

3D MOBILE-APP BASED RECYCLING GAME

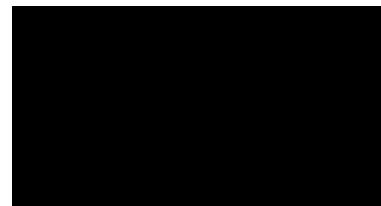
Final Year Project

Abstract

An attempt to develop a 3D based game to promote recycling for a local city council through the use of a mobile game app.

DECLARATION

All parts in this project were created and written with my own work. Although there are those parts in the project contains others' work, but it has been referenced and use for research purposes. Further, I declared that no other degree/qualification are involved in this project, other than for learning purposes.



ABSTRACT

Only a handful of recycling games exist commercially or on the internet; furthermore, there is a significantly low number, or even none, of such game developed on the basis of a 3D mobile app. The report will attempt to investigate why recycling games are very unpopular in the educational game market, and what other recycling games are out there in the game market. There will be an attempt to develop a 3D based game in order to promote recycling for a local city council through the use of a mobile game app.

The Unity file and APK can be found at: https://stummuac-my.sharepoint.com/personal/████████_stu_mmuc_ac_uk/_layouts/15/guestaccess.aspx?docid=1d1d138cd4f0c4cd489d6b0851343c243&authkey=ATMK90nZ1ZJOAQsxepIKyOk&expiration=2017-07-23T12%3a24%3a08.000Z

The link above contains all the components to create this project. An APK is also attached with the file when it is unzipped and opened. To open this project, it requires *Unity 5.4.0f3 (64bits)* or **above**, otherwise will cause missing file or script as it tries to open. For the APK file, it may necessary to debug the phone before put it into the phone and play. The recommended Android version to play this game is *Android 4.4.2 (KitKat)* or **above**.

Contents

DECLARATION	i
ABSTRACT.....	ii
List of Figures	vii
List of Tables	ix
1. INTRODUCTION	1
1.1 Structure of this Report.....	1
1.2 What is the problem	1
1.3 Suggest a Solution	1
1.4 Aims.....	2
1.5 Objectives.....	2
1.6 Timetable and Deliverables.....	2
1.7 Required Resources.....	3
1.8 Stakeholders.....	4
1.9 Existing Game.....	4
2. LITERATURE REVIEW	6
2.1 The definition of Games.....	6
2.2 Who is playing?	7
2.3 Games for children.....	8
2.4 Mobile Games	9
2.5 Computer Games Based learning.....	10
2.5.1 Educational Games.....	11
2.5.2 Learning exists in modern games	11
3. DESIGN DOCUMENTATION	13
3.1 Researches	13
3.2 Game treatment.....	13
3.2.1 Start Game.....	13
3.2.2 Leaderboard	14
3.2.3 How to Play	14
3.2.4 Credits	14
3.2.5 Quit Game	14
3.3 In Game	14
3.3.1 Gameplay.....	14

3.3.2 Game Camera	14
3.3.3 Head-up Display (HUD).....	14
3.3.4 Models.....	15
3.4 Target Audience	15
3.5 Controls	15
3.6 Design Template.....	15
Game Progression Diagram.....	19
PROJECT DEVELOPMENT METHODOLOGIES	20
WATERFALL METHODOLOGY	20
Advantages.....	20
Disadvantages	20
AGILE METHODOLOGY	21
Advantages.....	21
Disadvantages	21
Methodology to adopt	21
4 IMPLEMENTATION	22
4.1 Level Creation.....	22
4.2 Script	26
4.3 Assets	26
4.4 Sounds.....	26
4.5 Particles System	27
4.6 Control.....	28
4.7 Fonts.....	28
5. TESTING.....	29
5.1 Black Box Testing.....	29
5.1.1 Screen Size.....	29
Low Screen Resolution	29
Portrait Screen Resolution	30
5.1.2 Buttons' functionality.....	31
5.1.3 Controls	31
5.1.4 Setting a high-score	32
Before.....	32
After	33
5.1.5 Loading Screen	33
5.1.6 Random Item Generator	33
5.1.7 Time Up Menu Pop-up	35

Before reaches to 0	36
When reached to 0	36
5.1.8 Clicking Sound	37
5.1.9 Add/Monus Scoring System.	37
6. INTERVIEW	38
6.1 Purpose	38
6.2 Design the Questions	38
6.2.1 First Questionnaire Procedures.....	38
6.2.2 Second Questionnaire Procedures.....	38
6.3 What Participants can do?	38
6.4 Gathering the Results.....	38
6.5 Final Design of the questionnaires.....	39
6.6 Results	41
6.6.1 Questionnaire 1.....	41
6.6.2 Questionnaire 2.....	42
7. Evaluation	45
7.1 Questionnaire 1.....	45
7.1.1 Question 1.....	45
7.1.2 Question 2	45
7.1.3 Question 3	45
7.1.4 Question 4	45
7.1.5 Question 5	45
7.1.6 Question 6	45
7.2 Changes in the Game	46
7.2.1 First change	46
7.2.2 Second Change	48
7.3 Questionnaire 2.....	49
7.3.1 Question 1	49
7.3.2 Question 2	49
7.3.3 Question 3	50
7.3.4 Question 4	50
7.3.5 Question 5	50
7.3.6 Question 6	50
7.3.7 Question 7	50
7.3.7 Question 8	50
8. CONCLUSION.....	52

8.1 Problems and Issues.....	52
8.2 Personal Preference	52
8.3 Summary	52
Bibliography	54
REFERENCES.....	54
APPENDICES	55
Terms of Reference	55
Learning Outcomes	55
Risk Management	55
Aim(s)	56
Objectives.....	56
Timetables and Deliverables.....	56
Resources Used	57
Interim Report.....	57
Online Game Download Assets.....	58
Models.....	58
Sounds	59
Fonts.....	59
Smartphone Specification for Testing.....	59
ETHICS FORM	60
Checklist	60
Risk Assessment	63
	64

