move () and Flip () is to control

the speed of the player character and the flipping movement when player move right or left. The full script of PlayerController is shown in subsection 1. of Appendix D.

iii. Jumping and Falling



Figure 4.29 Jumping and Falling State of Player Character

The figure 4.29 shows the screenshot of jumping and falling state of player character. The player could control the character jump move upwards by pressing “W” key. The player is allowed to coyote jump, which means that the player can jump right after leaving a platform and still be allowed to jump again. So, a player could jump to a higher or farther platform.

```

IEnumerator CoyoteJumpDelay()
{
    coyoteJump = true;
    yield return new WaitForSeconds(0.2f);
    coyoteJump = false;
}
bool coyoteJump;
void Jump()
{
    FindObjectOfType<AudioManager>().Play("playerjump");
    if (isGrounded)
    {
        multipleJump = true;
        availableJumps--;

        rb.velocity = Vector2.up * jumpPower;
        animator.SetBool("Jump", true);
    }
    else
    {
        if (coyoteJump)
        {
            multipleJump = true;
            availableJumps--;

            rb.velocity = Vector2.up * jumpPower;
            animator.SetBool("Jump", true);
        }
        if (multipleJump && availableJumps > 0)
        {
            availableJumps--;

            rb.velocity = Vector2.up * jumpPower;
            animator.SetBool("Jump", true);
        }
    }
}
}

```

Figure 4.30 The functions used in PlayerController script to control coyote jump

The figure 4.30 shows the screenshot of the functions used in PlayerController script to control the coyote jump. The IEnumerator is used to pause an iteration of the coyote jumping time which to allow the player could jump shortly after leaving a platform.

iv. Melee Attack



Figure 4.31 Melee Attack State of Player Character

The figure 4.31 shows the screenshot of melee attack state of player character. The player could control the character to attack by pressing “E” key. The melee attack is using PlayerCombat script to control this feature.

```

public Animator animator;
public Transform attackPoint;

public LayerMask enemyLayers;
public float attackRange = 0.5f;
public int attackDamage = 40;

public float attackRate = 2f;
float nextAttackTime = 0f;

void Update()
{
    if(Time.time >= nextAttackTime)
    {
        if(Input.GetKeyDown(KeyCode.E))
        {
            Attack();
            nextAttackTime = Time.time + 1f / attackRate;
        }
    }
}

```

Figure 4.32 The function in PlayerCombat script

The figure 4.32 shows the screenshot of the function in PlayerCombat script that control the attack feature of the player character. The Update () function is to control the player to press “E” key to activate attack animation and function. The details of melee attack is discussed under subsection ii of section 4.3.5.

4.3.5 Game Mechanics Setup

i. Health Bar

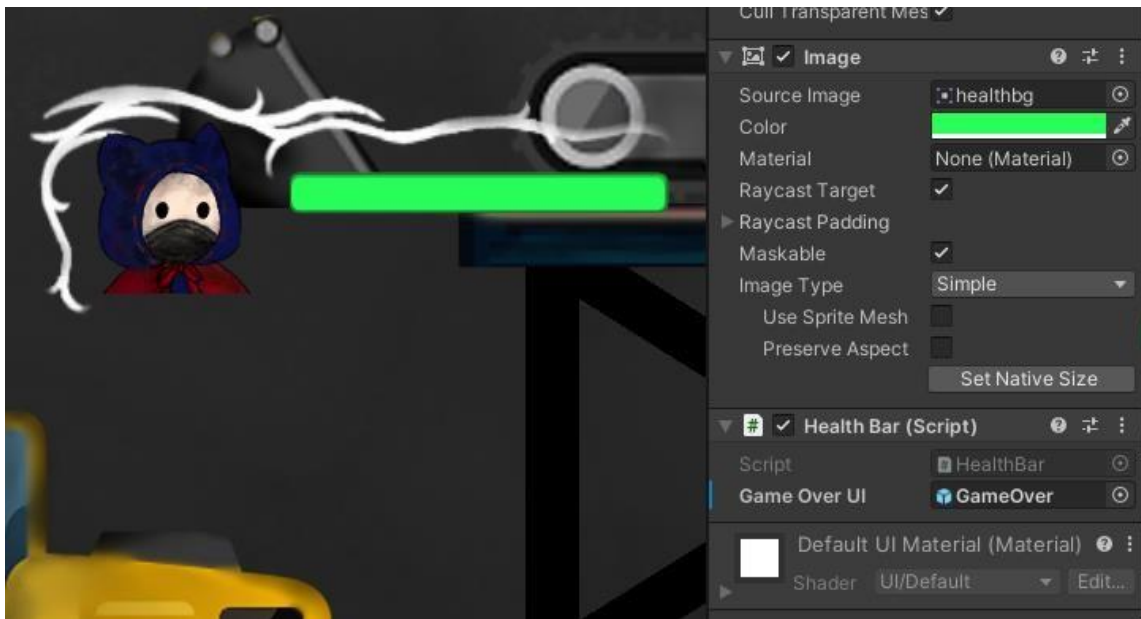


Figure 4.33 The health bar of the player character

The theme of Purification revolves around environmental issues, and the role of the health bar is to show that environmental issues have a negative impact on people's health. The HealthBar script is attached to handle decreasing and increasing the health points.

```

using UnityEngine;
using UnityEngine.UI;
using UnityEngine.SceneManagement;

public class HealthBar : MonoBehaviour
{
    Vector3 localScale;
    public static float healthAmount;
    public static float minHealth = 0f;

    void Start()
    {
        localScale = transform.localScale;
        healthAmount = 1;
    }

    void Update()
    {
        localScale.x = PlayerController.healthAmount;
        transform.localScale = localScale;

        if (localScale.x <= minHealth)
        {
            Die();
            PlayerController.healthAmount = 0f;
        }
    }

    //for game over screen
    public GameObject GameOverUI;
    public void GameOver()
    {
        GameOverUI.SetActive(true);
    }

    void Die()
    {
        Debug.Log("Player died");
        GameOver();
    }
}

```

Figure 4.34 The HealthBar full script

The figure 4.34 shows the full script of HealthBar that attached to the inspector of the player character's health bar. This script used to handle the increase and decrease of the health bar, the health amount of player is 1, when the health amount is less than 0 means the player character is die and the game over UI will pop up to ask player to restart.

- ii. Attack Type
 - Melee Attack

The figure 4.35 shows the melee attack setup of the player character which is apply an attack range by using OnDrawGizmo function and handle by PlayerCombat script that shown in figure 4.37. The figure 4.36 shows the inspector of the player character that attached with PlayerCombat script. An attack point and range are set to determine the range of attacking the enemy. And to ensure that the player only apply

damage of attack on the enemy, so a layer mask of enemy is set to be specific as take damage game objects in the game.



Figure 4.35 The melee attack setup of the player character.

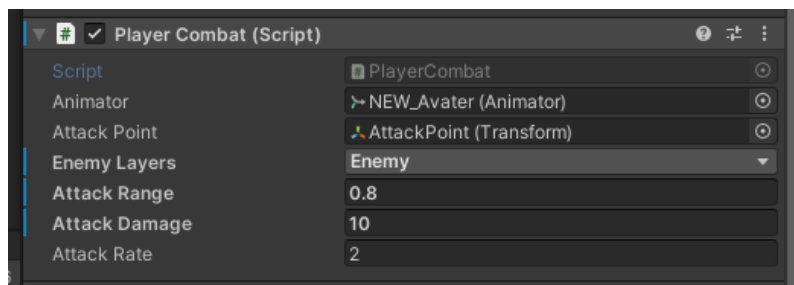


Figure 4.36 The inspector of the player character that attached with PlayerCombat script.

```

public Animator animator;
public Transform attackPoint;

public LayerMask enemyLayers;
public float attackRange = 0.5f;
public int attackDamage = 40;

public float attackRate = 2f;
float nextAttackTime = 0f;

void Update()
{
    if(Time.time >= nextAttackTime)
    {
        if(Input.GetKeyDown(KeyCode.E))
        {
            Attack();
            nextAttackTime = Time.time + 1f / attackRate;
        }
    }
}

void Attack()
{
    FindObjectOfType<AudioManager>().Play("attack");
    animator.SetTrigger("Attack");

    Collider2D[] hitEnemies = Physics2D.OverlapCircleAll(attackPoint.position,
    attackRange, enemyLayers);

    foreach(Collider2D enemy in hitEnemies)
    {
        enemy.GetComponent<GroundEnemy>().TakeDamage(attackDamage);
    }
}

private void OnDrawGizmosSelected()
{
    if (attackPoint == null)
        return;

    Gizmos.DrawWireSphere(attackPoint.position, attackRange);
}

```

Figure 4.37 The full script of PlayerCombat

- Ranged Attack

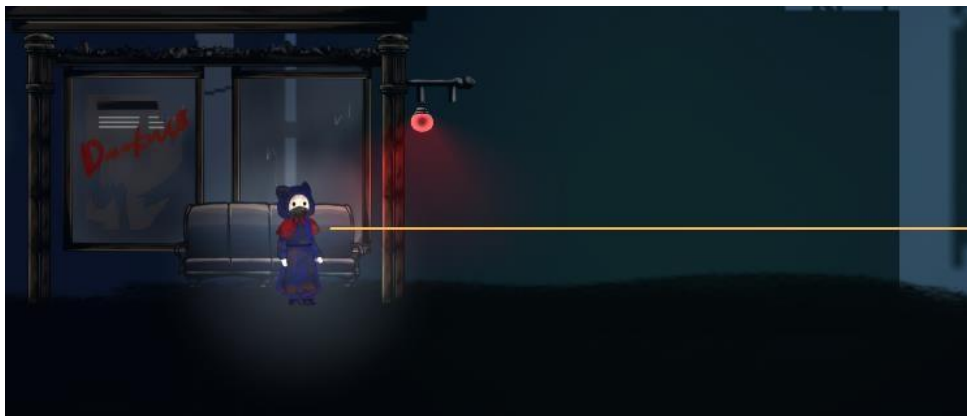


Figure 4.38 The screenshot of shooting by player character

The figure 4.38 shows the screenshot of shooting by player character. A fire point is set in front of the chest of the player character. By clicking left mouse click is to apply shooting and a ray is performed.



Figure 4.39 The screenshot of shooting with damage effect

The figure 4.39 shows the screenshot of shooting with damage effect. The damage effect only appears when player have shot on the enemy.

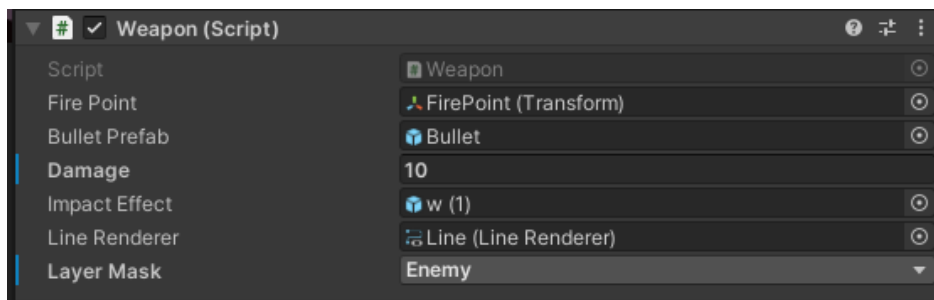


Figure 4.40 The inspector of the player character that attached with Weapon script.

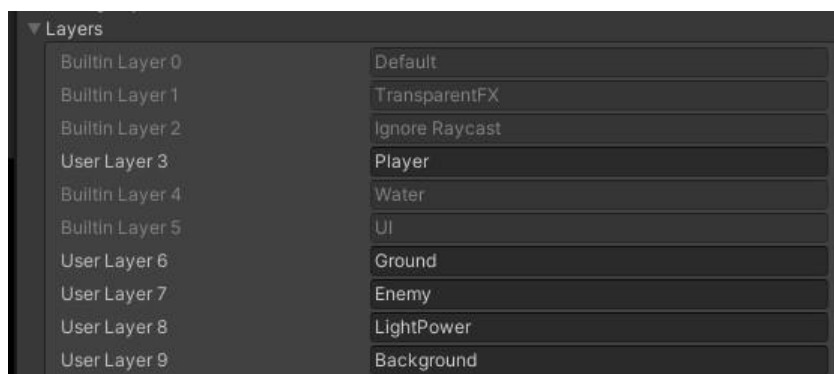


Figure 4.41 The layer mask of Unity

```

public Transform firePoint;
public GameObject bulletPrefab;
public int damage = 40;
public GameObject impactEffect;
public LineRenderer lineRenderer;

[SerializeField] private LayerMask layerMask;

void Update()
{
    if(Input.GetButtonDown("Fire1"))
    {
        StartCoroutine(Shoot());
    }
}

IEnumerator Shoot()
{
    FindObjectOfType<AudioManager>().Play("shoot");
    //Instantiate(bulletPrefab, firePoint.position, firePoint.rotation);
    RaycastHit2D hitInfo = Physics2D.Raycast(firePoint.position,
        firePoint.right);

    if(hitInfo.collider.gameObject.layer == 7)
    {
        FindObjectOfType<AudioManager>().Play("shoothit");
        GroundEnemy enemy = hitInfo.transform.GetComponent<GroundEnemy>();
        if (enemy != null)
        {
            enemy.TakeDamage(damage);
        }

        Instantiate(impactEffect, hitInfo.point, Quaternion.identity);

        lineRenderer.SetPosition(0, firePoint.position);
        lineRenderer.SetPosition(1, hitInfo.point);
    } else
    {
        lineRenderer.SetPosition(0, firePoint.position);
        lineRenderer.SetPosition(1, firePoint.position + firePoint.right *
            100);
    }

    lineRenderer.enabled = true;
    yield return new WaitForSeconds(0.02f);

    lineRenderer.enabled = false;
}
}

```

Figure 4.42 The script of Weapon

The figure 4.40 shows the inspector of the player character that attached with Weapon script. A fire point is set in front of the player character's chest which shown in figure 4.39. The Weapon script is to handle the raycast that moves ahead in its specified direction and only hit on the Enemy layer mask which shown in the figure of 4.43. And in the script is stating hit on layer == 7 which means the enemy layer mask is layer 7 in Unity as shown in figure 4.41. This game mechanic is applied from level 3 to the end of game.

iii. Waterfall

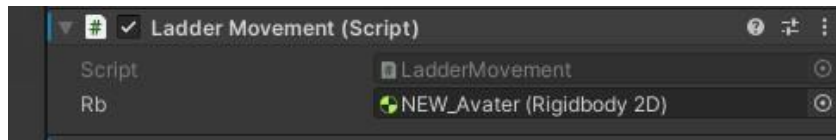


Figure 4.43 LadderMovement script attached in Player Character’s inspector



Figure 4.44 Player ascends with the current of the waterfall.

The figure 4.44 shows the LadderMovement script applied in Player Character. The script handling the waterfall as a ladder function for player could use “W” key to ascends with the current of the waterfall. This game mechanic allows the player to follow the water flow to reach higher platforms. And the figure 4.45 shows the screenshot of the player character ascends with the current of the waterfall.

iv. Jump Pad

The jump pad is used for player jumps and reach a higher platform. And the jump pad in this game is only used in the rural area’s houses and it is located inside the first floor of the house. The figure 4.46 and 4.47 shows the screenshots of using the jump pad to jump to the second floor of the house. According to the figure 4.48 of the JumpTap script, a jump pad is set with a bounce force so the player could jump higher. If the bounce is higher, the higher point that the player can reach.



Figure 4.45 JumpTap script attached in the JumpPad



Figure 4.46 The screenshot of jump pad in the game



Figure 4.47 The screenshot of player uses the jump pad to jump to the second floor

```

public float bounce = 10f;

private void OnCollisionEnter2D(Collision2D collision)
{
    if(collision.gameObject.CompareTag("Player"))
    {
        collision.gameObject.GetComponent<Rigidbody2D>().AddForce(Vector2.up *
            bounce, ForceMode2D.Impulse);
    }
}

```

Figure 4.48 The JumpTap script

v. See Through the Wall

The mechanics of see through the wall is using a sprite mask to interact with other sprites. A sprite mask is added to the player character as shown in figure 4.50, and the mask interaction of the wall would be set as Visible Outside Mask as shown in figure 4.51. The player's sprite mask interacts with the walls, making them visible based on the shape of the sprite mask as shown in figure 4.49. According to figure 4.49, the wall is invisible before the player is entering the house, the wall is only visible when the player is entering the house.



Figure 4.49 The screenshots of using see through wall features in game

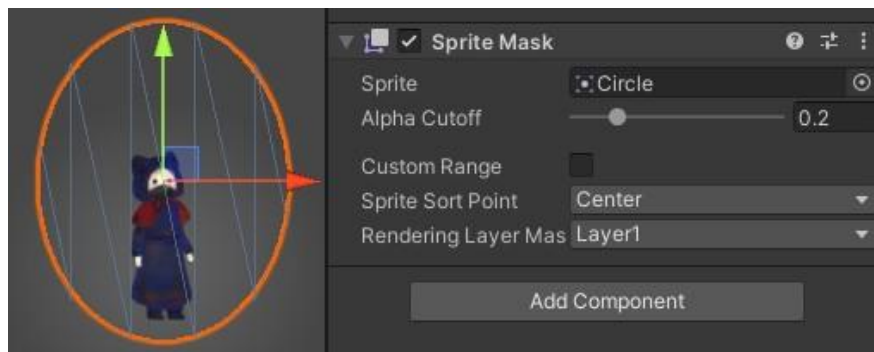


Figure 4.50 The sprite mask of the player character

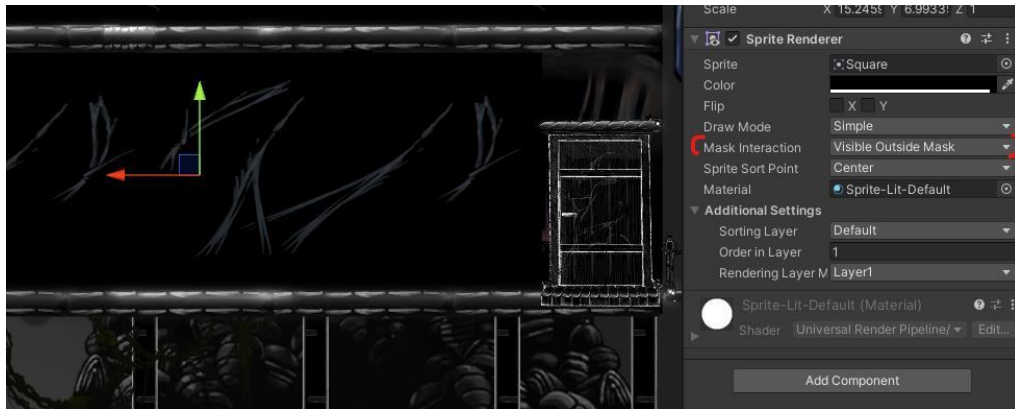


Figure 4.51 The setting of mask interaction of the wall

vi. Open Door

The figure 4.52 shows the inspector of the closed door that attached with the OpenDoorControl script. This script it to handle the message pop out and the open-door animation. According to the figure 4.53 below, the player could not go inside the house without open the door. When the player press “F” key, the door opens and locking collider is unactive.

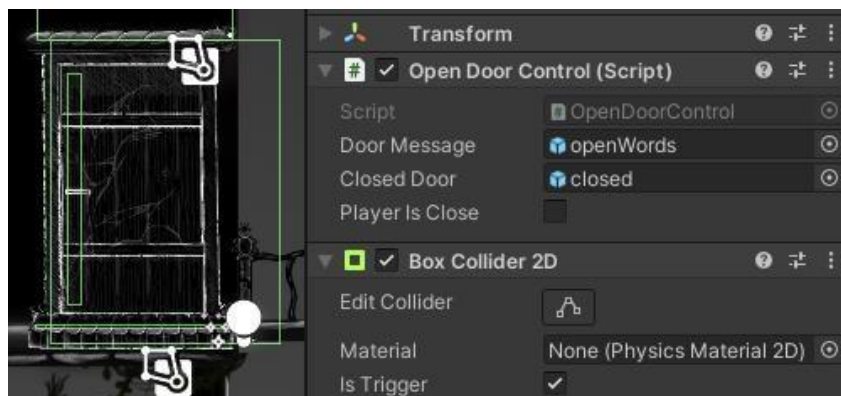


Figure 4.52 The OpenDoorControl script is attached to the closed door



Figure 4.53 The screenshots of open door

vii. Moving Elevator

The moving elevator is design in the urban area, the darkness city in the game. The moving elevator is used for player to take it to a higher platform. The figure 4.54 shows the two types of moving elevator in game. A MovingPlatform script is attached to the moving elevator to handle the direction of the elevator by setting the waypoints as shown in figure 4.55 and 4.56.



Figure 4.54 The types of moving elevator in game

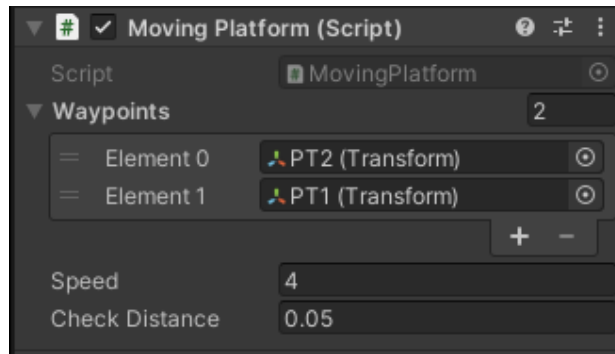


Figure 4.55 The MovingPlatform script attached to the moving elevator.



Figure 4.56 The waypoints of the moving elevator

```

void Update()
{
    transform.position = Vector2.MoveTowards(
        transform.position,
        targetWaypoints.position,
        speed * Time.deltaTime);

    if(Vector2.Distance(transform.position,targetWaypoints.position) <
        checkDistance)
    {
        targetWaypoints = GetNextWaypoint();
    }
}

private Transform GetNextWaypoint()
{
    currentWaypintIndex++;
    if(currentWaypintIndex >= waypoints.Length)
    {
        currentWaypintIndex = 0;
    }

    return waypoints[currentWaypintIndex];
}

```

Figure 4.57 The function of MovingPlatform

The figure 4.57 shows the function of MovingPlatform script that handle the waypoints of the moving elevator. The moving elevator moves in the order of the waypoints, and continues to the next point after reaching the first point, and so on.

viii. Teleporter



Figure 4.58 The teleporter in game

The figure 4.58 shows the teleporter in the game, the teleporter used in level 4-7. The teleporter is used for player to teleport another destination in a second.

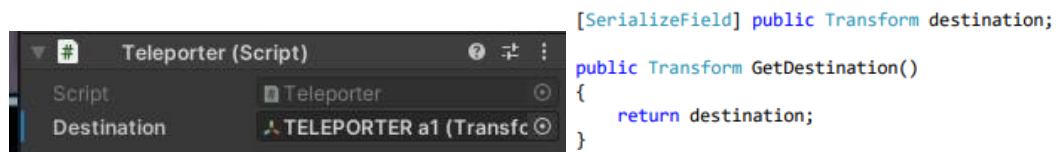


Figure 4.59 The Teleporter script function and teleporter inspector.

The figure 4.59 shows the teleporter script function which is to handle the teleporter could teleport the player to another teleport destination. And the teleport destination is assigned to each teleporter.



Figure 4.60 The PlayerTeleporter script and the player character inspector.

The figure 4.60 shows the PlayerTeleporter script that attached to the player character’s inspector. According to the figure above, the function in the script is to handle the player to press “E” key for teleporting.

ix. Acid Drops (Rain & Flame)



Figure 4.61 The material of the acid drops

The figure 4.61 shows the material of the acid drops, the acid drops is made up of particle system in Unity. The Drop material is used for creating the acid rain, and the Fire material is used for creating the fire drops act as global warming.

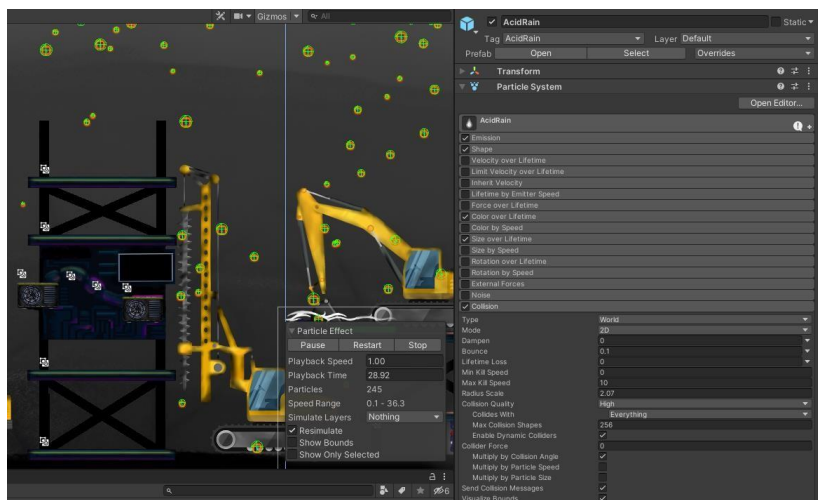


Figure 4.62 The particles system collision setting.

The figure 4.62 shows the particles system of the acid drops, the particles collision is added and set the particles system collides with everything. The particles system will collide with all the layers.

```
private void OnParticleCollision(GameObject other)
{
    if (other.CompareTag("AcidRain"))
    {
        healthAmount -= 0.02f;
    }
}
```

Figure 4.63 The function that control the particles collision on player

The figure 4.63 is the function that control the particles collision on player. This script is attached to the PlayerController script. When the player collides with the game objects with tag "AcidRain", the player takes a damage.

x. Enemy Follow

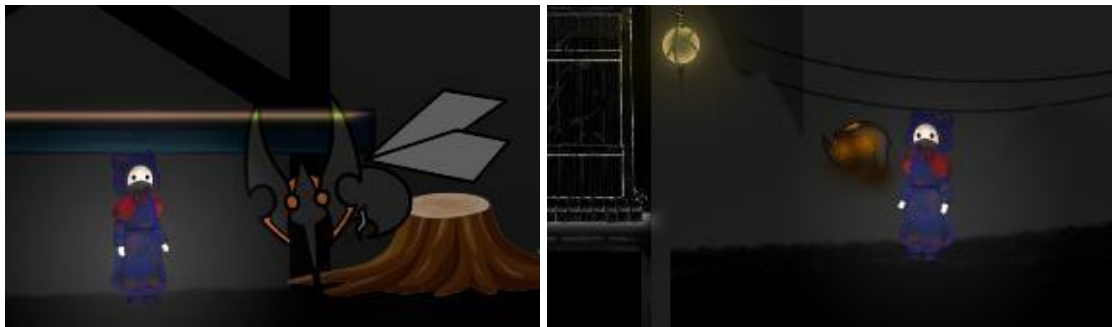


Figure 4.64 The enemy that follow the player

The figure 4.64 shows the enemy type that follow the player. There are mutated mosquito and lava. The enemy that attached with EnemyFollow script will keep follow the player until the player defeat them.



Figure 4.65 The EnemyFollow script that attached to the enemy

The figure 4.65 shows the EnemyFollow script that attached to the enemy's inspector. The speed and stopping distance is added to control the enemy can move smoothly.

```

public class EnemyFollow : MonoBehaviour
{
    public float speed;
    public float stoppingDistance;
    public Transform target;

    void Start()
    {
        target = GameObject.FindGameObjectWithTag
            ("Follow").GetComponent<Transform>();
    }

    void Update()
    {
        if(Vector2.Distance(transform.position, target.position)>3)
        {
            transform.position = Vector2.MoveTowards(transform.position,
                target.position, speed * Time.deltaTime);
        }
    }
}

```

Figure 4.66 The full script of the EnemyFollow

The figure 4.66 shows the full script of the EnemyFollow, the Update() function is to handle the features of the enemy could keep move towards or follow the player. The enemy will find the player to follow, because the player has been set as the follow target of the enemy.

xi. Waypoint Enemy

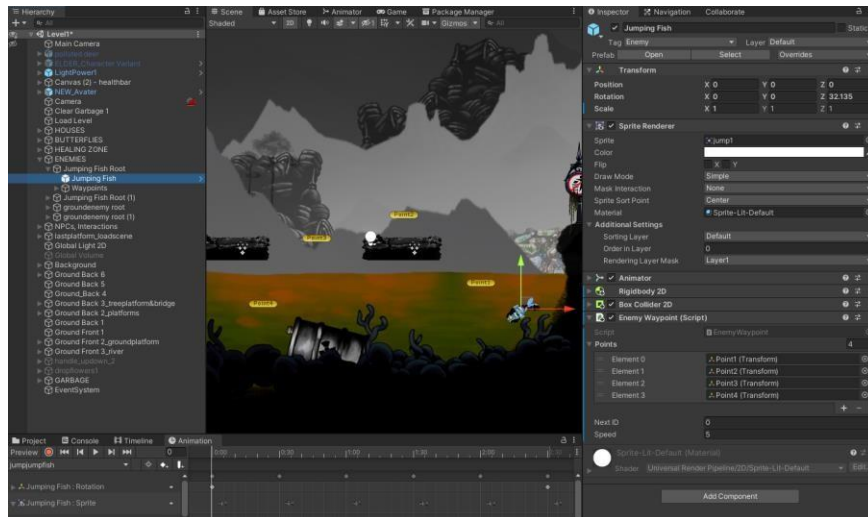


Figure 4.67 The EnemyWaypoint script that attached to the enemy

The EnemyWaypoint script is attached to a game object, and the script controls its movement. However, Figure 4.67 shows the EnemyWaypoint script attached to the Jumping Fish enemy. A waypoint is a point on the route or on the marching line. The script will move according to the set waypoint and control the NPC to move from the last point to the starting point.

```

void Init()
{
    GetComponent<BoxCollider2D>().isTrigger = true;

    GameObject root = new GameObject(name + "_Root");
    root.transform.position = transform.position;
    transform.SetParent(root.transform);
    GameObject waypoints = new GameObject("Waypoints");
    waypoints.transform.SetParent(root.transform);
    waypoints.transform.position = root.transform.position;
    GameObject p1 = new GameObject("Point1"); p1.transform.SetParent
    (waypoints.transform); p1.transform.position = root.transform.position;
    GameObject p2 = new GameObject("Point2"); p2.transform.SetParent
    (waypoints.transform); p2.transform.position = root.transform.position;

    points = new List<Transform>();
    points.Add(p1.transform);
    points.Add(p2.transform);
}

```

Figure 4.68 The function of EnemyWaypoint script -1

The figure 4.68 shows the function that shows above is in EnemyWaypoint script which to handle the waypoints setup in Unity. The setting of the waypoint is to create an empty GameObject and then move to the desired waypoint, and then set the GameObject in the script.

```

void MoveToNextPoint()
{
    Transform goalPoint = points[nextID];
    if (goalPoint.transform.position.x > transform.position.x)
        transform.localScale = new Vector3(-1, 1, 1);
    else
        transform.localScale = new Vector3(1, 1, 1);

    transform.position = Vector2.MoveTowards(transform.position,
        goalPoint.position, speed * Time.deltaTime);

    if (Vector2.Distance(transform.position, goalPoint.position) < 0.1f)
    {
        if (nextID == points.Count - 1)
            idChangeValue = -1;
        if (nextID == 0)
            idChangeValue = 1;

        nextID += idChangeValue;
    }
}

```

Figure 4.69 The function of EnemyWaypoint script -2

The figure 4.69 above shows the function in EnemyWaypoint script which to control the enemy move to next waypoint and able to move forwards and backwards continuously.

xii. Dropped Items

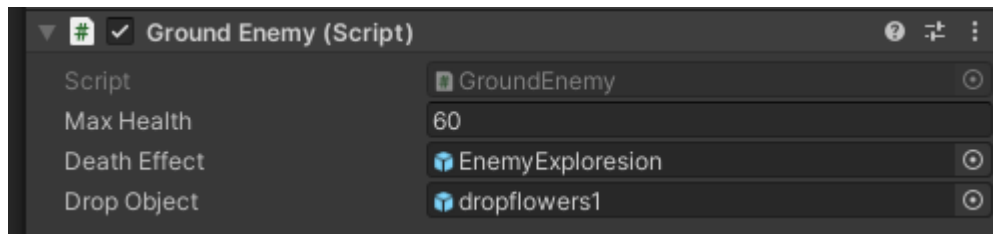


Figure 4.70 The GroundEnemy script attached to the enemy's inspector

The dropped items mechanics is using the GroundEnemy script to handle. The Drop Object is to assign the drop items of the enemy, and the assigned item will drop when the enemy is cleared which is using the function of DropFlower() in the script as shown in figure 4.71 below.


```

void Die()
{
    Instantiate(deathEffect, transform.position, Quaternion.identity);
    Destroy(gameObject);
    FindObjectOfType<AudioManager>().Play("explode");
    DropFlower();
}

void DropFlower()
{
    Vector2 position = transform.position;
    GameObject dropflower = Instantiate(DropObject, transform.position,
    Quaternion.identity);
    dropflower.SetActive(true);
    //Destroy(dropflower, 2f);
}

```

Figure 4.71 The functions that handle drop items mechanics in GroundEnemy script

In the Die () function, when the enemy dies, the DropFlower() function will continue to be executed. The dropped item will only be activated after the enemy has been cleared.

- Healing Flower Point



Figure 4.72 The drop item 1 – Healing flower point

The figure 4.72 shows one of the drop items which is the healing flower point. This drop item will only increase player health by 20 points.

- Small Healing Flower Zone



Figure 4.73 The drop item 2 – Small healing flower zone

The figure 4.73 shows one of the drop items which is the small healing zone. The small healing zone has the same role with the Healing Blooming Tree Zone which can continuously replenish the player's full health. The only difference between them is the recharge speed, and the small healing zone's recharging speed is slower.

xiii. Turn Off the Factory Wastewater Discharge Tap

The figure of 4.74 shows the CloseFactory script attached to the Factory that discharges wastewater into a river. This script is used to handle the player pressing the "E" key to close the tap and set the active or inactive state of the game object. The flow of turning off the tap are shown in figure 4.75, 4.76 and 4.77. When the player near the tap and presses the "E" key within range, the tap will close, wastewater will no longer be discharged, and the poisonous river will disappear by appearing the hidden platform and area below.

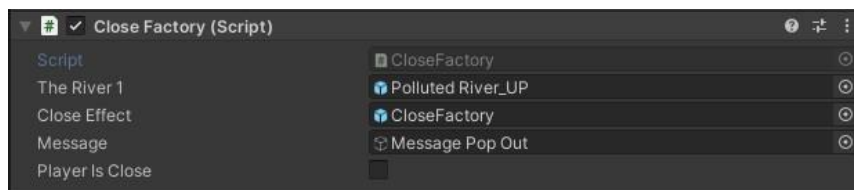


Figure 4.74 The CloseFactory script attached to the Factory



Figure 4.75 The screenshot of the factory before turning off the tap.