List of Figures

Figure 1:BBC Bitesize Recycling Game	4
Figure 2: Chart of Age and Gender of Gamers.....	7
Figure 3: Questionaut	8
Figure 4: Gut Instinct.....	9
Figure 5: A Chart of Most Popular Mobile Games Genre	10
Figure 6: Main Menu.....	16
Figure 7: Stage Mode	16
Figure 8: Loading Screen	17
Figure 9:HUD during Gameplay	17
Figure 10: Leaderboard	18
Figure 11: How-to-Play Menu	18
Figure 12: Credit Scene	19
Figure 13: Diagram of Game's Navigation	19
Figure 14: Waterfall System.....	20
Figure 15: Agile System.....	21
Figure 16: Main Menu Implementation.....	22
Figure 17: Selecting a Stage	23
Figure 18: In Loading Progress	23
Figure 19: Finished Loading	24
Figure 20: In the Game.....	24
Figure 21: Game Paused	25
Figure 22: Game Finished	25
Figure 23: Leaderboard Implementation.....	26
Figure 24: In Game Particles	27
Figure 25: Particles System Inspector.....	28
Figure 26: Main Menu Resolution: 400x320.....	29
Figure 27: Game Play Resolution: 400x320	30
Figure 28: Main Menu Resolution 600x1024.....	30
Figure 29: Game Play Resolution 600x1024	31
Figure 30: Leaderboard Before Implement a High-score	32
Figure 31: Leaderboard After Setting a New High-score	33
Figure 32: Restart 1.....	34
Figure 33: Restart 2	34
Figure 34: Restart 3	35
Figure 35: 1s Remaining.....	36
Figure 36: 0s Remaining.....	36
Figure 37: Questionnaire 1	39
Figure 38: Questionnaire 2	40
Figure 39: Before: Brown Bin Inspector.....	46
Figure 40: Before: Brown Bin in Game Level	47
Figure 41: After: Brown Bin Inspector	47
Figure 42: After: Brown Bin in Game Level	48
Figure 43: Rubbish throwing from left and right	49
Figure 44: Checklist 1 out of 3.....	60
Figure 45: Checklist 2 out of 3.....	61

Figure 46: Checklist 3 out of 3.....	62
Figure 47: Risk Assessment 1 out of 2	63
Figure 48: Risk Assessment 2 out of 2	64

List of Tables

Table 1: Gantt Chart.....	3
Table 2: Black Box Testing on Buttons	31
Table 3: Models.....	58
Table 4: Sounds	59
Table 5: Fonts.....	59
Table 6: Phone Specification.....	59

1. INTRODUCTION

1.1 Structure of this Report

The report will be divided into 8 chapters; each chapter will have a specific aspect of the project. At below is a list of the chapters' outline of what each of the chapters may contain.

Chapter 1: Introduction – includes a background information about the project. The real issue that the project is trying to investigate. How the project will be developed, solve this problem. Also, define what are the aims and objectives of this project.

Chapter 2: Literature Reviews – investigate many possible types of research that are related to this project. Examine on similar researches that relevant to the problem and how did they try to solve it. Provide an overview of different aspects of games that will be used in this project, especially what makes a good game that encourages players to stay longer.

Chapter 3: Design – A design documentation fully explaining what features and functionalities will the game have. Design Templates to visualise how the game will look like. Also, a comparison between different methodologies, which will be used to develop this game.

Chapter 4: Implementation – Outlines of the details that are implemented in the game. Screenshots of what the game is looked like now after it has successfully been built.

Chapter 5: Testing – A summary of what parts of the game have been tested; any bugs were occurred during testing the game and has it solved.

Chapter 6: Interview – contain procedures of the interview. A design of the questionnaires that will be used in the interview. Graphs to summarise the results based on the answers which were provided from participants.

Chapter 7: Evaluation – Examine critically the achieved results and relative them to the original objectives. Show evidence of the changes that have made base on the results of the questionnaire.

Chapter 8: Conclusion: Conclusion: Finalise the work that I have to achieve in this project. A description of suggestions for further work, for this project. Outline the limitations which have occurred when developing the game.

1.2 What is the problem

Recycling games are one method to promote recycling to society, especially if targeting at younger age groups. It is easy to play and is an engaging way to teach or to remind people why recycling is so important for society and which type of rubbish goes to which colour of recycling bins. While these games describe as enjoyable, they are unpopular compared to those other educational games. Due to this reason, they have been very niche in the educational gaming market, and so far none exist in the mobile market.

1.3 Suggest a Solution

To come up with a new solution, an attempt to developed a 3D mobile-app based game with the aim of promoting recycling more effectively. Research are assembled before developing the game, which will be used during the interview stage to ascertain whether this approach works.

1.4 Aims

- To design, develop and evaluate a 3D Mobile Recycling game to educate about the importance of recycling and promote it more effectively than other platforms.
- To gain a good insight and understanding of how does the playability and usability work in games and apply it to the game.

1.5 Objectives

- Decisive analyse and critical evaluation to achieve effective results for the report.
- Perform research by questionnaires and exist research before carry out the evaluation.
- Reviews by investigating what type of games can educate a player while playing the game.
- Create the recycling game through the use of an applicable mobile game design engine.
- Using an effective plan, i.e. Gantt Chat, to handle the time more efficiently.
- Analyses a suitable software development methodology to create the game.
- Perform numerical techniques to the project.
- Frequently of testing when building the game.
- Regular back-ups in place of contingency plan for the product and the report.

1.6 Timetable and Deliverables

It is vital to estimates how many hours are needed to be spent on the report and the project (game). It will be recommended to spend a good minimum of 10 hours per week, thus an average of 5 hours per week on the project. A Gantt Chat will also be produced to help keep track of the time duration of the report and project. However, it may not necessary always be on track, as sometimes, in some circumstances of the report or project may complete in much lesser time than expected.