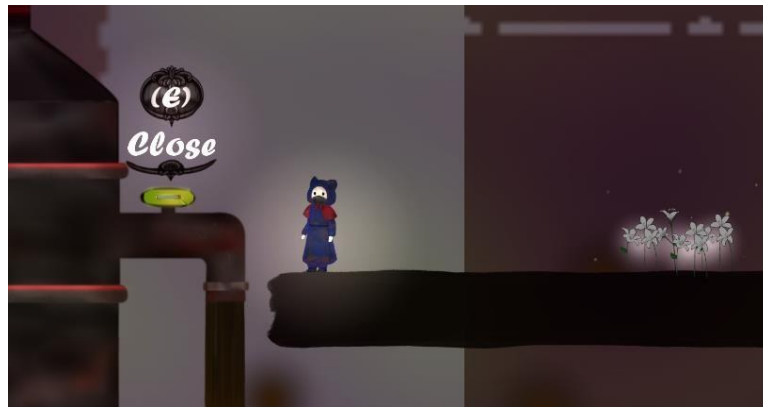


Figure 4.76 The screenshot of player near the wastewater discharge tap



Figure 4.77 The screenshot of after turning off the wastewater discharge tap.

xiv. Healing Zone Game Mechanic

The figure 4.78 below shows the healing function in HealingZone script. The function of IEnumerator Heal () is to handle the increasing health amount of the player to full which is 1f. The player only recharges their health points in the range of healing

zone. The figure 4.79 shows the GameObject that attached with Healing Zone mechanic, there are the big healing blooming tree and the drop item of small healing flower zone.

```
IEnumerator Heal()  
{  
    for (float currentHealth = PlayerController.healthAmount; currentHealth <= 1; currentHealth += 0.001f)  
    {  
        PlayerController.healthAmount = currentHealth;  
        yield return new WaitForSeconds(Time.deltaTime);  
    }  
    PlayerController.healthAmount = 1f;  
}
```

Figure 4.78 The healing function in HealingZone script

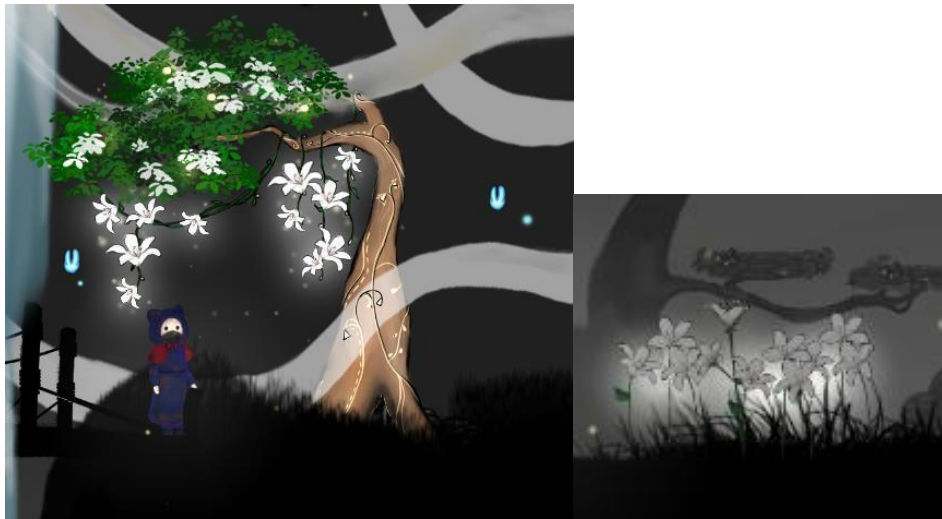


Figure 4.79 The GameObject that attached with Healing Zone mechanic

xv. Deduct Zone Game Mechanic

The figure 4.80 below shows the healing function in HealingZone script. The function of IEnumerator Deduct () is to handle the decreasing health amount of the player continuously. If the player's health reaches 0, the player dies and the game over UI is displayed. The figure 4.81 shows the GameObjects that attached with Deduct Zone mechanic, there are the burning garbage zone and polluted river.

```

IEnumerator Deduct()
{
    for (float currentHealth = PlayerController.healthAmount; currentHealth >
        0; currentHealth -= 0.0008f)
    {
        PlayerController.healthAmount = currentHealth;
        yield return new WaitForSeconds(Time.deltaTime);
    }

    if (PlayerController.minHealth <= 0)
    {
        Die();
    }
}

```

Figure 4.80 The deducting health function in DeductZone script



Figure 4.81 The GameObject that attached with Deduct Zone mechanic

- xvi.** Purify Polluted Place
- Garbage Hill & Burning Garbage

The concept of purify garbage hill and burning garbage is same, only the light power's appearance is different.

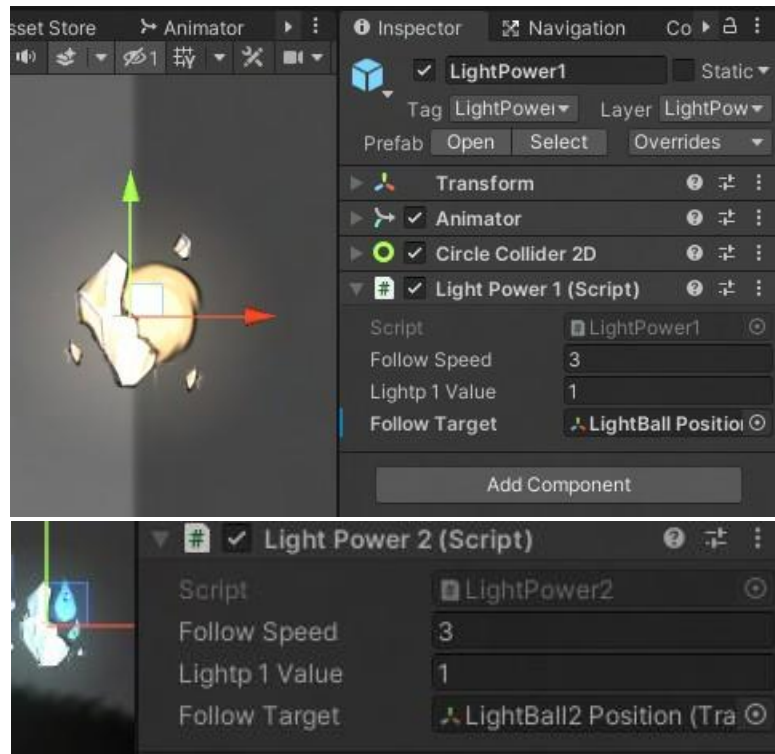


Figure 4.82 The Light Power of scattered light

The gameplay of purify environment is the main game mechanism in Purification. It represents one of the main tasks which is to use the light power of scattered light in Purification. The figure 4.82 shows the light power of scattered light. And LightPower script is applied on it to handle the scattered light could follow the player after being collected.

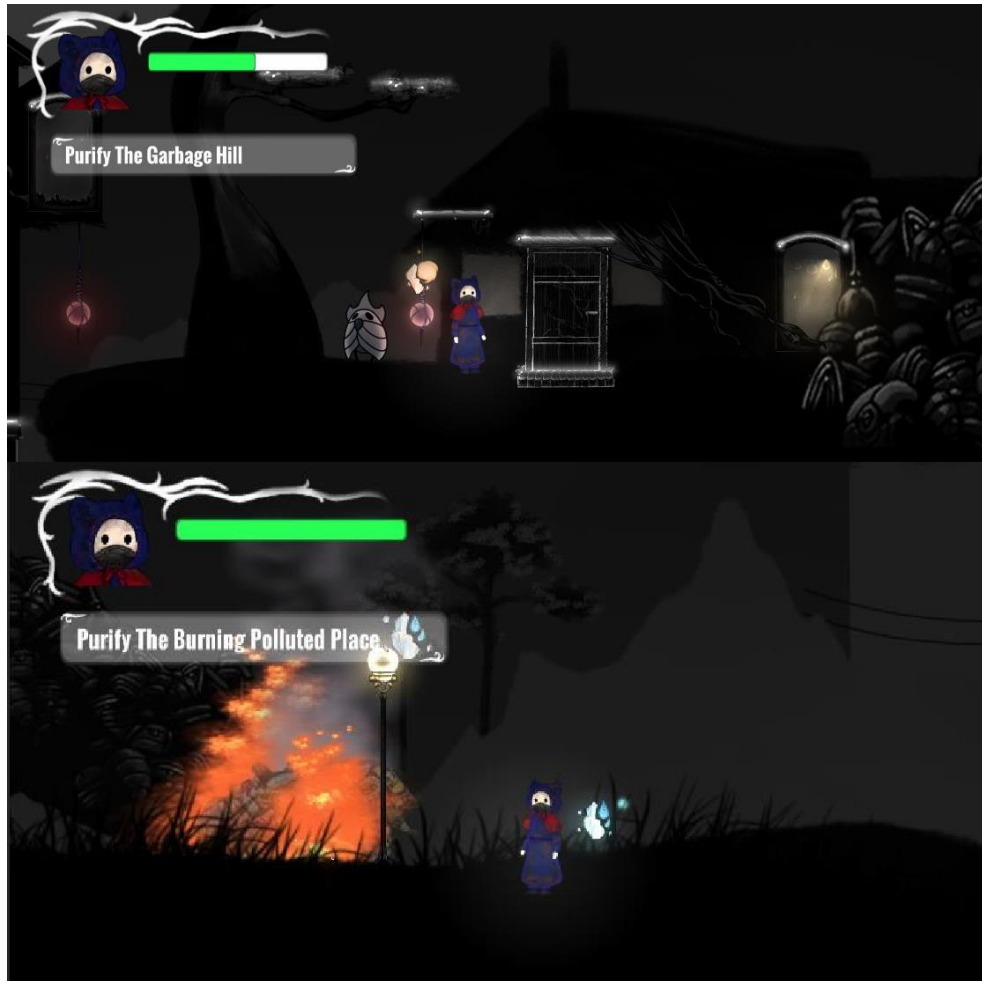


Figure 4.83 Light Power of scattered light follow the player after being collected

After the player collect the scattered light, the scattered light follows the player as shown in figure 4.83. The player only can collect and use one scattered light at one time. There is one blockage that requires the player to clear the environment to pass.

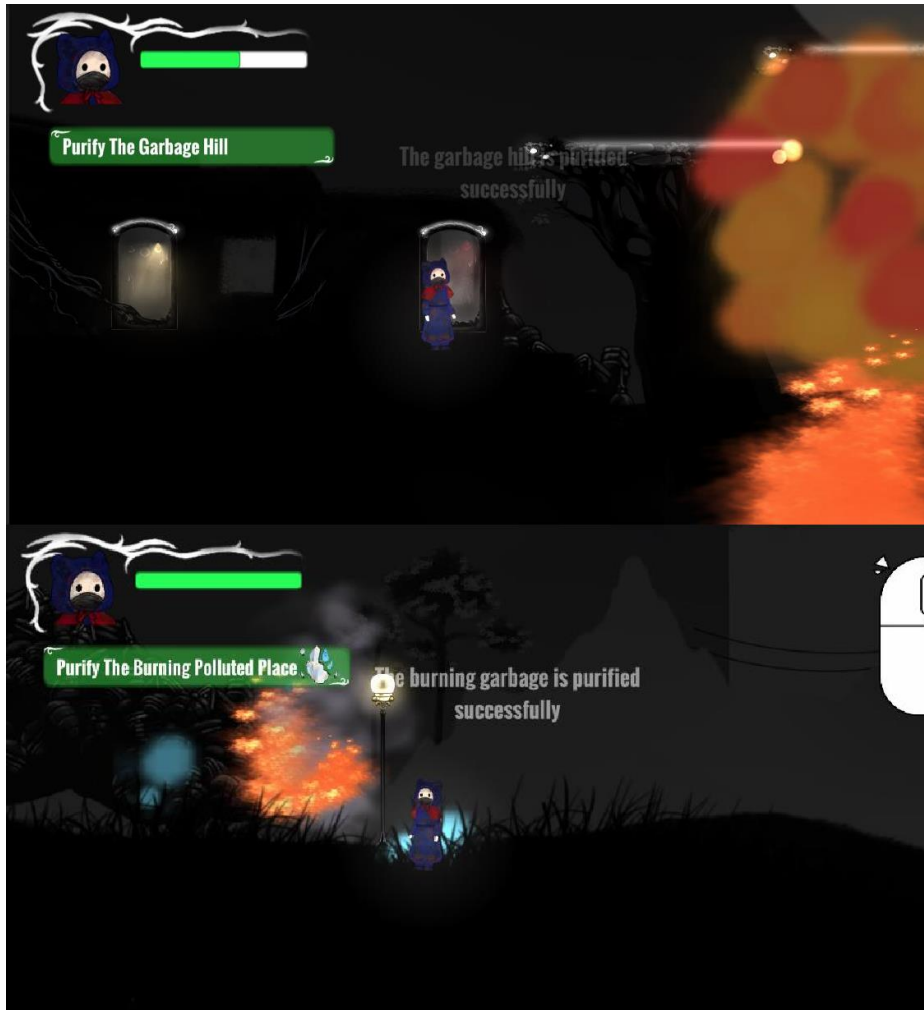


Figure 4.84 Light Power of scattered light clear the garbage.

The LightPower1 script is to handles the purify function. When player is near to the polluted blockage, the scattered light will detect and triggers the purify function, which is then removed with exploding particle effects.

xvii. Purify The Death Zone

- Death Zone

The figure 4.85 shows the death zone of the game. The whole death zone is attached with the KeyDeathZone script which is used to distinguish the type of Powerball key as shown in figure4.86 and 4.87. If it is a different color key type, the death zone cannot be cleared.



Figure 4.85 The death zone

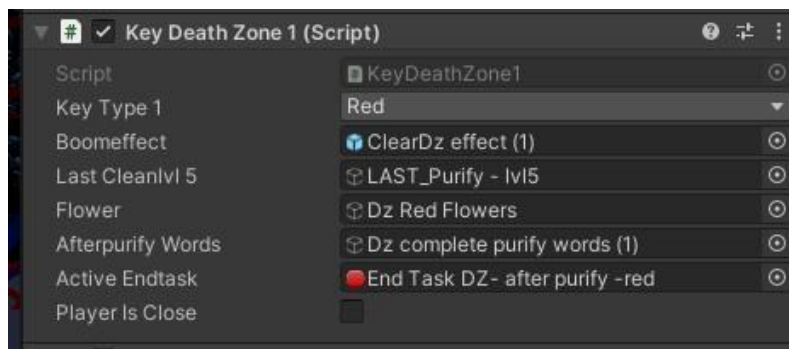


Figure 4.86 The KeyDeathZone script attached to the death zone

```
[SerializeField] private DzKey1.KeyType1 keyType1;
public DzKey1.KeyType1 GetKeyType()
{
    return keyType1;
}

public void OpenDeathZone()
{
    Vector2 position = transform.position;
    flower.SetActive(false);
    LastCleanlv15.SetActive(true);
    boomeffect.SetActive(true);
    FindObjectOfType<AudioManager>().Play("purify2");

    //the deathzone active false
}
```

Figure 4.87 Scrip function of KeyDeathZone

- Death Zone Flowers

The figure 4.88 shows the death zone flowers in the death zone. The death zone flowers are handling the mechanics of attacking the player by attached the DeathZone script as shown in figure 4.89. According to Figure 4.90, a shooting range is set in the death zone flowers and shooting speed. The death zone flowers fire bullets at the player when the player is within shooting range.



Figure 4.88 The death zone flowers

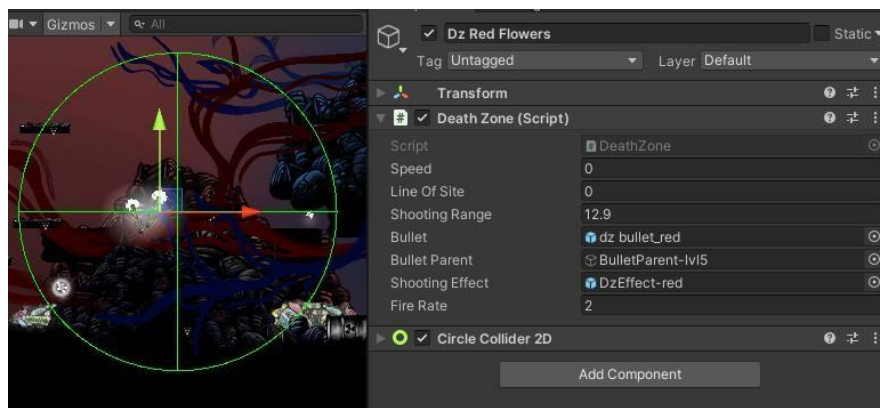


Figure 4.89 The DeathZone script attached to the death zone flowers

```

public float speed;
public float lineOfSite;
public float shootingRange;
public GameObject bullet;
public GameObject bulletParent;

public GameObject shootingEffect;

public float fireRate = 1f;
private float nextFireTime;

private Transform player;
private void Update()
{
    float distanceFromPlayer = Vector2.Distance(player.position,
transform.position);
    if(distanceFromPlayer <lineOfSite && distanceFromPlayer>shootingRange)
    {
        transform.position = Vector2.MoveTowards(this.transform.position,
player.position, speed * Time.deltaTime);
    }

    else if(distanceFromPlayer <= shootingRange && nextFireTime < Time.time)
    {
        Instantiate(bullet, bulletParent.transform.position,
Quaternion.identity);
        nextFireTime = Time.time + fireRate;
    }
}
}

```

Figure 4.90 The script function of DeathZone

- Powerball Key for Purify Death Zone

The figure 4.91 shows the Powerball key and the DzKey script is attached to Powerball key's inspector. According to figure 4.92, the script is used to distinguish whether the Powerball key type is red, blue, or yellow.



Figure 4.91 The Powerball as key for death zone

```

[SerializeField] private KeyType1 keyType1;
public enum KeyType1
{
    Red,
    Blue,
    Yellow
}

public KeyType1 GetKeyType()
{
    return keyType1;
}

```

Figure 4.92 The script of DzKey

- Update Powerball key holder

After a player collects a Powerball key, the UI will update with the type of key collected and stored in the holder as shown in figure 4.93. And figure 4.94 shows that the script of DzKeyHolder is attached to Player Character. According to figure 4.95, the script is used to handle collecting key activity to holder and update key type according to color.



Figure 4.93 The Powerball key holder in UI

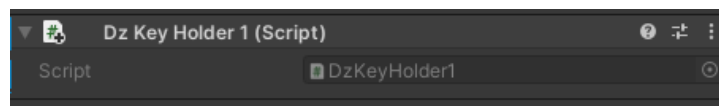


Figure 4.94 The script of DzKeyHolder attached to Player Character

```

public event EventHandler OnKeysChanged;
private List<DzKey1.KeyType1> keyList;

private void Awake()
{
    keyList = new List<DzKey1.KeyType1>();
}

public List<DzKey1.KeyType1> GetKeyList()
{
    return keyList;
}

public void AddKey(DzKey1.KeyType1 keyType1)
{
    Debug.Log("Added Key:" + keyType1);
    keyList.Add(keyType1);
    OnKeysChanged?.Invoke(this, EventArgs.Empty);
}

```

Figure 4.95 The script function of DzKeyHolder

- Activate the purification of death zone.

The figure 4.96 to 4.98 shows the process of activate the purification of death zone. The activation mechanism of Purification only appears when player used Powerball clear the death zone flowers. After pressing “P” key, the purification mechanism is

activated, and the death zone is cleared and purified. The animation of purification of death zone is discussed under subsection 4.3.6



Figure 4.96 The Activation Mechanism of Purification

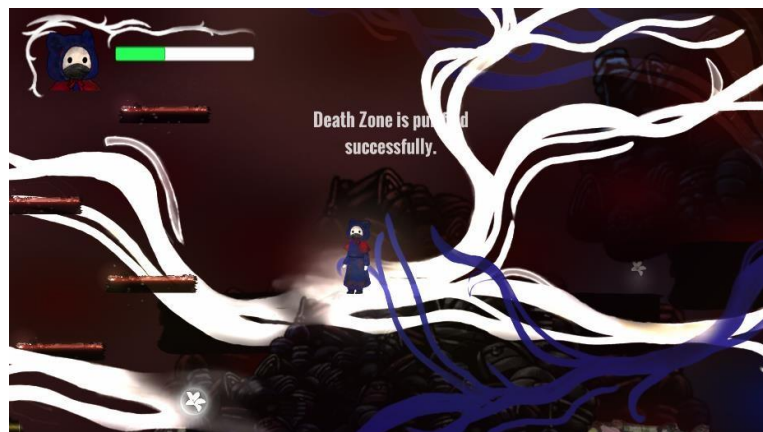


Figure 4.97 After activating the mechanism.



Figure 4.98 The death zone is cleared.

xviii. Plantation

The figure 4.99 shows the last tree in the last game level. The player has to collect 4 power elements to save or grow the tree. The 4.100 shows the 4 power elements for plantation, there are purification, light, water, and flowering booster.



Figure 4.99 The last tree

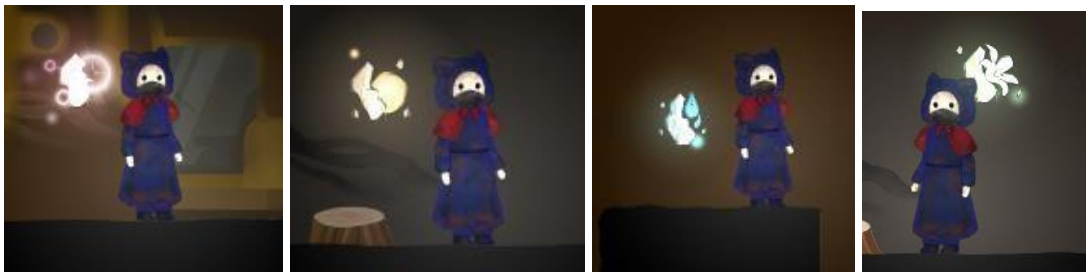


Figure 4.100 The 4 elements for plantation

Figure 4.101 shows the quest to save the last tree, which is shown when the player reaches the last tree's place. Players should collect energy elements one by one to grow the last tree, another holder will only be revealed after the previous step is completed. Figure 4.102 shows successful planting, the animation for planting the last tree is discussed in Section 4.3.6. The PlantStep1 script is attached to plant step 1 and handles distinguishing the correct power element and updating the task list progress, steps 2 to 4 use the same concept as the step 1 script.

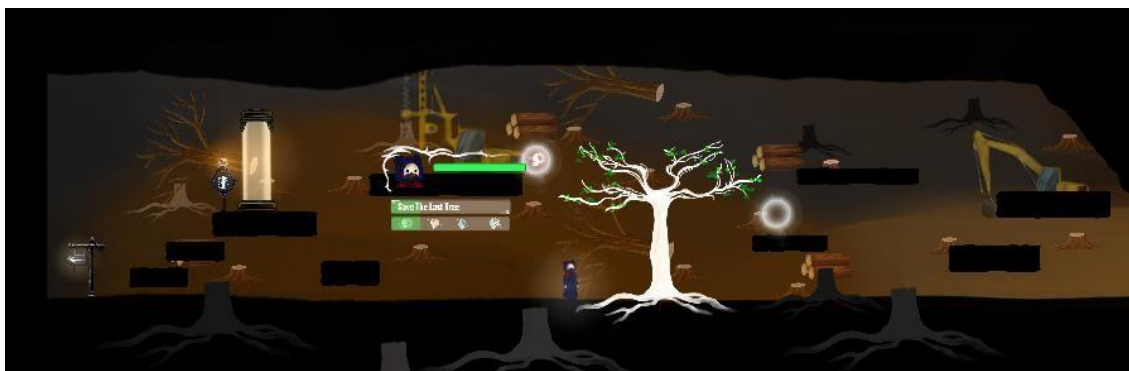


Figure 4.101 The task of save the last tree



Figure 4.102 Plantation success

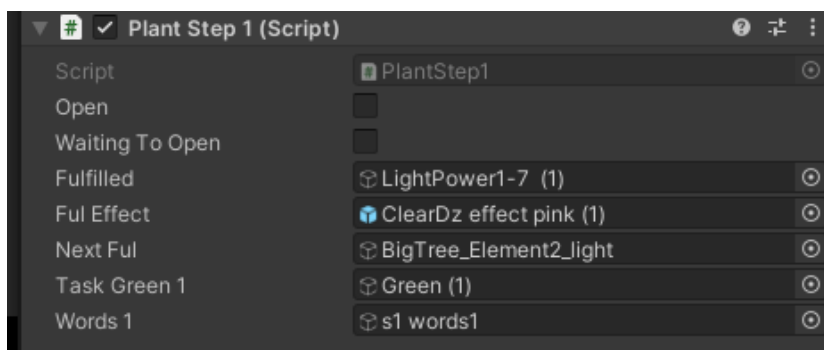


Figure 4.103 The script of PlantStep1 is attached to the first step of plantation

xix. Task List

The figure 4.104 shows the screenshot of player have receive the task. The task is updated on the left side. The task only will turn green and disappear after player has completed the task. The figure 4.104 and 4.102 shows one of task in game which is "Purify the garbage hill".



Figure 4.104 Receive the task

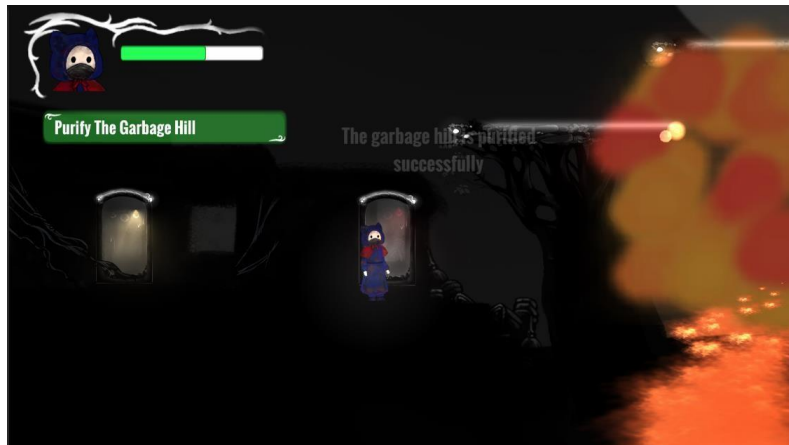


Figure 4.105 After done the task

xx. Message Pop Out



Figure 4.106 Message pop-out

In order to let the player, know how can interact with some NPC or object. For example, the message pop out function is added to the story NPC, so that when the player is close to the NPC, a message will be triggered so that the player can know that the NPC can be interacted with. The pop-up prompt information includes, Listen, Talk and Activate. And (F) means that the player needs to press the "F" key to interact, so the player can choose to interact or leave. The figure 4.106 shows a message op-out when trigger the story NPC. The MessagePop script is applied to the story NPC, handling the trigger function between the player and the NPC.

xxi. Dialogue With Story NPC

- Dialogue Panel

Table 4.5 Comparison before and after implementation of the dialogue mechanism


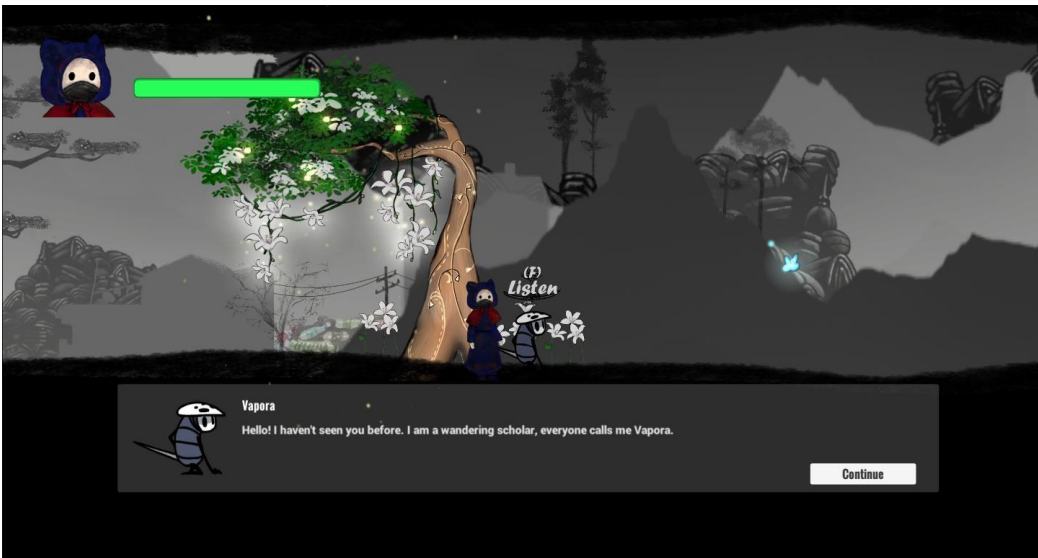
Comparison before and after implementation
Before

After


Table 4.7 shows the comparison before and after implementation of the dialogue mechanism. Before the implementation, the dialogue did not include the message popup function, and the player could still move even if he talked to the NPC. After implementation, the player cannot move after pressing "F" to interact with an NPC. The continue button is only shown for the player to click after the sentence ends.

- Script control

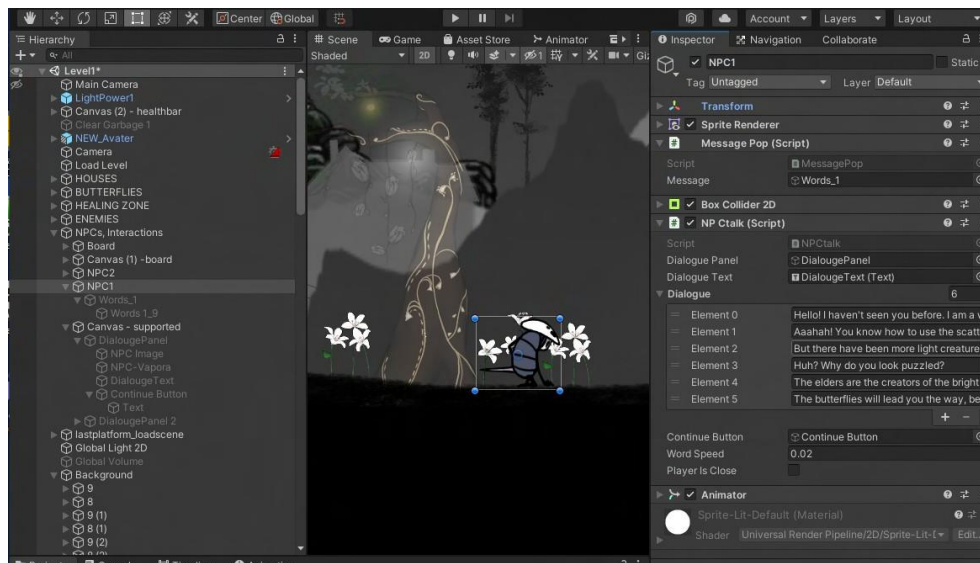


Figure 4.107 The MessagePop and NPCTalk scripts that applied in Story NPC

Figure 4.107 shows the MessagePop and NPCTalk scripts that applied in Story NPC. The MessagePop script is used to control the trigger function of the message pop out, and the message will only appear when the script detects that the player reaches the trigger range. The NPCTalk script handles the sequence of dialogue sentences, word animation, and word speed. The CharArray function written in the script will make the dialogue sentences appear in order.

```

void Update()
{
    if(Input.GetKeyDown(KeyCode.F) && playerIsClose)
    {
        GetComponent<Animator>().Play("Npc_Vapora");
        npcSound.SetActive(true);
        if (dialoguePanel.activeInHierarchy)
        {
            zeroText();
            theplayer.canMove = true;
        }

        else
        {
            dialoguePanel.SetActive(true);
            StartCoroutine(Typing());
            theplayer.canMove = false;
        }
    }

    if(dialogueText.text == dialogue[index])
    {
        continueButton.SetActive(true);
        theplayer.canMove = false;
    }
}

```

Figure 4.108 The NPCTalk script's function

The if-else algorithm shown in figure 4.108 above is in the NPCTalk script, which is used to control that the dialog box will be displayed only when the trigger range is reached and the interaction key is pressed, and the StartCoroutine will start to enter the dialogue statement. Finally, the continue button will only activate when the sentence is over.

```

public void NextLine()
{
    continueButton.SetActive(false);

    if(index < dialogue.Length -1)
    {
        index++;
        dialogueText.text = "";
        StartCoroutine(Typing());
        theplayer.canMove = false;
    }

    else
    {
        zeroText();
    }
}

public void zeroText()
{
    dialogueText.text = "";
    index = 0;
    dialoguePanel.SetActive(false);
    theplayer.canMove = true ;
    npcSound.SetActive(false);
}
}

```

Figure 4.109 The NPCTalk script's function

The function `NextLine()` shown above is in the `NPCTalk` script, which is used to handle the dialogue sentence sequences. After the next line of array is 0, the `zeroText()` function is executed and the dialogue panel will close.

4.3.6 Animation Setup

i. The Beginning Story of Purification

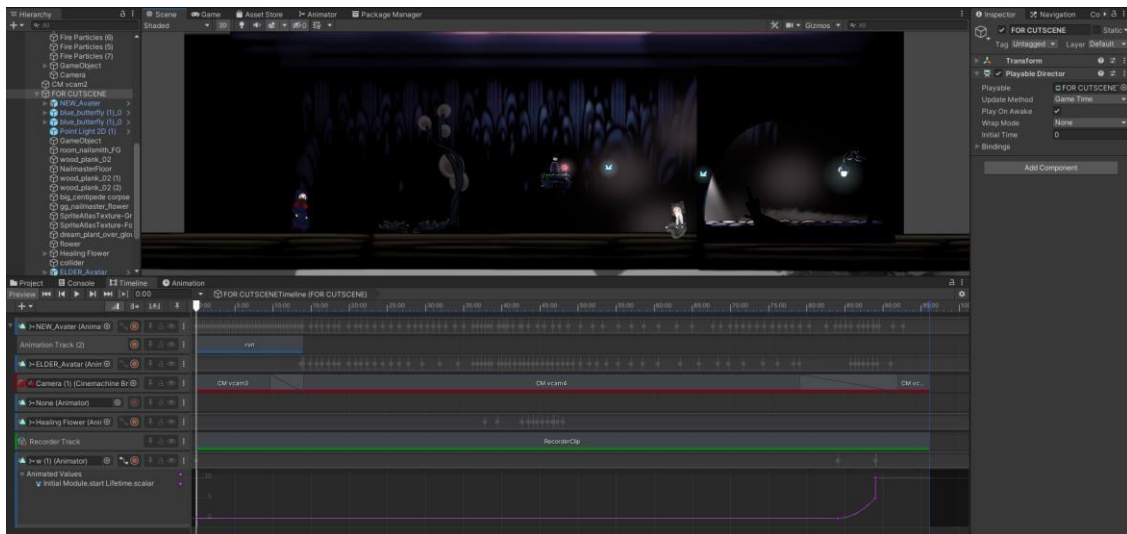


Figure 4.110 The story opening animation timeline of Purification

The Purification game is a serious 2D game, and one of the objectives that mentioned in Section 1.1 is to design and develop a serious 2D platform game that combines storytelling with gameplay. So, this project decided to set up story animations in addition to setting up NPCs to convey the storyline. The story animation uses the Cinemachine Cutscene to handle the animation transition. Cinemachine allows to shoot the desired plots, and the timeline is to add and record any transitions of character, environment, particle effects and camera as keyframes. Recorder Track is to record the animation and saved as MPC format in PC. Figure 4.110 shows a part of story opening animation timeline of Purification.

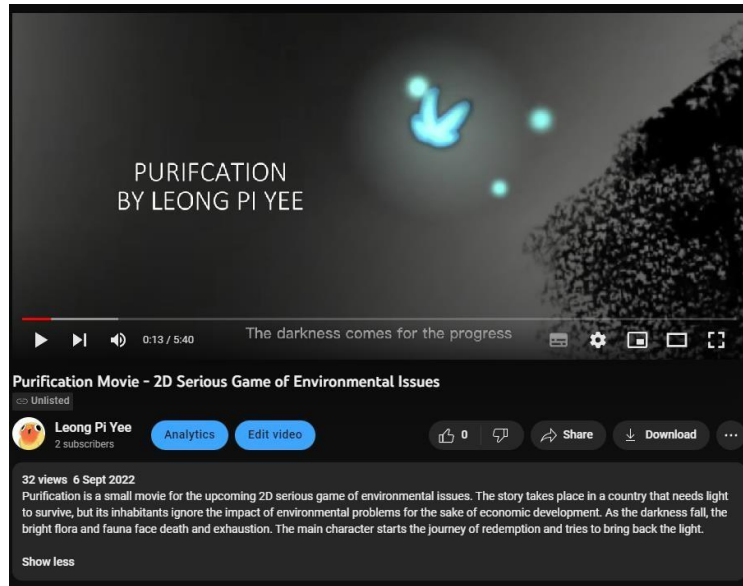


Figure 4.111 Screenshot of animation video uploaded on YouTube

The Purification story opening was uploaded on YouTube and was also used to participate 24th DigiCon6 Asia animation competition. And this animation will also be used as the animation that will be played before the game starts. This animation tells the story of the main character before starts the journey of redemption. Figure 4.111 shows the screenshot of animation video that have uploaded on YouTube.

ii. Healing Zone

- Healing Flower Bloom

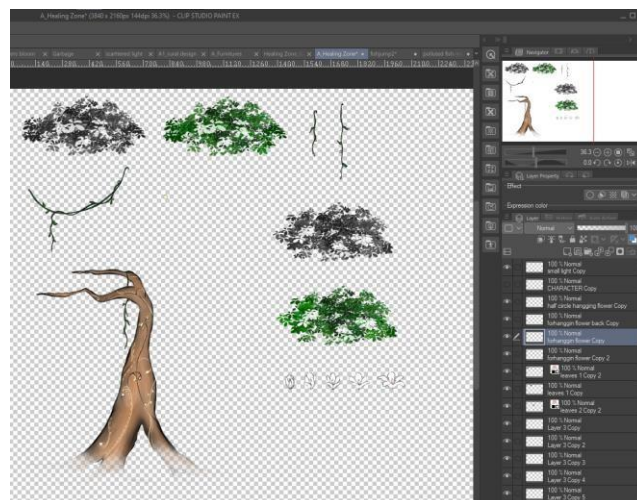
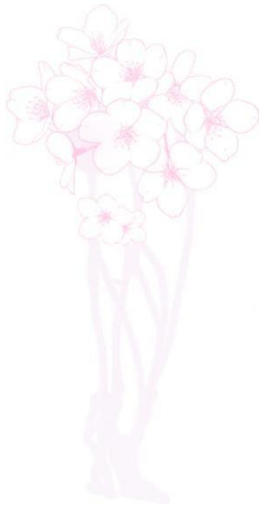





Figure 4.112 The design and creation of Healing Zone in Clip Studio Paint

The Healing Zone is one of the bright creatures in this project that can replenish the player's health. The healing zone is designed as a combination of flowers and tree. And its flowers are drawn a set of pictures of flowers in full bloom, which are used to make blooming animations. Figure 4.112 shows the design and creation of the Healing Zone in Clip Studio Paint. The various parts of the Healing Zone are neatly separated in the image, and then imported into Unity and used the sprite editor to slice these parts into multi sprite.