Table 1: Gantt Chart

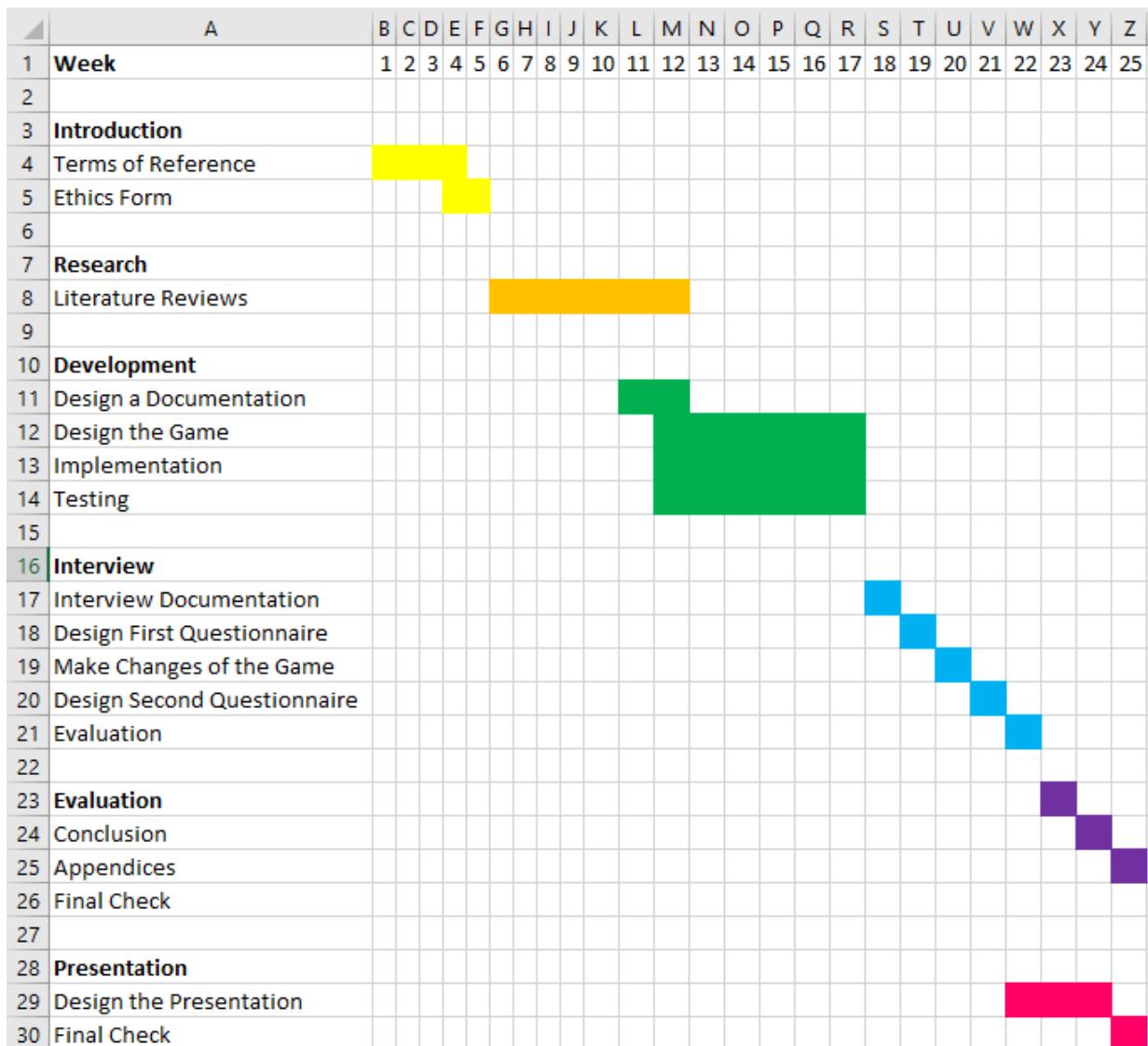


Figure 1: Gantt Chart

Important: - Vacations are not included in the Gantt Chart, but these weeks will also be treated as process stage for the proposal.

1.7 Required Resources

Ensuring an effectively proposed project is achieved, below are the software and hardware that will be used:

- Word Processing (Microsoft Word)
- Type Form for Questionnaire (Survey Monkey)
- Figures Analyses and Graph Designs (Microsoft Excel)
- Game Engine (Unity3D / Unreal Engine 4)
- Game Scripting (MonoDevelop / Microsoft Visual Studio)

- Computer Animation and Modelling Software (Autodesk Maya / 123 Catch)
- Web Browser (Google Chrome / Internet Explorer)
- File Back-up (OneDrive / Google Drive / USB)
- Testing (A smartphone)
- A Powerful Computer

1.8 Stakeholders

- Society
- Local Council
- Younger age groups
- Schools

1.9 Existing Game

An example was found online from the BBC website called The Recycling Games. It requires the player to drag and drop items, which they are given from the random machine generator to one of the three recycling bins. The players will have seven attempts to get it correct, and each time when they get it right the bear will award them with one point (a bear icon which it shows on top of the game screen). The scores will then finalised after the seventh attempt.

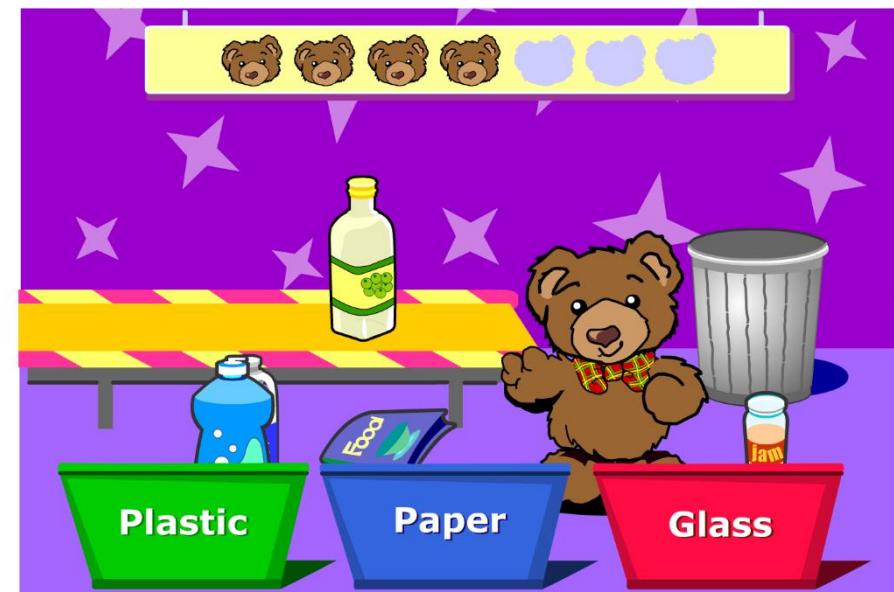


Figure 1:BBC Bitesize Recycling Game

(The Recycling Game, 2016)

The game was enjoyable and very efficient to promote advertising but to a certain extent; therefore, to date, it only exists on the internet and no such games were made in a mobile app, in addition to 3D version. So in the project, there will be an attempt to use a mobile games development software to create a 3D recycling game similar or better to the one found on BBC website but will be in the mobile version. For the report, attempts will be investigated to why the number of recycling games

is so low, especially for the mobile game market. To achieve both the objectives, the need for accurate and relevant results must be gathered through market researches for the solution to deliver a successful game and effective report.

2. LITERATURE REVIEW

In this chapter, an investigation is attempted to focus and solve those issues to this project. Are there any possible educational games already exist in mobiles? Are they already exist in another games' genre? Furthermore, why educational games are unpopular in the gaming market? Research which is gathered in this chapter will be assembled into a summary of academic theories, which will be used to approach to those issues later in the project.

By the end of the chapter, the reader should have a clear idea of what type of game to design for that will make people want to play. But ultimately, the game should be teaching the players about the impact can affect the community, while it meant to be fun and enjoyable to be played as a game.

2.1 The definition of Games

One of the famous theorist in video game studies, Jesper Juul, described: "*A game is a rule-based formal system with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort in order to influence the outcome, the player feels attached to the outcome, and the consequences of the activity are optional and negotiable*" (Jesper J., 2003).

From his point of view about games, he describes that every game does have a set of instructions which players do need to follow in order to play. As the player progress through the levels, if the more risks and efforts they are willing to put into the game, the greater of the reward will be; which it makes sense as the player will have more experience to take on harder challenges to earn better rewards.

Jesper Juul has also indicated that other than good usability and game mechanics, which he feels it is the outer core of a game, a successful game must also consider the inner core features. To explain this, he finalised it into six points:

1. **Rules:** Games are rule-based.
2. **Variable, quantifiable outcome:** Games have variable, quantifiable outcomes.
3. **The value assigned to possible outcomes:** That the different potential outcomes of the game are assigned different values, some being positive, some being negative.
4. **Player effort:** That the player invests effort in order to influence the outcome. (i.e. games are challenging)
5. **Player attached to outcome:** That the players are attached to the outcomes of the game in the sense that a player will be the winner and "happy" if a positive outcome happens, and loser and "unhappy" if negative outcome happens.
6. **Negotiable consequences:** The same game [set of rules] can be played with or without real-life consequences.

So, by combining most or all the Juul's six-game frameworks in the final product, there is a chance that players will likely to play the game. Hence, they feel the game is more exciting to play, with varies of outcome and the uncertainties that are attached to it. This means a player is likely to spend more time to understand the game – becoming the expert of that game.

As well as Player effort, some games have negotiable consequences that can affect a player in some circumstances, in the real-life. For example, gambling games – if the player loses in a game, it not just "lose" but also loses something in real life, which is money in this condition.

After studying from Juul's six-game frameworks, he believes that games can still be enjoyable to play even without the good graphics and a narrative script. However, this is just one of the core towards creating a successful game; hence, it still needs to include workable game usability and reasonable game visuals and sounds to keep players entertained.

2.2 Who is playing?

In the early years when games were recently released in the market, many people stereotype that games were just for kids. However, nowadays, as games have diversified to many genres (Role-playing, Action, Strategy, etc.) and sub-genre (Shooter, Fantasy, Real-time strategy, etc.), which it is no longer just played by young age group anymore but for all ages.

"People of all ages play video games. There is no longer a 'stereotype game player,' but instead, a game player could be your grandparent, your boss, or even your professor."

(Allaire J., 2014)

Back in 2014, a research showed that 39% of gamers are age of 36+, 32% were between age 18 – 35 and only the least percentage of 29% for 18 and under age group who plays video games. That is an average of a 31-year-old gamer. It has revolutionised the way how people think about games as an entertainment media over these former years.

And it, not just the age group which had an impact on, the number of female gamers has also increased over the recent years, with an impressive percentage of 48% which is almost the same as male gamers.

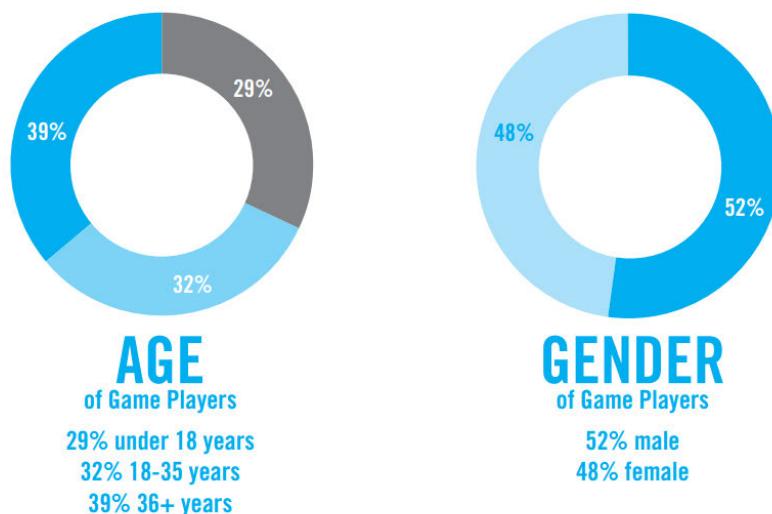


Figure 2: Chart of Age and Gender of Gamers

(ESA, 2014)

As so many people now play games, which means even if developing and selling for one particular genre is not just about targeting at one specific age group or gender, it can be for both of them. A good example will be casual games i.e. Candy Crush Saga or Angry Birds.