Table 4.6 Comparison between before and after implementation of Haling Zone

Comparison before and after implementation	
Before	After
	

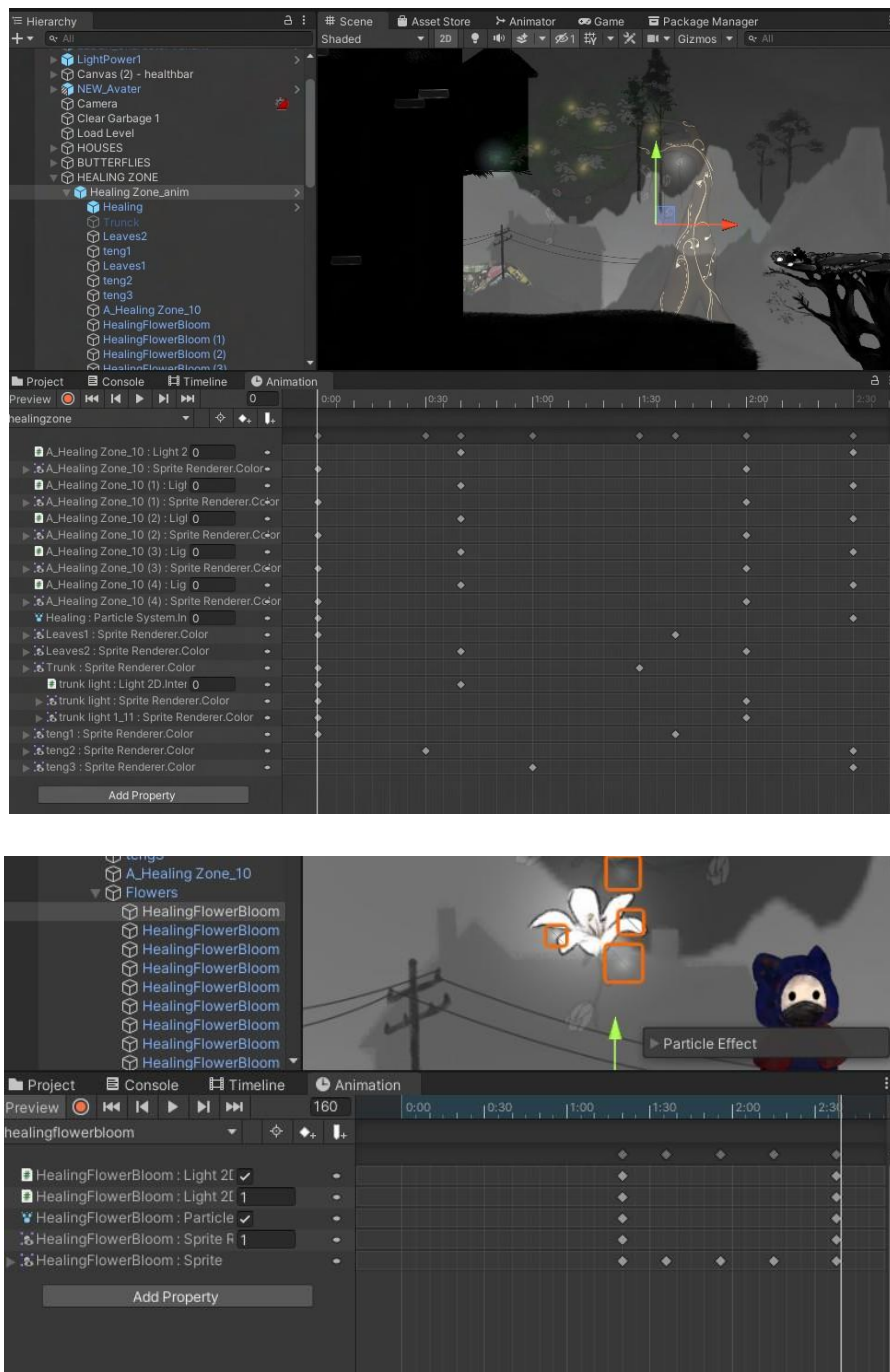


Figure 4.113 Animation transitions of Healing Zone and Blooming Flower

Figure 4.113 is the animation transition of the Healing Zone and Blooming Flower. The Healing Zone is animated from blurry to clear which include the lighting and particle effects too, and the animation sequences is the trees first appearing, then blooming flowers. The animations play only the player character is close to it, and this mechanics is control by TriggerTreeAnim and TriggerFlowerAnim scripts.



Figure 4.114 The blooming Healing Zone

The figure 4.114 shows the Healing Zone blooming after completing the animations. The 2D lighting and particles are added to enhance the ambiance of recharging health under a blooming healing tree.

- Scripting control

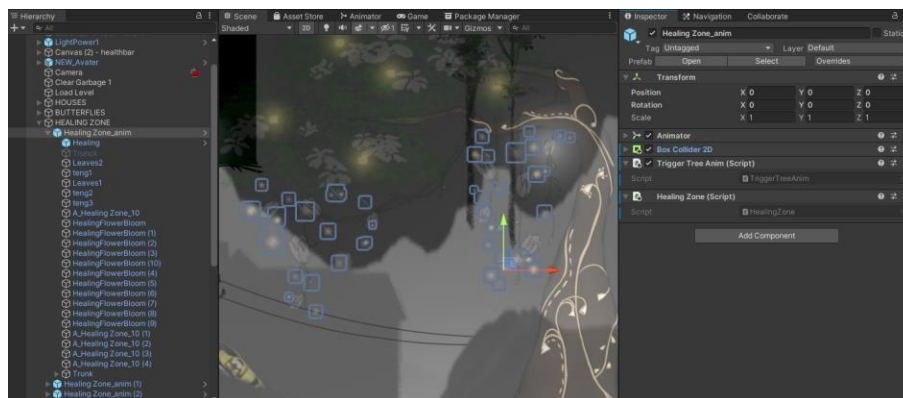


Figure 4.115 The TriggerTreeAnim and TriggerFlowerAnim scripts that applied in Healing Zone

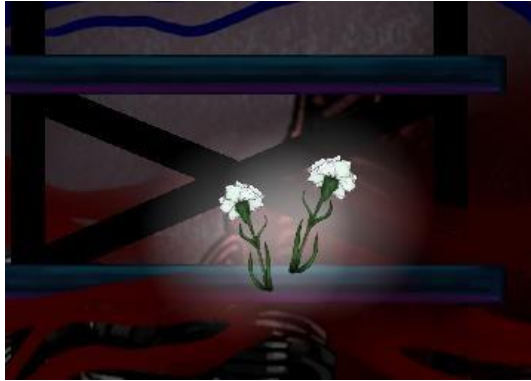
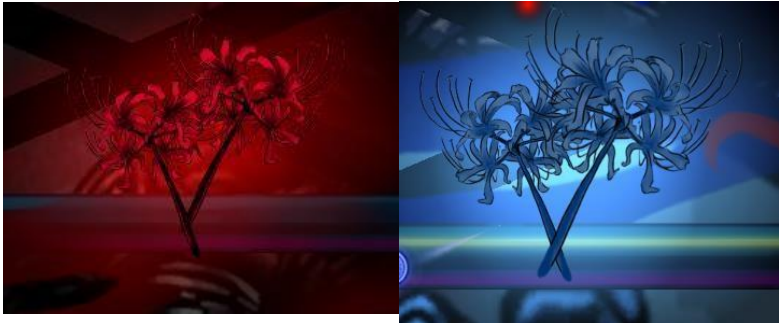
The TriggerTreeAnim and TriggerFlowerAnim scripts are attached on the game object where it is controlled the Healing Zone. The figure 4.115 shows the scripts that

applied in the Healing Zone. The TriggerTreeAnim and TriggerFlowerAnim scripts are handle tree and flower animation respectively. When the player approaches and touches the collider of the HealingZone, the animation will be triggered, and the animation will only play once after the player approaches. The tree and flower colliders are separate, which gives a gradual effect to the animation. When the animation is completed, it remains the last state as shown in figure 4.114.

iii. Death Zone

- Death Zone Flower Bloom

Table 4.7 Animation before and after blooming of death zone flowers

<p>Before Activate the Death Zone Flower Bloom</p>

<p>After Activate the Death Zone Flower Bloom</p>


The table 4.7 shows the animation before and after blooming of death zone flowers. When the player is close to the death zone flower, the death zone flower will have a bloom animation.



Figure 4.116 The frame by frame design and creation of Death Zone Flowers Blooming in Clip Studio Paint

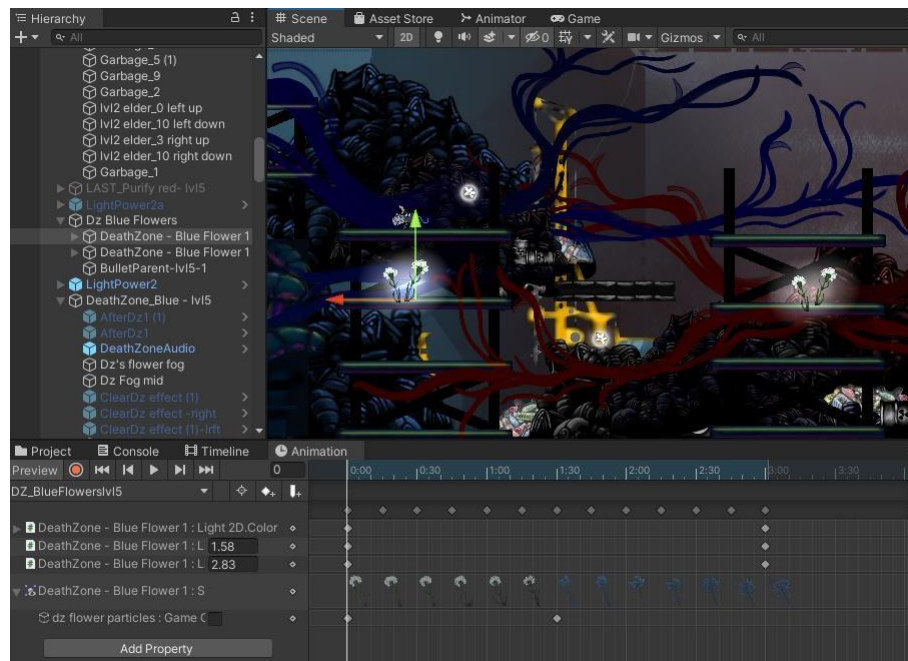


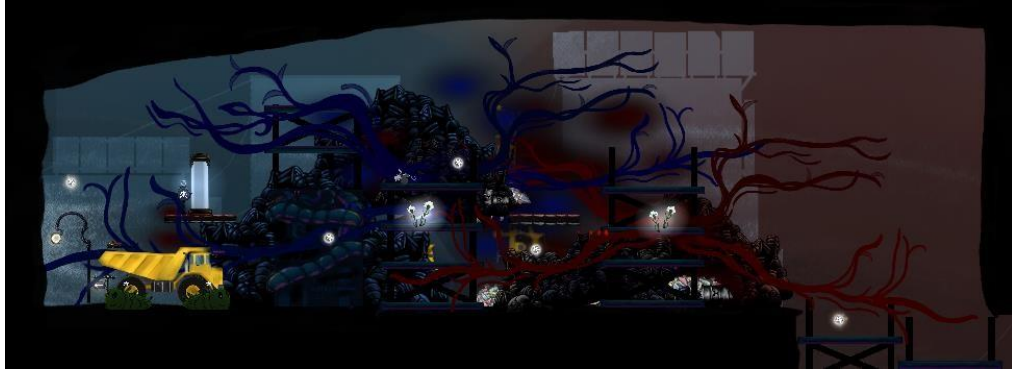
Figure 4.117 Animation transitions of Death Zone Flowers

The figure 4.116 shows the frame-by-frame design and creation of Death Zone Flowers Blooming in Clip Studio Paint. And figure 4.117 shows the Animation transitions of Death Zone Flowers. The frame-by-frame death zone flowers blooming animation is added to the animation transitions.

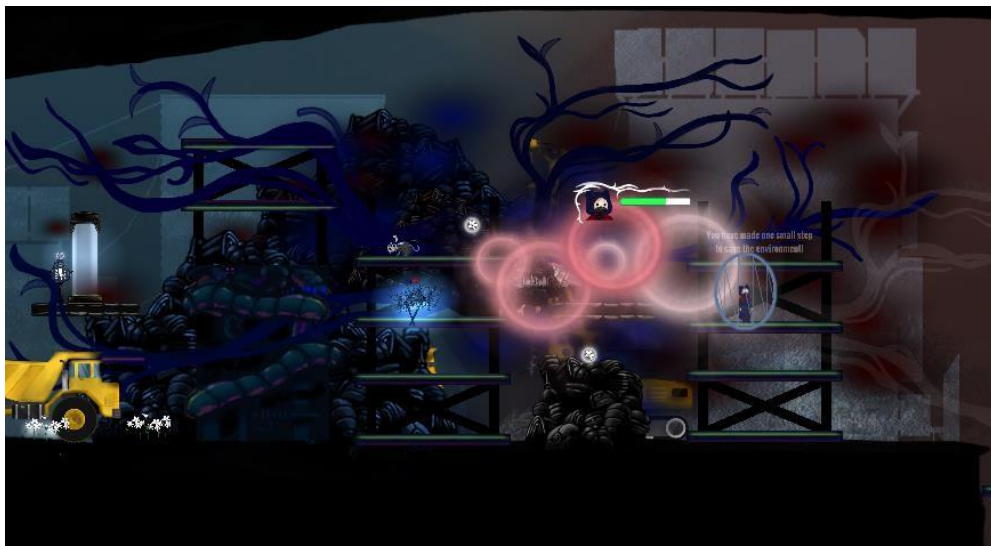
- Purification of Death Zone

Table 4.8 Animation before and after purification of Death Zone

Before purification of Death Zone

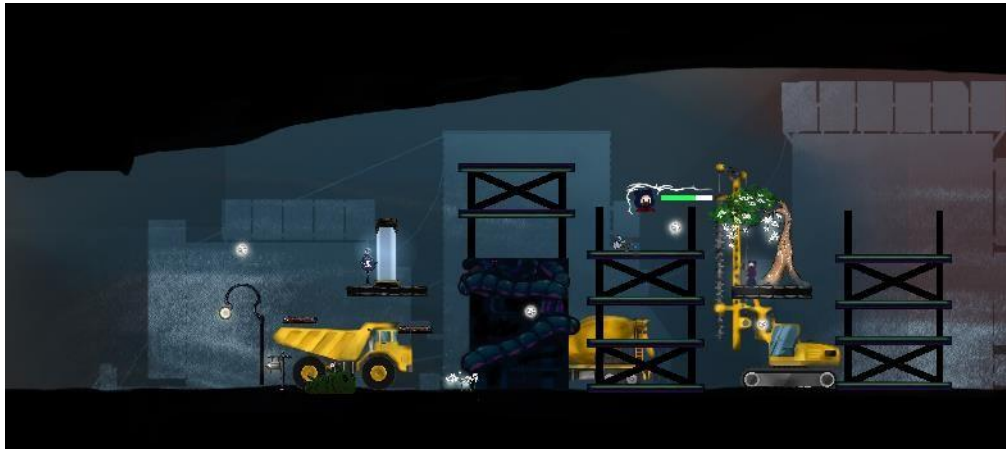


Purification of Death Zone in progress





After Purification of Death Zone



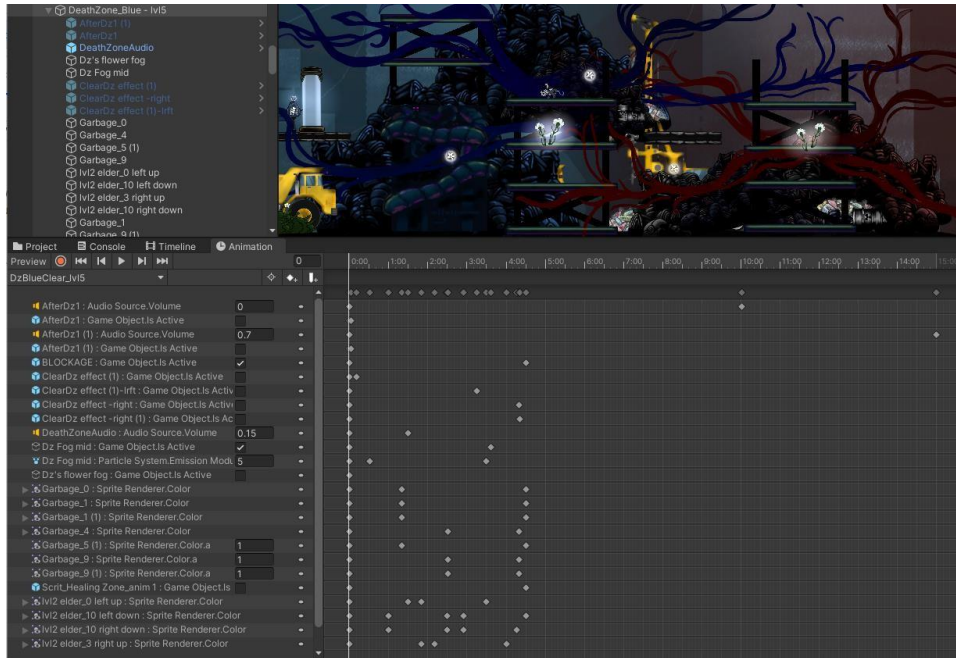



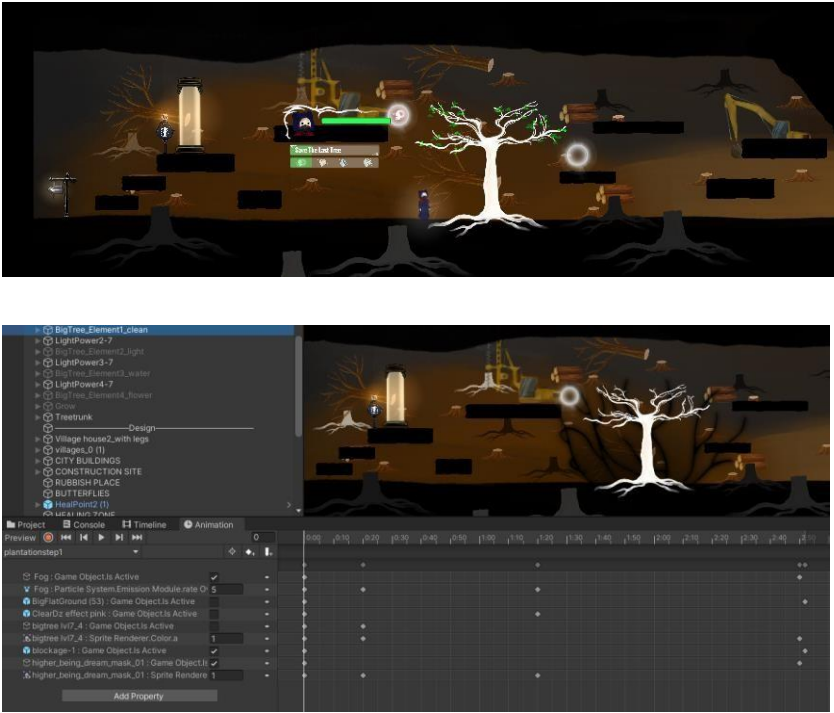

Figure 4.118 Animation transitions of the Purification of Death Zone

The table 4.8 shows the animation before and after purification of death zone. When the player is activating the purification mechanism of the death zone. The animation will start and play only once. Figure 4.118 shows an animation transition set up in Unity, which includes setting effects and audio transitions.

iv. Save The Last Tree

The animation for saving the last tree has 4 steps and the player collects power elements to plant the tree. The tree will grow into different states step by step. The table 4.9 shows the animation state of saving the last tree. Each step of plantation has its own animation transitions.