2.3 Games for children

When gathering the evidence for games that specifically designed for children to play, it seems there is a low figure of research that is found to what games can be catalogues as for children. One of the reasons could be the intelligence, the different between young children compare to adults (or even teenagers) when answering a question during the interview, i.e. an adult is likely to respond to the questions more effectively than a child would. So, the interviewers may need to consider some of the factors before they ask those questions to a child. *"Do children have sufficient reading abilities to fill in a written questionnaire? Are their cognitive abilities sufficient to understand the questions of an interviewer? Are their linguistic (verbal) abilities adequate to express what they want to say? On the whole, it seems doubtful that results from empirical studies with children could correspond to scientific standards like objectivity, reliability and validity."* (Fromme J. 2003). As a result, it is very hard to gather meaningful data from young children before designing a new game for them, and it is the reason why most games may categorise children as youth instead.

However, there are few surveys has reported that educational games have been designed to aim at children's market. It does make sense to some degree, as Merrilea Mayo, a game-based learner, claimed that educational games' goal is to help people to learn, in a more motivate way rather than old school fashion way. In her discovery, she has found: *"Games are also particularly adept at dosing information delivery. Complex tasks are presented first as a small core experience that is practised multiple times before being progressively extended into a longer, more complex sequence"* (Mayo M., 2009).

Here are some examples which were found in children games website:



Figure 3: Questionaut



Figure 4: Gut Instinct

The two screenshots are from gameplays which were found on the BBC Bitesize website [KS2 Bitesize]. The game on the left called Questionaut, and on the right called Gut Instinct. Both games are educational game based which will require the player to think and problem-solving before they answer the question, and questions mainly based in English, mathematics and Science. The titles in both games are related to some sort of questioning field so that players immediately know what the game is about. For game environment, the two games approach artistic style very differently as you can see on the screenshots, but their environment sets in fantasy. Questionaut approaches more 2.5D art style and heavily based in animation style, while Gut Instinct style more with bright and colourful colours in the interface and the background. They both do have violence or bad languages in the game, which there will not be given any negative effects on a child. Both of the games' controls are simple as it only selects and clicks on the answers with a mouse.

2.4 Mobile Games

In definition, there can be many ways to define what “mobile games” are. Despite the fact in today’s technologies, which it can refer to games that are played in handheld portable devices i.e. cell phones and PDAs with wireless communication wireless functionality. Furthermore, portable consoles and lightweight laptops’ games are now being classed as mobile games. It can be confusing to define the terminology “mobile games”. Here is a research discovered by Jeong and Kim on how the term “mobile game” changed as technologies evolving.

“The characteristics of mobile games are different from other device platforms such as PC and console games, which do not have both portability and wireless capability. For example, Game Boy (GB) with no communication functionality was only regarded as a portable console device. However, this concept has lost some of its ground in the market since the advent of new mobile game devices from portable consoles such as Play Station Portable (PSP) and Nintendo Dual Screens (NDS), as wireless networked games began to be serviced through the new mobile game devices”

(E. J. Jeong; D. J. Kim)

Since the first smartphone (iPhone 1st Generation) was launched back in 2007, it has created a new market for the game. There are many types of game genre in the mobile game, but the casual game genre has the biggest proportion (46%) than others, which almost dominated half the market. Educational games (puzzle and board games) are also a popular genre in the market with a percentage of 31%. This indicates that players prefer to play these particular genres on their mobile device, rather than on consoles or portable devices (e.g. PSP). This is a good advantage for potential games in educational based, especially recycling games, to invest in the mobile game market as the educational game segment is big.

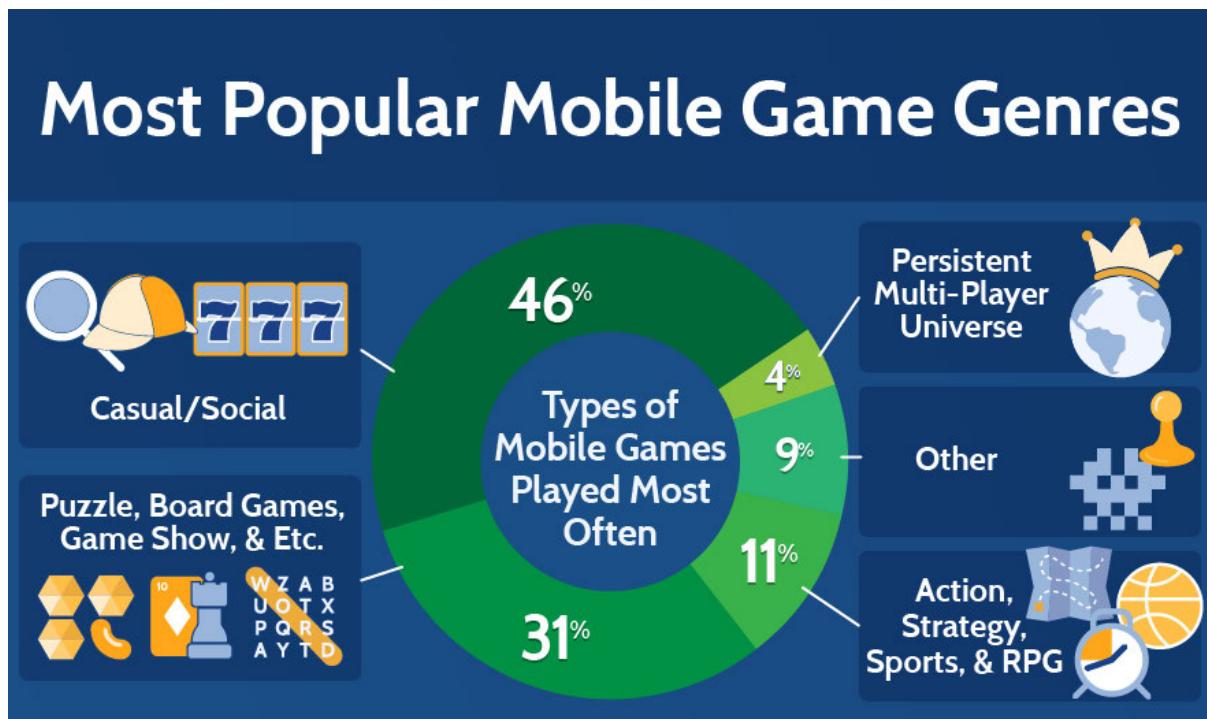


Figure 5: A Chart of Most Popular Mobile Games Genre

(BigFishGames. 2016)