Table 4.9 The animation state of saving the last tree.

<p>Before</p>	
<p>Step</p>	<p>Animation Transitions</p>
<p>1</p>	
<p>2</p>	



v. Non-Player Character (NPC)

- Dark Creatures – Enemy (The Jumping Fish)

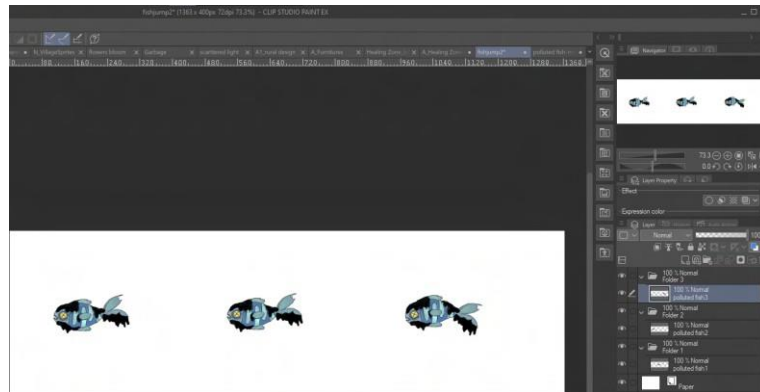


Figure 4.119 The design and development of Jumping Fish in Clip Studio Paint

Figure 4.119 shows the enemy NPC, jumping fish design drawn and created in Clip Studio Paint. The animation of this NPC will use the photo frame to make the jumping animation of this fish. The file can be exported as a PNG image format, and then imported into unity, using unity's sprite editor to slice the image into multiple images.

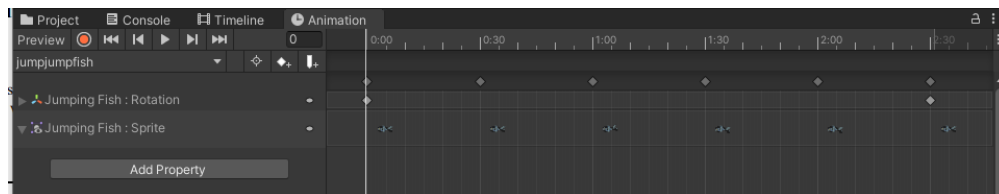


Figure 4.120 Animation transitions of jumping fish

Figure 4.120 is the animation transition window of jumping fish. By animating this NPC, put every frame of jumping fish into the timeframe to run. Moving this NPC to a different point will be handled with the EnemyWaypoint script.

vi. The Ending of Purification

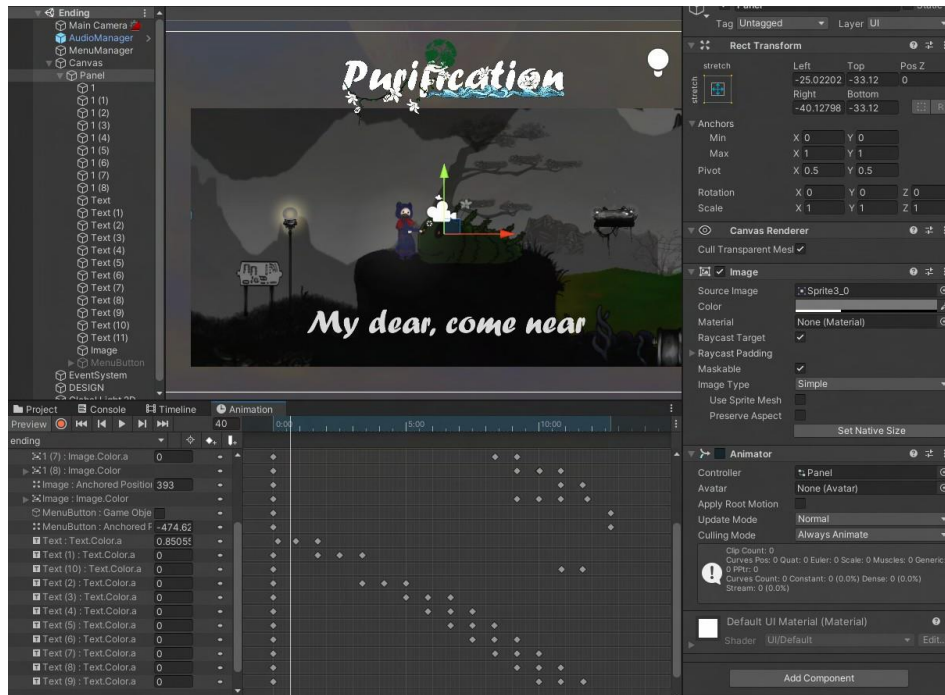


Figure 4.121 The animation transition of the ending of Purification

The figure 4.121 shows the animation transitions of the ending of Purification. The ending animation only show when player is completed level 7. A button to return to the main menu panel will appear after this animation ends.

4.3.7 Audio Manager

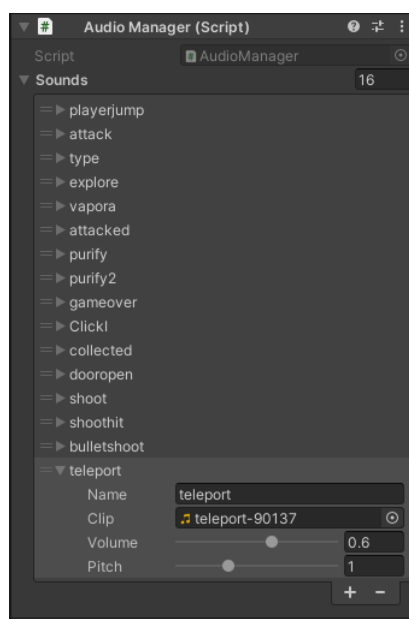


Figure 4.122 Audio Manager

Audio manager is added in all the game levels, and it is used to apply the sound effect to each player action or every activity such as button click, melee attack, jump, teleport and so on. The audio manager will keep the audio clip in the script.

4.4 Discussion

This section discusses the test format for the project Purification. Purification will undergo alpha testing and beta testing. The alpha testing for Purification will use Functional Acceptance Testing (FAT) to test the functionality of project. And User Acceptance Test (UAT) used for beta testing.

4.4.1 Alpha Testing

Alpha testing used Functional Acceptance Testing (FAT) to test the functionality of project. The table 4.10 shows the alpha testing form template. The full alpha testing result shows on Appendix C.

Table 4.10 Testing form template

Tester Name: Leong Pi Yee				
Test Case 1: Main Menu				
No.	Functionality	Pre-Condition	Expected Result	Pass/ Fail
1	Turn to Level Select Menu	Click on the Play button	The game start when player clicks to select the section/ level to start.	

2	Skip the beginning story animation	Click on the Skip button	The game start from tutorial level after clicks on Skip button	
2	Adjust the volume bar by sliding	Click on the settings button	The volume could be adjusted.	
3	Credits information show on scene	Click on the credits button	The credit information able to show out.	
4	Quit the game application.	Click on the quit button	The game will be closed.	
5	Back to the main menu	Click on the back button	The scene will back to the main menu.	

4.4.2 Beta Testing

For beta testing, the game is released on the easiest platform for people to download and play, namely Itch.IO. Project descriptions uploaded in Itch.IO leave a feedback form which is Google Form for testers to give feedback and suggestions. The Itch.IO link of the game is: “<https://aliceleongpy.itch.io/purification>”. The testing form question shows in Appendix B.

What is your age group?

30 responses

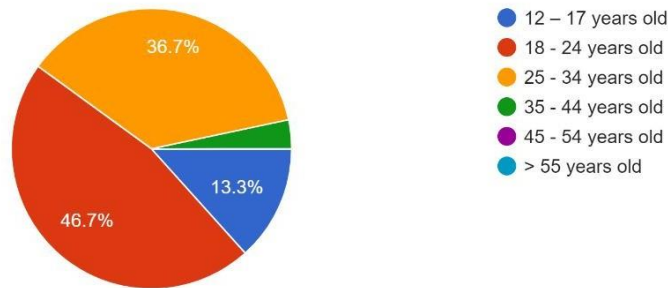


Figure 4.123 Result of “What is your age group?”

According to Figure 4.123 above, 46.7% of the respondents to this survey are between the ages of 18 to 24 years old, 36.7% of the respondents are from the age group of 25 to 34 years old and only 13.3% of the respondents are between ages of 12 to 17 years old. So, most of the respondents are in the youth age group.

What environmental issues you have found in Purification?

30 responses

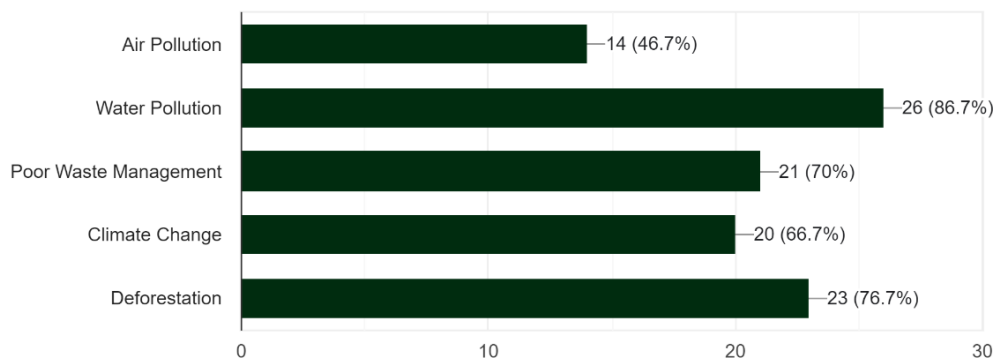


Figure 4.124 Result of “What environmental issues you have found in Purification?”

Based on the figure 4.124 above, most of the respondents are found all the environmental issues in Purification. The least found environmental issue in the game by respondents is air pollution which is only 46.7% respondents.

Do you think the Purification is easy to understand?

30 responses

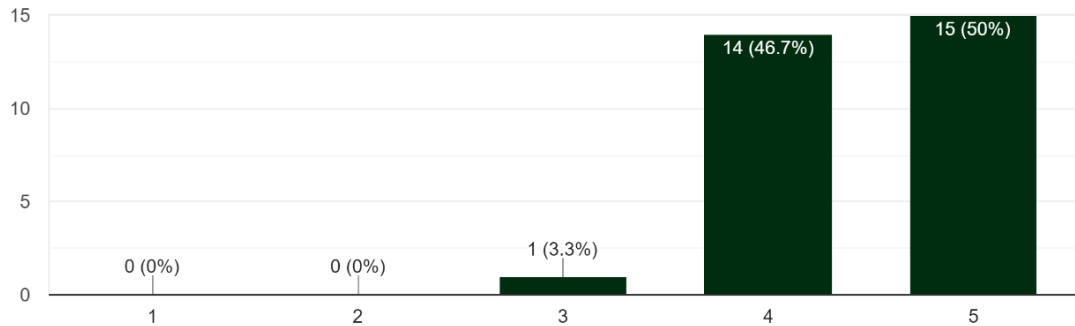


Figure 4.125 Result of “Do you think Purification’s game play is fun and interesting?”

Based on the figure 4.125 above, there are 15 out of 30 respondents are strongly agree and 14 out of 30 respondents agree that they think Purification is easy to understand. Therefore, it can be concluded that the statement was understood by most respondents and they find the mechanics, controls and game story are easy to understand.

Do you think the guideline or task given in Purification is clear and understandable?

30 responses

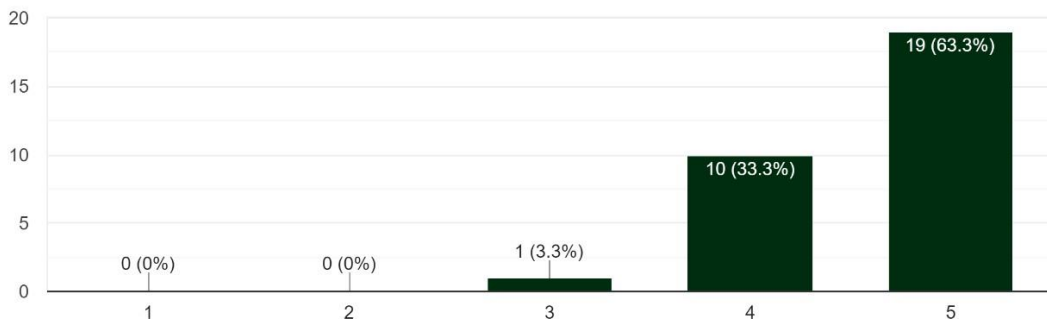


Figure 4.126 Result of “Do you think the guideline or task given in Purification is clear and understandable?”

Based on the figure 4.126 above, there are 19 out of 30 respondents which is accounted for the highest proportions at 63.3% are strongly agree that they could understand the task list and complete it whereas only 1 respondent is being neutral in this statement. Therefore, it can be concluded that this game mechanics of quest list are understood by most of the respondents.

Do you think Purification deliver awareness info about environmental issues?
30 responses

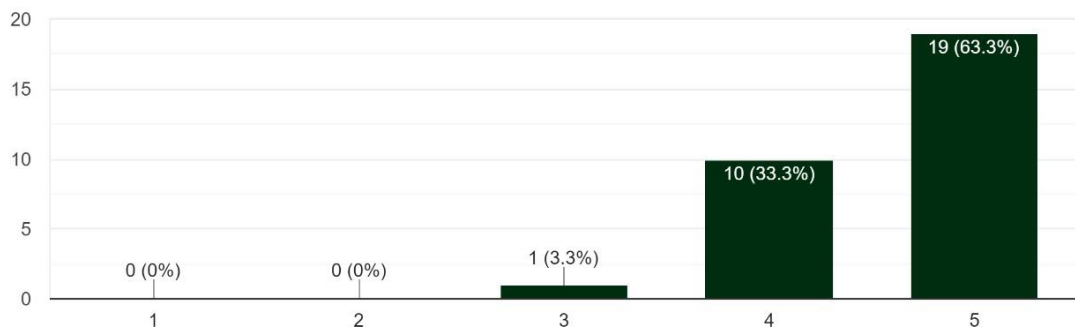


Figure 4.127 Result of “Do you think Purification deliver awareness info about environmental issues?”

Based on the figure 4.127 above, there are 19 out of 30 respondents which is accounted for the highest proportions at 63.3% are strongly agree that they think Purification has deliver awareness info of environmental issues. And there are 10 out of 30 respondents are agree with this statement too. Therefore, it can be concluded that this game has deliver the awareness of environmental issues successfully.

Do you think Purification’s animations are easy to understand? (Including the purification of garbage, death zone and plantation)

30 responses

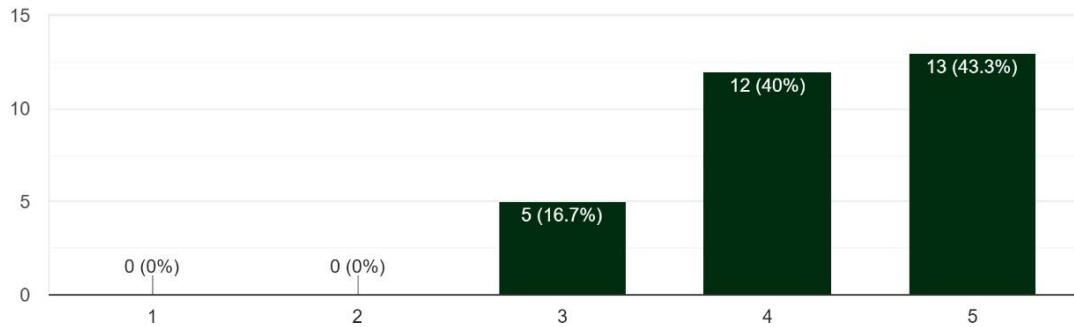


Figure 4.128 Result of “Do you think Purification’s animations are easy to understand? (Including the purification of garbage, death zone and plantation)”

Based on the figure 4.128 above, there are 13 out of 30 respondents which is accounted for the highest proportions at 43.3% are strongly agree that they think that Purification’s animations are easy to understand. There are 12 out of 30 respondents are agree with this statement and only 5 respondents are being neutral. Therefore, it can be concluded that most of the respondents can understand the animations in Purification.

Does Purification have a lot of bugs and glitches?

30 responses

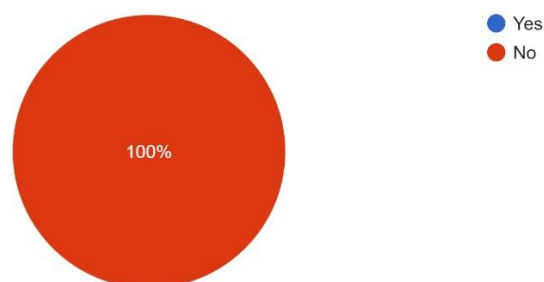


Figure 4.129 Result of “Does Purification have a lot of bugs and glitches?”

Based on the figure 4.129 above, there are no respondents found any bugs and glitches in Purification.



Figure 4.130 Result of stating the bugs and glitches

Since there is no respondents found any bugs in Purification, so there is 0 responses on this question.

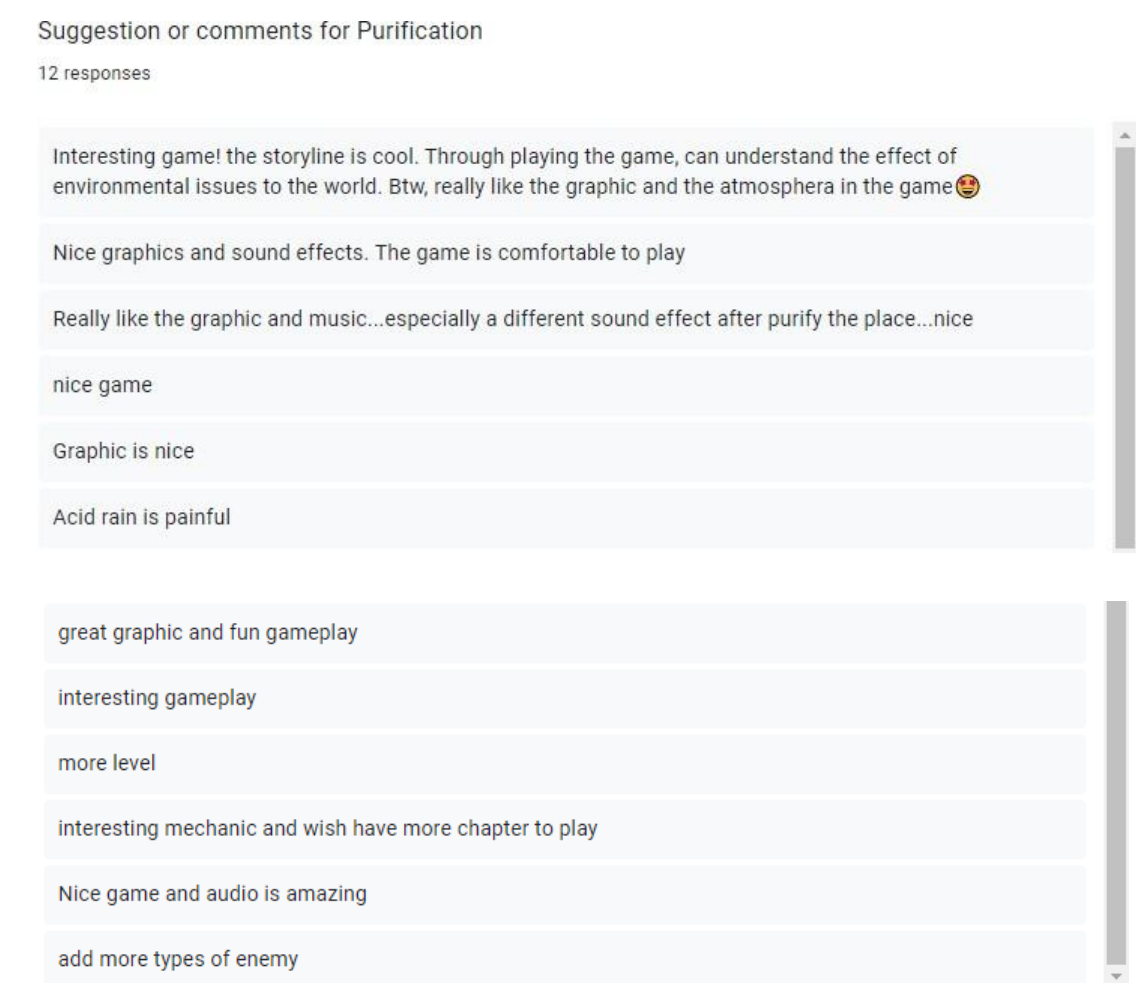


Figure 4.131 Result of “Suggestion or comments for Purification”

The figure 4.131 shows the suggestion or comments from respondents. Most of the respondents have a positive comment on graphic and sound effect. There are few suggestions from the responses, there are asking to add on more types of enemies and increase gameplay level.

4.5 Deployment

Game deployment refers to the process of distributing and making a video game available to the public or to a specific target audience. This can include distributing the game through physical retail channels, online marketplaces such as Itch.io, Steam or GOG. The deployment process may also involve testing the game for bugs and compatibility with various hardware and software configurations, as well as setting up servers to host multiplayer games. The goal of game deployment is to ensure that the game is easily accessible and runs smoothly for players. This project, Purification: A Serious Game of Environmental Issues, has been published on Itch.io for players to download. The publishing details, including the screenshots and QR code of the game, can be found in Appendix D.

4.6 Chapter Summary

In conclusion, during the implementation stage, the game goes through multiple development stages until it can be play by the player. The purpose of implementation is to outline the tasks that need to be accomplished and implement them into the game, making it ready for use. Additionally, unit tests will be run on each component that needs to be tested.

CHAPTER 5

CONCLUSION

5.1 Objective Revisited

In summary, the project's primary objective was to create an engaging and informative game around environmental awareness which is to develop a 2D platformer serious game, Purification. Purification is a serious game that uses a compelling storyline and visually striking environment design to convey its message to players. Through playing Purification, players can gain a deeper understanding of the impact of environmental issues and the importance of protecting the environment, ultimately raising their overall awareness of these critical issues.

This project aims to solve the problem of raising awareness about environmental issues, as traditional methods have proven to be insufficient. To address this, the proposed solution is to develop a serious game that is both entertaining and educational in nature, with the goal of increasing environmental awareness. In Chapter 2, an in-depth analysis of existing games related to environmental protection. The result of this analysis was the creation of a new game, Purification, which incorporates the strengths of these previous games while also addressing their shortcomings, making it an effective tool for raising environmental awareness.

The creation of the game "Purification" includes various elements such as art design, animation, coding, recording, and audio engineering. Most game assets and NPC's audio are developed and designed by me; other assets and audios used are free without copyright issues. Game levels are designed to facilitate the user by conveying stories, guides, and quests. Purification is a PC Windows game available for download from Itch.io. It's free to play and has low system requirements, so it's easily accessible to the public.

5.2 Limitation

During the game's development, something went wrong with the mechanics of clearing dead zones. Animations for clearing areas are not working properly. This problem is caused by lack of experience and time of the responsible developers. Despite efforts to fix it, the dead zone's animation method did not produce the expected results. This issue caused delays in the development process, with some animations in the game not being completed on time. To solve this, scripts were created to handle animation performing issues. During the beta testing phase, testers did not have any negative feedback on the game mechanic.

One of the major limitations faced during the development of this game was the tight deadline. As game development is a multifaceted and intricate process, but this project is completed by 1 person, which take more time than anticipated. The game's environment, characters, storylines, animations, and other elements all require the work of a single person to design, draw and develop. Even only the design phase, it also takes up a significant amount of time. Despite the time constraints, the project, Purification was complete within the given deadline.

5.3 Future Work

One of the future works for the game's improvement was to address feedback received during the beta testing phase. This included the addition of different types of enemies and the creation of more levels. However, due to time constraints, Purification currently only has 8 levels as a proof of concept. To further enhance the game, more levels could be added to provide a more detailed understanding of the causes, effects, and methods of environmental protection. Additionally, the variety of enemies could be expanded to include more mutated animals and plants that affected by the environmental pollution.

Despite the efforts made during the development phase, there are still several improvements that have not been implemented due to time constraints. One of the most significant improvements is the implementation of a save and load system, which allows players to save their progress and pick up where they left off. Currently, when the player

quits the game, the progress is lost, and they have to start over from the beginning of the level. With the implementation of a save and load system, players can continue their progress and enjoy the game more seamlessly.


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APPENDICES

APPENDIX A: User Acceptance Testing Form of Prototype



**BCC 3012 UNDERGRADUATE PROJECT I :
A Survey for "Purification: A Serious
Game of Environmental Issues"**



Dear respected respondents,
Assalamualaikum and Salam Sejahtera.

I am a student from the University Malaysia Pahang(UMP) who is currently taking the subject of BCC 3012 Undergraduate Project 1 which is also called Final Year Project. My name is Leong Pi Yee (CD19083), and my FYP is to develop a 2D platformer serious game called "Purification" which aimed to raise public awareness of the importance of environmental awareness in creating a healthier living environment.

I would like to gain in-depth feedback from respondents to understand the likelihood and expectations for playing this serious game!

This survey contains
Section A: Demographic Profile
Section B: Views on Purification

I really appreciate that you spend your time and cooperation filling these questionnaires. Your response is confidential and will only be used for educational purposes only. Thank you, respondents! Have a nice day! 😊

 aliceleong990331@gmail.com (not shared) [Switch accounts](#) 

Section A: Demographic Profile



Description (optional)

Gender *

- Male
- Female

Age *

- 12 - 17 years old
- 18 - 24 years old
- 25 - 34 years old
- 35 - 44 years old
- 45 - 54 years old
- > 55 years old

Do you often play games? *

- Yes
- No
- Sometimes

What type of games are you interested in? *

- Role- playing
- Action- adventure
- Story- driven
- Real-time strategy
- Platform
- Shooters
- Puzzle
- Other...

Do you play serious game before? *

- Yes
- No

What environmental issues do you think are the most concern? *

- Water Pollution
- Air Pollution
- Climate Change
- Deforestation
- Waste Management
- Other...

⋮

Do you often see posters or advertisements about protecting the environment? *

Yes

No

Have you participated in any online or offline activities with the theme of environmental protection? *

Yes

No

Section B: Views on Purification ✕ ⋮

Dear respected respondents, this section is aim to collect the users' views and requirements after playing the prototype of Purification. Respondents, please continue filling the survey after playing this game prototype.

The game's website link : <https://play.unity.com/mg/other/purification-a-serious-game-of-environmental-issues-1>

**This is just a prototype of the game to prove the design and concept of the game. It is not the final product. This game is an original design and any similarities will be investigated. Thank you!

I can understand the story of this game through the dialogue between the Deer NPC and the player in the beginning. *

1 2 3 4 5

Strongly Disagree Strongly Agree

I can understand the quest list and complete it. *

1 2 3 4 5

Strongly Disagree Strongly Agree

I can understand to use the picked up items to clear the trash. *

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

The words and graphic are easy to understand the game content. *

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Do you think the game mechanics in this game are suitable? *

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Do you think it would be better that player could view the simple level map in game level? *

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

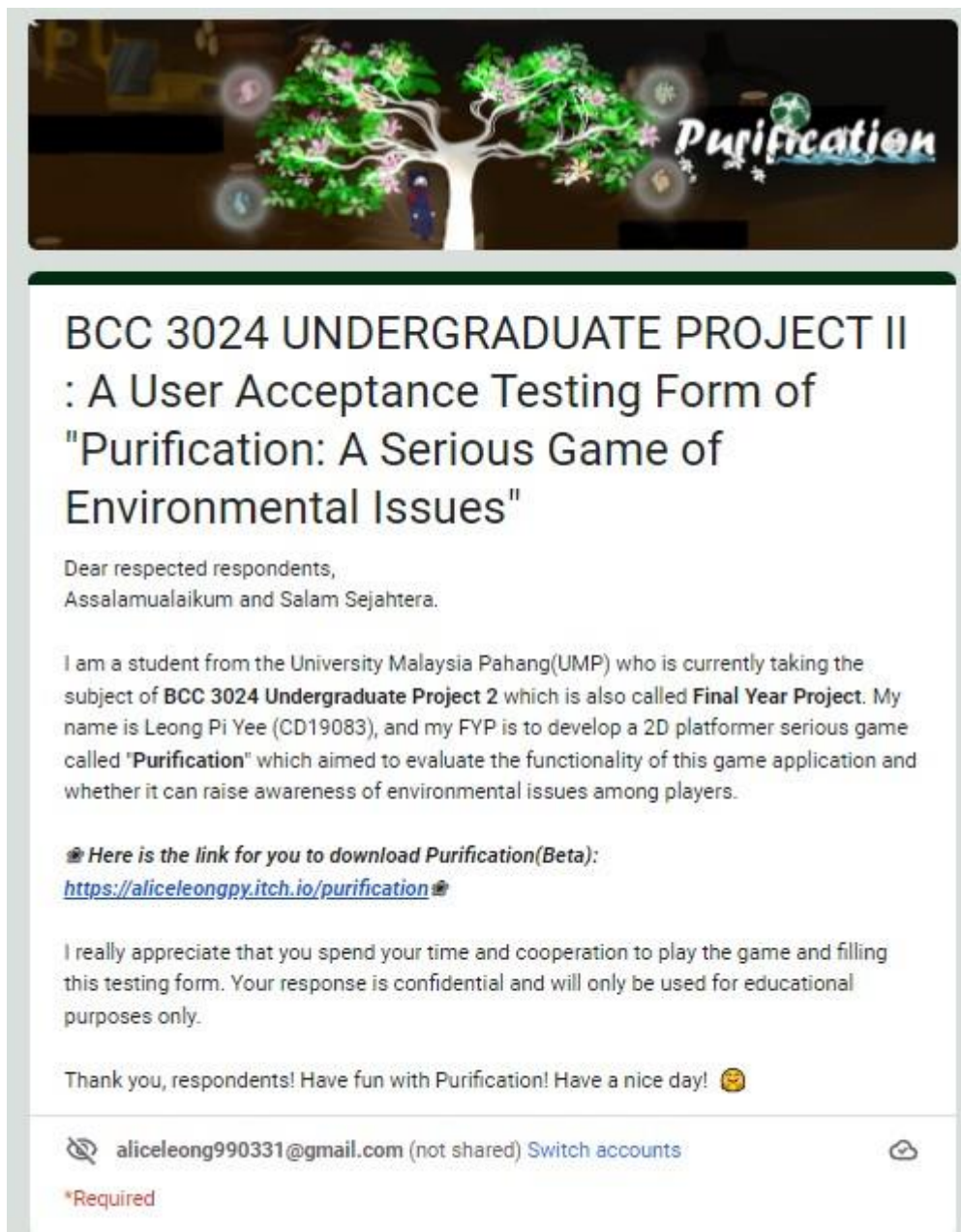
Do you think each level continues the storyline could makes people more understand the game content? *

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly Agree

Suggestion or comments for Purification

Long-answer text

APPENDIX B: User Acceptance Testing Form of Purification



The image shows a screenshot of a user acceptance testing form. At the top, there is a banner image featuring a stylized tree with green leaves and pink flowers, set against a dark background with floating icons. The word "Purification" is written in a white, cursive font on the right side of the banner.

**BCC 3024 UNDERGRADUATE PROJECT II
: A User Acceptance Testing Form of
"Purification: A Serious Game of
Environmental Issues"**

Dear respected respondents,
Assalamualaikum and Salam Sejahtera.

I am a student from the University Malaysia Pahang(UMP) who is currently taking the subject of **BCC 3024 Undergraduate Project 2** which is also called **Final Year Project**. My name is Leong Pi Yee (CD19083), and my FYP is to develop a 2D platformer serious game called "**Purification**" which aimed to evaluate the functionality of this game application and whether it can raise awareness of environmental issues among players.

📧 *Here is the link for you to download Purification(Beta):*
<https://aliceleongpy.itch.io/purification> 📧

I really appreciate that you spend your time and cooperation to play the game and filling this testing form. Your response is confidential and will only be used for educational purposes only.

Thank you, respondents! Have fun with Purification! Have a nice day! 😊

🔗 aliceleong990331@gmail.com (not shared) [Switch accounts](#) 📧

*Required

What is your age group? *

- 12 – 17 years old
- 18 - 24 years old
- 25 - 34 years old
- 35 - 44 years old
- 45 - 54 years old
- > 55 years old

What environmental issues you have found in Purification? *

- Air Pollution
- Water Pollution
- Poor Waste Management
- Climate Change
- Deforestation

Do you think the Purification is easy to understand? *

- 1 2 3 4 5
- Strongly Disagree Strongly Agree

Do you think Purification's game play is fun and interesting? *

- 1 2 3 4 5
- Strongly Disagree Strongly Agree

Do you think the guideline or task given in Purification is clear and understandable?

1 2 3 4 5

Strongly Disagree Strongly Agree

Do you think Purification deliver awareness info about environmental issues?

1 2 3 4 5

Strongly Disagree Strongly Agree

Do you think Purification's animations are easy to understand? (Including the purification of garbage, death zone and plantation)

1 2 3 4 5

Strongly Disagree Strongly Agree

Does Purification have a lot of bugs and glitches? *

- Yes
- No

If Yes, what is it?