2.5 Computer Games Based learning

Classifying games that related to education is complicated. It is difficult to select a right technique to exemplify what educational games, serious games and their relationship to virtual worlds is, and there are many ways to define it. Some researchers view that the genre itself has not been fully developed yet, compare to another genre, for example, role-playing games that have a good player engagement (e.g. storyboard) and well-structured settings. *"They share with games and simulations the three-dimensional environment, but they do not have the focus on a particular goal, such as advancing to the next level or successfully navigating the scenario."* (Aldrich C., 2009), whilst some see educational games do not exist. (E-learning, 2016)

2.5.1 Educational Games

Educational games are different to other genres in terms of fun. It is still fun to play, as they have the elements (e.g. challenge, virtual worlds) of a game, but their goal is to make sure the learning is taking place, whilst it still providing the enjoyment and excitement of a game.

"The first step towards understanding how computer games can transform learning and education is changing the widely shared perspective that games are "mere entertainment". It is more than just a multi-billion dollar industry and more than a compelling toy for both children and adults, computer games are important because they let people participate in new worlds. They let players, think, talk and act - they let players inhabit - roles otherwise inaccessible to them. These virtual worlds are what makes games such powerful contexts for learning. In virtual worlds, learners experience the concrete realities that words and symbols only describe." (Global Conflicts Press Kit)

Not to get confused with serious games. Although they both is about learning a subject, but they both are slightly different learning style. For example: educational games are used to teach a player in a particular subject, making the player to learn a new skill. *"They give us the fundamental needs of learning by providing - enjoyment, passionate involvement, structure, motivation, ego gratification, adrenaline, creativity, social interaction and emotion."* (Teaching and Learning Resources, 2011)

Whilst serious games approach teaching in a different way. *"They are games designed for a purpose other than entertainment. Serious games use game environments and techniques to train or educate users or to promote a product or service in an engaging and entertaining way. The "serious" aspect comes from the fact that they are used by industries like defense, education, scientific exploration, health care, emergency management, city planning, engineering, religion, and politics."* (Designing Digitally, 2013)

2.5.2 Learning exists in modern games

An educational reformer, David H. Jonassen, has discovered there is a showing of some educational attributes in existing video games. On his discovery, he reported: *"Historically, computers have been used in education primarily as tools for supporting drill and practice for factual recall"*. (Jonassen D. H, 1988)

And not just drill and practice games, Heinich R. Molenda, another educational reformer, has also discovered that strategy games do have some sort of elements related to education. Compare to other games, strategy games involve autonomous decision-making skills and tactics, which related to some attributes in education. Like serious games, it is *"suspend the rules of reality in order to use the rules of a game, simulations attempt to model a system in a manner that is consistent with reality."* (Heinich R. M, 1996). Therefore, a simulation or strategy game stimulates some sort of real life situations, but in more of a gaming environment (e.g. fantasy), for players to engage with, and making them to decipher information for their own understanding to create solutions for themselves.

Since from then, games have played a vital role in student-centred learning environment, as some cases can be a little difficult to solve the problem by theory then by practical methods, for example, flight simulation. There are some reports show good educational games can motivate a learner to learn more, as Bowman and Malone have stated *"Good drill and practice games use the "action" genre of video games to engage learners"* (Bowman 1982; Malone 1980), making education more fun and exciting to study; making in a way that relate to meaningful contexts for learners. Here is another good statement from a learning theorist, who believes that new technologies can make an impact on learning in general. *"Using video games to support student exploration of microworlds or*

as a construction tool is more consistent with the emerging paradigm of instruction.” (Papert 1980; Rieber 1996)

3. DESIGN DOCUMENTATION

3.1 Researches

After gathering the research in literature reviews, there is evidence showing that games in educational sector are growing in mobile games, yet no games have been made for recycling. The generation of games is also changed in age and gender who are playing games, which games are not just for kids but for everyone.

3.2 Game treatment

The genre of this game is an indie/educational type in mobile platform aiming at for causal player. It will follow a similar concept as Catch Eggs in a Basket, where the player should try and catch the eggs that are falling from the top of the screen. However, in this game, certain items can only be collected with the correct bin, which players cannot just collect anything. If the player collects a wrong type of rubbishes, one point will be deducted as a penalty for incorrect knowledge. Players can also switch their current recycling bin to another one during any time of the game when try to collect other types of rubbishes.

This may develop a couple of techniques of how the way players will use to approach the game. For example, some players may try to collect all the rubbishes to get as many points as possible, even though they may have few minus. On other hand, others will only stay with one colour recycling bin and collect the rubbishes only of that bin to earn points to reduce the chance of collecting wrong rubbishes.

In the main menu, there will have five options to choose from:

- Start Game
- Leaderboard
- How to Play
- Credits
- Quit Game

The game will feature a background music, as well as animations (e.g. particles) moving behind the buttons and the title of the game. For design of the buttons, it should have some degree of shadowing and rendering, giving that 3D effect like clicking on a real button. The title of the game should be big and uses a wacky font compare to other texts, so it gets a player's attention. Overall, the GUIs should stand out more than the background, colours will be chosen precisely to prevent any overlapping with the colours of the background.

3.2.1 Start Game

Beginning with selecting 'Start Game' option, it will load up a new scene, Stage Mode. There are two modes for the player to choose in this scene: Casual Stage and Hardcore Stage. Both stages will have almost the same game mechanics and level, but the duration of the gameplay is going to be longer/shorter than the other one.

Once the player has selected a mode, a loading screen will pop out, along with a progress bar at the bottom to tell the player how long left until the game can start. While it is loading, facts about recycling will be displayed while the player is waiting, which this is a very useful way to promote or remind people about the importance and effects can do for communities. The player needs to press

enter/spacebar or click the screen before it can start, so it prevents players from having a misleading start as they may not be ready yet.

3.2.2 Leaderboard

The reason for setting up a leaderboard is to create a competition between players, which appropriately should make the game bit more challenging to play. It is a method of progression, as it gives feedback by using the point system (e.g. scoring), letting players know what they have earned for their effort. On the leaderboard, five highest scores from a player will be displayed vertically and in the ascend order.

3.2.3 How to Play

In this scene, there will be a description of controls and rules of how to play this game. There will be some rubbishes based from the game level which is used as an example, which makes it easier to recognise than using names. Each example will also provide a brief description to inform what colour recycling bin can hold what rubbishes. For controls, bullet points are used, hence to keep the structure short and simple.

3.2.4 Credits

Credits will be very short and quick; the names of people and programme include:

- The person or people who made it
- The organisation
- Mentors/supervisors
- Gaming Engine

3.2.5 Quit Game

Exit the game.

3.3 In Game

3.3.1 Gameplay

The player takes control as a bin, during in the game, to try to score as many points as possible by collecting the correct rubbishes that are falling from the top. If a player does wish to collect another type of rubbishes, there are 2 buttons at the bottom of the screen that allows the player to switch to a different colour of bin, and it can be changed during any time when playing the game.

3.3.2 Game Camera

The projection of the camera will be displayed as orthographic views rather than perspective views. The reason is because orthographic view can picture all the objects to appear at the same scale, even if some objects are slightly further away from the camera. It is also easier to view three-dimensional objects to two-dimensional objects, which it is best to go with this game as it creates a 2.5-dimensional effect for the modelling in game. The camera will be at a fixed position, so the player can see everything that is happening in the game on one big screen.

3.3.3 Head-up Display (HUD)

There will be two HUD at the top of the screen, top left corner and top right corner. At the top left, it displays the current score of the game. Whenever the player has collected a rubbish, the HUD will automatically add/minus a point depends on which colour bin did the player chosen during that time when collected a rubbish.

Whilst on the top right corner, a countdown clock is displayed to allow players to see how much time left before the game is finished. Once the timer reaches to zero, spawning rubbishes will be stopped generating, and a menu will pop out asking the player whether to restart the game or go back to the main menu.

A pause button is also will be in the game. It is centralised at the top of the screen between the two HUDs. Having this feature can allow players to pause the game, in case for any circumstances. In the pause menu, there will have three buttons for players to choose: Resume, Restart and Quit Game.

3.3.4 Models

To add a realistic look to the game, three-dimensional models are imported into the game when building it in the game engine. To bring it into the game engine will need additional plug-ins to make sure the polygons, textures and materials of the model are successfully imported, which both Unity3D and Unreal Engine 4 have its own plug-in to import the models into their engine.

There will have many different models for different recycling bins to collect, and all of them will be stored into a list of game objects for random spawn generator to spawn it out. There will be a one second delay before an object is spawn into the game.

3.4 Target Audience

The type of audiences that will be interested in this kind of game are people who just want to have a quick game to play, rather than going into sequence of storylines. It also designed for people who do not have much game experience, but just want to have some fun on their smartphone.

However, overall the game will be target to as many audiences as possible in the mobile game market, as it is a causal and fun educational game that will encourage the society to recycle.

3.5 Controls

Players simply use their finger or tilting the phone left and right to move the recycling bin. The Y and Z position for the recycling bins will stay the same, no matter where the player moves the bin except in horizontal direction of X position.

3.6 Design Template

Note: The final product (Game) may change during the progress of building the game, as the designs are for illustration purposes and do not show what the game looks like.