Your answer _____

Suggestion or comments for Purification

Your answer _____

APPENDIX C: Functional Acceptance Testing Form of Purification

Tester Name: Leong Pi Yee				
Test Case 1: Main Menu				
No.	Functionality	Pre-Condition	Expected Result	Pass/ Fail
1	Turn to Level Select Menu	Click on the Play button	The game start when player clicks to select the section/ level to start.	Pass
2	Skip the beginning story animation	Click on the Skip button	The game start from tutorial level after clicks on Skip button	Pass
2	Adjust the volume bar by sliding	Click on the settings button	The volume could be adjusted.	Pass
3	Credits information show on scene	Click on the credits button	The credit information able to show out.	Pass
4	Quit the game application.	Click on the quit button	The game will be closed.	Pass
5	Back to the main menu	Click on the back button	The scene will back to the main menu.	Pass

Test Case 2: Gameplay Tutorial Level

No.	Functionality	Pre-Condition	Expected Result	Pass/ Fail
1	Character can move left and right	Press on A/D keys or left/right arrow keys	The character response on the correct key of movement either left or right	Pass
2	Character can jump	Press on W key, spacebar, or up arrow key.	The character jump smoothly.	Pass
3	Character can coyote jump	Press on W key, spacebar, or up arrow key 2 times.	The character jump 2 times smoothly.	Pass
4	Character can attack enemy	Press on E key	The character can attack the enemy	Pass
5	Player trigger message pop out	Player moves near to board, teleporter, or story NPC.	Player triggers the message pop out when near to the board, teleporter, or story NPC successfully.	Pass
6	Player interacts with NPC through dialogue	Player trigger message pop out and press on F key	A dialogue panel shows	Pass

7	Deduct health points	Player gets close and attack by the enemy	The health bar's health points decreased	Pass
8	Recharge the health points in healing zone trigger range	Player reaches the trigger range of the healing zone	The health points increased smoothly.	Pass
9	The healing zone can animate when the player is within the trigger range	Player reaches the trigger range of the healing zone	The animation of healing zone plays smoothly.	Pass
10	Player ascends with the current of the waterfall	Player gets close to the waterfall and press W key	Player ascends with the current of the waterfall smoothly.	Pass
11	Task added in task list	Player reaches the task given place	The task is updated in the task list	Pass
12	Task turn green and removed	Player completes the task	The task is turn green and removed in task list.	Pass
13	Player collects the light power of scattered light	Player gets close and	The scattered light follows the player.	Pass

		collect the scattered light		
14	Player uses the scattered light to purify the garbage hill	Player reaches the polluted place that need to purify	The scattered light moves to the polluted place and purify it automatically	Pass
15	Player able go to next level	Player explored the game level and reach final point	The scene load to next level, level 1	Pass

Test Case 3: Gameplay Level 1				
No.	Functionality	Pre-Condition	Expected Result	Pass/ Fail
1	Character can move left and right	Press on A/D keys or left/right arrow keys	The character response on the correct key of movement either left or right	Pass
2	Character can jump	Press on W key, spacebar, or up arrow key.	The character jump smoothly.	Pass
3	Character can coyote jump	Press on W key, spacebar, or up	The character jump 2 times smoothly.	Pass

		arrow key 2 times.		
4	Character can attack enemy	Press on E key	The character can attack the enemy	Pass
5	Player trigger message pop out	Player moves near to board, teleporter, or story NPC.	Player triggers the message pop out when near to the board, teleporter, or story NPC successfully.	Pass
6	Player interacts with NPC through dialogue	Player trigger message pop out and press on F key	A dialogue panel shows	Pass
7	Deduct health points	Player gets close and attack by the enemy	The health bar's health points decreased	Pass
8	Recharge the health points in healing zone trigger range	Player reaches the trigger range of the healing zone	The health points increased smoothly.	Pass
9	The healing zone can animate when the player is within the trigger range	Player reaches the trigger range of the healing zone	The animation of healing zone plays smoothly.	Pass

10	Player ascends with the current of the waterfall	Player gets close to the waterfall and press W key	Player ascends with the current of the waterfall smoothly.	Pass
11	Task added in task list	Player reaches the task given place	The task is updated in the task list	Pass
12	Task turn green and removed	Player completes the task	The task is turn green and removed in task list.	Pass
13	Player collects the light power of scattered light	Player gets close and collect the scattered light	The scattered light follows the player.	Pass
14	Player uses the scattered light to purify the garbage hill	Player reaches the polluted place that need to purify	The scattered light moves to the polluted place and purify it automatically	Pass
15	Player able go to next level	Player explored the game level and reach final point	The scene load to next level, level 1	Pass

Test Case 4: Gameplay Level 2				
No.	Functionality	Pre-Condition	Expected Result	Pass/ Fail
1	Character can move left and right	Press on A/D keys or left/right arrow keys	The character response on the correct key of movement either left or right	Pass
2	Character can jump	Press on W key, spacebar, or up arrow key.	The character jump smoothly.	Pass
3	Character can coyote jump	Press on W key, spacebar, or up arrow key 2 times.	The character jump 2 times smoothly.	Pass
4	Character can attack enemy	Press on E key	The character can attack the enemy	Pass
5	Player trigger message pop out	Player moves near to board, teleporter, or story NPC.	Player triggers the message pop out when near to the board, teleporter, or story NPC successfully.	Pass
6	Player interacts with NPC through dialogue	Player trigger message pop out and press on F key	A dialogue panel shows	Pass

7	Deduct health points	Player gets close and attack by the enemy	The health bar's health points decreased	Pass
8	Recharge the health points in healing zone trigger range	Player reaches the trigger range of the healing zone	The health points increased smoothly.	Pass
9	The healing zone can animate when the player is within the trigger range	Player reaches the trigger range of the healing zone	The animation of healing zone plays smoothly.	Pass
10	Player ascends with the current of the waterfall	Player gets close to the waterfall and press W key	Player ascends with the current of the waterfall smoothly.	Pass
11	Task added in task list	Player reaches the task given place	The task is updated in the task list	Pass
12	Task turn green and removed	Player completes the task	The task is turn green and removed in task list.	Pass
13	Player collects the light power of scattered light	Player gets close and	The scattered light follows the player.	Pass

		collect the scattered light		
14	Player uses the scattered light to purify the garbage hill	Player reaches the polluted place that need to purify	The scattered light moves to the polluted place and purify it automatically	Pass
15	Player able go to next level	Player explored the game level and reach final point	The scene load to next level, level 1	Pass

Test Case 5: Gameplay Level 3				
No.	Functionality	Pre-Condition	Expected Result	Pass/ Fail
1	Character can move left and right	Press on A/D keys or left/right arrow keys	The character response on the correct key of movement either left or right	Pass
2	Character can jump	Press on W key, spacebar, or up arrow key.	The character jump smoothly.	Pass
3	Character can coyote jump	Press on W key, spacebar, or up	The character jump 2 times smoothly.	Pass

		arrow key 2 times.		
4	Character can attack enemy	Press on E key	The character can attack the enemy	Pass
5	Player character can shoot the enemy	Press left mouse click	The character can use ranged shoot by using raycasting on enemies	Pass
6	The player can open the door of the house with the yellow light on	The player approaches the door and press "F" to open it	The door open	Pass
7	Player trigger message pop out	Player moves near to board, teleporter, or story NPC.	Player triggers the message pop out when near to the board, teleporter, or story NPC successfully.	Pass
8	Player interacts with NPC through dialogue	Player trigger message pop out and press on F key	A dialogue panel shows	Pass
9	Deduct health points	Player gets close and attack by the enemy	The health bar's health points decreased	Pass

10	Recharge the health points in healing zone trigger range	Player reaches the trigger range of the healing zone	The health points increased smoothly.	Pass
11	The healing zone can animate when the player is within the trigger range	Player reaches the trigger range of the healing zone	The animation of healing zone plays smoothly.	Pass
12	Player ascends with the current of the waterfall	Player gets close to the waterfall and press W key	Player ascends with the current of the waterfall smoothly.	Pass
13	Task added in task list	Player reaches the task given place	The task is updated in the task list	Pass
14	Task turn green and removed	Player completes the task	The task is turn green and removed in task list.	Pass
15	Player collects the light power of scattered light	Player gets close and collect the scattered light	The scattered light follows the player.	Pass
16	Player uses the scattered light to	Player reaches the polluted	The scattered light moves to the polluted	Pass

	purify the garbage hill	place that need to purify	place and purify it automatically	
17	Player able go to next level	Player explored the game level and reach final point	The scene load to next level, level 1	Pass

Test Case 6: Gameplay Level 4				
No.	Functionality	Pre-Condition	Expected Result	Pass/ Fail
1	Character can move left and right	Press on A/D keys or left/right arrow keys	The character response on the correct key of movement either left or right	Pass
2	Character can jump	Press on W key, spacebar, or up arrow key.	The character jump smoothly.	Pass
3	Character can coyote jump	Press on W key, spacebar, or up arrow key 2 times.	The character jump 2 times smoothly.	Pass
4	Character can attack enemy	Press on E key	The character can attack the enemy	Pass

5	Player character can shoot the enemy	Press left mouse click	The character can use ranged shoot by using raycasting on enemies	Pass
6	The player can take the moving elevator to higher or lower platform	The player jumps and stand on the moving elevator	The player takes the moving elevator to higher or lower platform successfully	Pass
7	Player trigger message pop out	Player moves near to board, teleporter, or story NPC.	Player triggers the message pop out when near to the board, teleporter, or story NPC successfully.	Pass
8	Player interacts with NPC through dialogue	Player trigger message pop out and press on F key	A dialogue panel shows	Pass
9	Deduct health points	Player gets close and attack by the enemy	The health bar's health points decreased	Pass
10	Recharge the health points in healing zone trigger range	Player reaches the trigger range of the healing zone	The health points increased smoothly.	Pass

11	After attack the enemy, the enemy drop item	Player clears the enemy	The enemy drop item successfully and the player could collect it	Pass
12	Player recharges the health points by collecting the heal flower point/ small healing flower zone	Player clears the enemy and drop heal flower point item/ small healing flower zone	Player can recharges the health point successfully and smoothly	Pass
13	Task added in task list	Player reaches the task given place	The task is updated in the task list	Pass
14	Task turn green and removed	Player completes the task	The task is turn green and removed in task list.	Pass
15	Player collects the Powerball key	Player finds and collect the Powerball key	The Powerball key is collected, and the key holder is updated correct key type	Pass
16	Player uses the Powerball key to purify the death zone flowers and activate the	Player has collected the correct key type	The death zone flowers are cleared, and the purification mechanism is activated	Pass

	purification mechanism	to the death zone flowers		
17	Activate the purification mechanism to purify and clear the death zone	Player press “P” to activate the purification	The animation of purification of death zone is smooth and the death zone is cleared and purified	Pass
18	Player collects the light power of scattered light	Player gets close and collect the scattered light	The scattered light follows the player.	Pass
19	Player uses the scattered light to purify the garbage hill	Player reaches the polluted place that need to purify	The scattered light moves to the polluted place and purify it automatically	Pass
20	Player able go to next level	Player explored the game level and reach final point	The scene load to next level, level 1	Pass

Test Case 7: Gameplay Level 5				
No.	Functionality	Pre-Condition	Expected Result	Pass/ Fail

1	Character can move left and right	Press on A/D keys or left/right arrow keys	The character response on the correct key of movement either left or right	Pass
2	Character can jump	Press on W key, spacebar, or up arrow key.	The character jump smoothly.	Pass
3	Character can coyote jump	Press on W key, spacebar, or up arrow key 2 times.	The character jump 2 times smoothly.	Pass
4	Character can attack enemy	Press on E key	The character can attack the enemy	Pass
5	Player character can shoot the enemy	Press left mouse click	The character can use ranged shoot by using raycasting on enemies	Pass
6	The player can take the moving elevator to higher or lower platform	The player jumps and stand on the moving elevator	The player takes the moving elevator to higher or lower platform successfully	Pass
7	Player trigger message pop out	Player moves near to board, teleporter, or story NPC.	Player triggers the message pop out when near to the board,	Pass

			teleporter, or story NPC successfully.	
8	Player interacts with NPC through dialogue	Player trigger message pop out and press on F key	A dialogue panel shows	Pass
9	Deduct health points	Player gets close and attack by the enemy	The health bar's health points decreased	Pass
10	Recharge the health points in healing zone trigger range	Player reaches the trigger range of the healing zone	The health points increased smoothly.	Pass
11	After attack the enemy, the enemy drop item	Player clears the enemy	The enemy drop item successfully and the player could collect it	Pass
12	Player recharges the health points by collecting the heal flower point/ small healing flower zone	Player clears the enemy and drop heal flower point item/ small healing flower zone	Player can recharge the health point successfully and smoothly	Pass

13	Task added in task list	Player reaches the task given place	The task is updated in the task list	Pass
14	Task turn green and removed	Player completes the task	The task is turn green and removed in task list.	Pass
15	Player collects the Powerball key	Player finds and collect the Powerball key	The Powerball key is collected, and the key holder is updated correct key type	Pass
16	Player uses the Powerball key to purify the death zone flowers and activate the purification mechanism	Player has collected the correct key type to the death zone flowers	The death zone flowers are cleared, and the purification mechanism is activated	Pass
17	Activate the purification of mechanism to purify and clear the death zone	Player press “P” to activate the purification	The animation of purification of death zone is smooth and the death zone is cleared and purified	Pass

18	Player collects the light power of scattered light	Player gets close and collect the scattered light	The scattered light follows the player.	Pass
19	Player uses the scattered light to purify the garbage hill	Player reaches the polluted place that need to purify	The scattered light moves to the polluted place and purify it automatically	Pass
20	Player able go to next level	Player explored the game level and reach final point	The scene load to next level, level 1	Pass

Test Case 8: Gameplay Level 6				
No.	Functionality	Pre-Condition	Expected Result	Pass/ Fail
1	Character can move left and right	Press on A/D keys or left/right arrow keys	The character response on the correct key of movement either left or right	Pass
2	Character can jump	Press on W key, spacebar, or up arrow key.	The character jump smoothly.	Pass

3	Character can coyote jump	Press on W key, spacebar, or up arrow key 2 times.	The character jump 2 times smoothly.	Pass
4	Character can attack enemy	Press on E key	The character can attack the enemy	Pass
5	Player character can shoot the enemy	Press left mouse click	The character can use ranged shoot by using raycasting on enemies	Pass
6	The player can take the moving elevator to higher or lower platform	The player jumps and stand on the moving elevator	The player takes the moving elevator to higher or lower platform successfully	Pass
7	Player trigger message pop out	Player moves near to board, teleporter, or story NPC.	Player triggers the message pop out when near to the board, teleporter, or story NPC successfully.	Pass
8	Player interacts with NPC through dialogue	Player trigger message pop out and press on F key	A dialogue panel shows	Pass

9	Deduct health points	Player gets close and attack by the enemy	The health bar's health points decreased	Pass
10	Recharge the health points in healing zone trigger range	Player reaches the trigger range of the healing zone	The health points increased smoothly.	Pass
11	After attack the enemy, the enemy drop item	Player clears the enemy	The enemy drop item successfully and the player could collect it	Pass
12	Player recharges the health points by collecting the heal flower point/ small healing flower zone	Player clears the enemy and drop heal flower point item/ small healing flower zone	Player can recharges the health point successfully and smoothly	Pass
13	Task added in task list	Player reaches the task given place	The task is updated in the task list	Pass
14	Task turn green and removed	Player completes the task	The task is turn green and removed in task list.	Pass

15	Player collects the Powerball key	Player finds and collect the Powerball key	The Powerball key is collected, and the key holder is updated correct key type	Pass
16	Player uses the Powerball key to purify the death zone flowers and activate the purification mechanism	Player has collected the correct key type to the death zone flowers	The death zone flowers are cleared, and the purification mechanism is activated	Pass
17	Activate the purification of mechanism to purify and clear the death zone	Player press “P” to activate the purification	The animation of purification of death zone is smooth and the death zone is cleared and purified	Pass
18	Player collects the light power of scattered light	Player gets close and collect the scattered light	The scattered light follows the player.	Pass
19	Player uses the scattered light to purify the garbage hill	Player reaches the polluted place that need to purify	The scattered light moves to the polluted place and purify it automatically	Pass

20	The acid drops deduct the player's health when player exposed under the acrid drops	The player exposed under the acid drops and collided with it	The player's health is deducted	Pass
21	Player able go to next level	Player explored the game level and reach final point	The scene load to next level, level 1	Pass

Test Case 9: Gameplay Level 7				
No.	Functionality	Pre-Condition	Expected Result	Pass/ Fail
1	Character can move left and right	Press on A/D keys or left/right arrow keys	The character response on the correct key of movement either left or right	Pass
2	Character can jump	Press on W key, spacebar, or up arrow key.	The character jump smoothly.	Pass
3	Character can coyote jump	Press on W key, spacebar, or up arrow key 2 times.	The character jump 2 times smoothly.	Pass

4	Character can attack enemy	Press on E key	The character can attack the enemy	Pass
5	Player character can shoot the enemy	Press left mouse click	The character can use ranged shoot by using raycasting on enemies	Pass
6	The player can take the moving elevator to higher or lower platform	The player jumps and stand on the moving elevator	The player takes the moving elevator to higher or lower platform successfully	Pass
7	Player trigger message pop out	Player moves near to board, teleporter, or story NPC.	Player triggers the message pop out when near to the board, teleporter, or story NPC successfully.	Pass
8	Player interacts with NPC through dialogue	Player trigger message pop out and press on F key	A dialogue panel shows	Pass
9	Deduct health points	Player gets close and attack by the enemy	The health bar's health points decreased	Pass
10	Recharge the health points in healing zone trigger range	Player reaches the trigger	The health points increased smoothly.	Pass

		range of the healing zone		
11	After attack the enemy, the enemy drop item	Player clears the enemy	The enemy drop item successfully and the player could collect it	Pass
12	Player recharges the health points by collecting the heal flower point/ small healing flower zone	Player clears the enemy and drop heal flower point item/ small healing flower zone	Player can recharges the health point successfully and smoothly	Pass
13	Task added in task list	Player reaches the task given place	The task is updated in the task list	Pass
14	Task turn green and removed	Player completes the task	The task is turn green and removed in task list.	Pass
15	Player collects the Powerball key	Player finds and collect the Powerball key	The Powerball key is collected, and the key holder is updated correct key type	Pass
16	Player uses the Powerball key to	Player has collected the	The death zone flowers are cleared, and the	Pass

	purify the death zone flowers and activate the purification mechanism	correct key type to the death zone flowers	purification mechanism is activated	
17	Activate the purification mechanism to purify and clear the death zone	Player press “P” to activate the purification	The animation of purification of death zone is smooth and the death zone is cleared and purified	Pass
18	Player collects the light power of scattered light	Player gets close and collect the scattered light	The scattered light follows the player.	Pass
19	Player uses the scattered light to purify the garbage hill	Player reaches the polluted place that need to purify	The scattered light moves to the polluted place and purify it automatically	Pass
20	The acid drops deduct the player’s health when player exposed under the acrid drops	The player exposed under the acid drops and collided with it	The player’s health is deducted	Pass

21	Collect the 4 power elements to grow the last tree	The player find collect the power elements	The power element is following the player after player has collected them	Pass
22	The last tree grows step by step when receiving the power element	The player collects the power element and put it to the last tree	The last tree grows step by step after receiving the power element, the growing animation runs smoothly	Pass
23	Player able go to next level	Player explored the game level and reach final point	The scene load to next level, level 1	Pass

APPENDIX D: Deployment of Project



A screenshot of a web browser displaying the website for "Purification: A Serious Game of Environmental Issues". The browser address bar shows "aliceleongpy.titch.io/purification". The website has a dark theme and includes a navigation menu with options like "Dashboard", "Manage", "Edit game", "Analytics", "Widget", "Edit theme", and "PUBLISHED". The main content area features a title "Purification: A Serious Game of Environmental Issues" and a greeting "Hi, guys! This is Alice Leong Pi Yee!". Below this is a paragraph describing the game as a 2D platform serious game. A feedback form link is provided: "https://forms.gle/Pv25KhztSCSM77nn?". There is a section for a video trailer titled "PURIFICATION TRAILER & ...". The "Download" section shows a "Download" button and the file name "Purification_v10.zip" with a size of "490 MB". The "Install instructions" section says "Download the zip file, unzip it, click on Purification.exe and then have fun!". The right sidebar shows a "View all by aliceleongpy" section with an "Add To Collection" button. The background of the website features a dark, atmospheric scene with red and blue light trails.