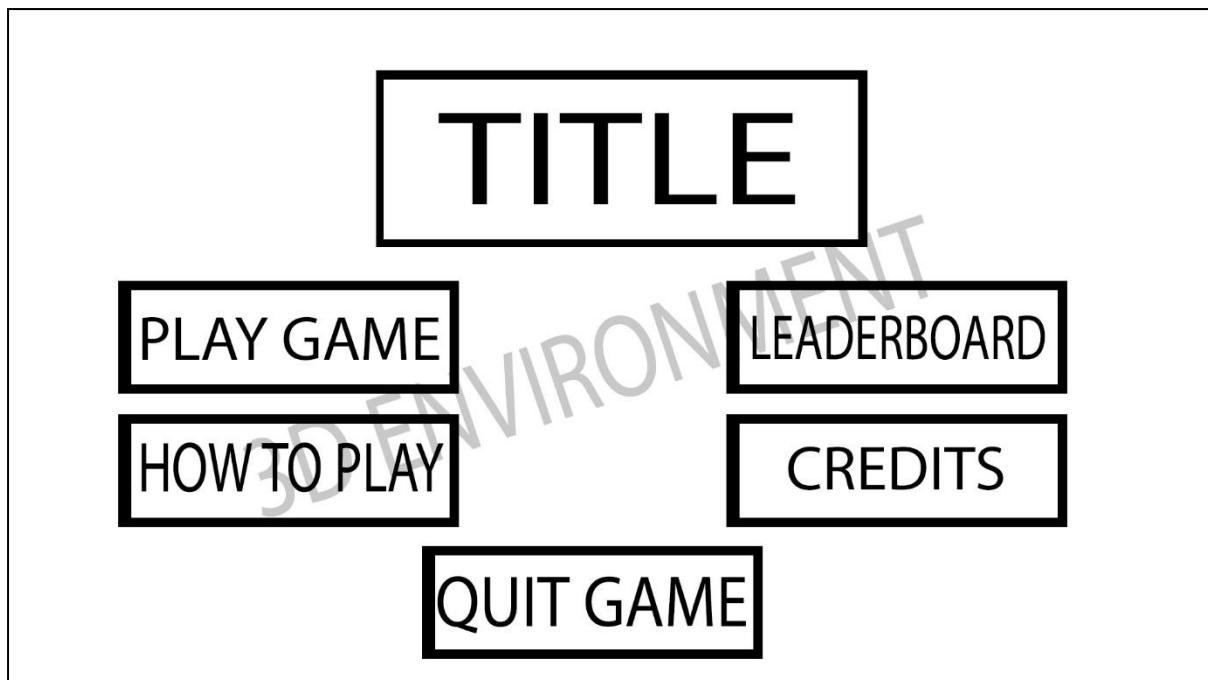


Figure 6: Main Menu

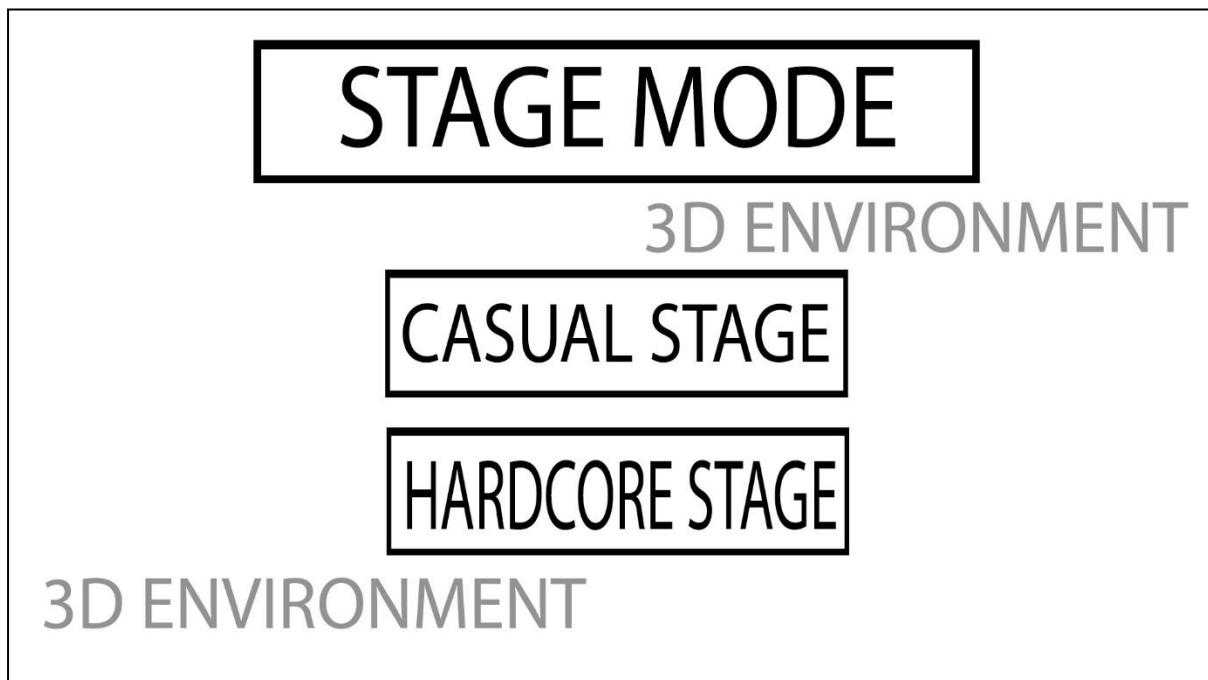


Figure 7: Stage Mode

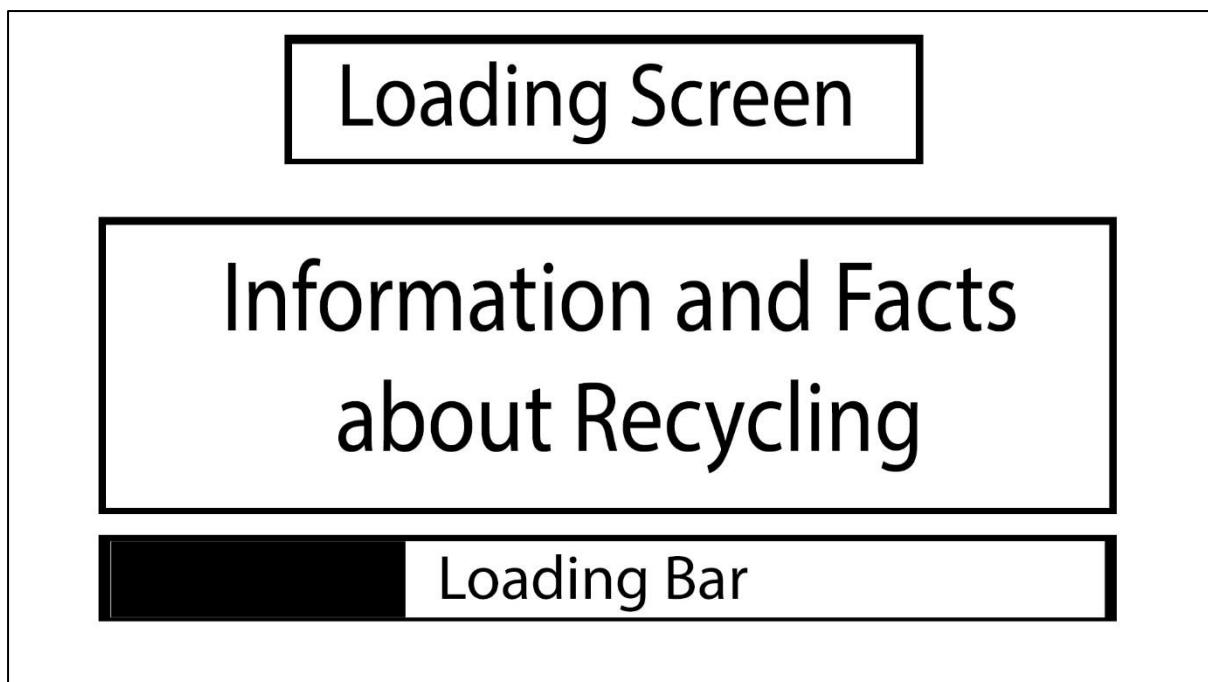


Figure 8: Loading Screen

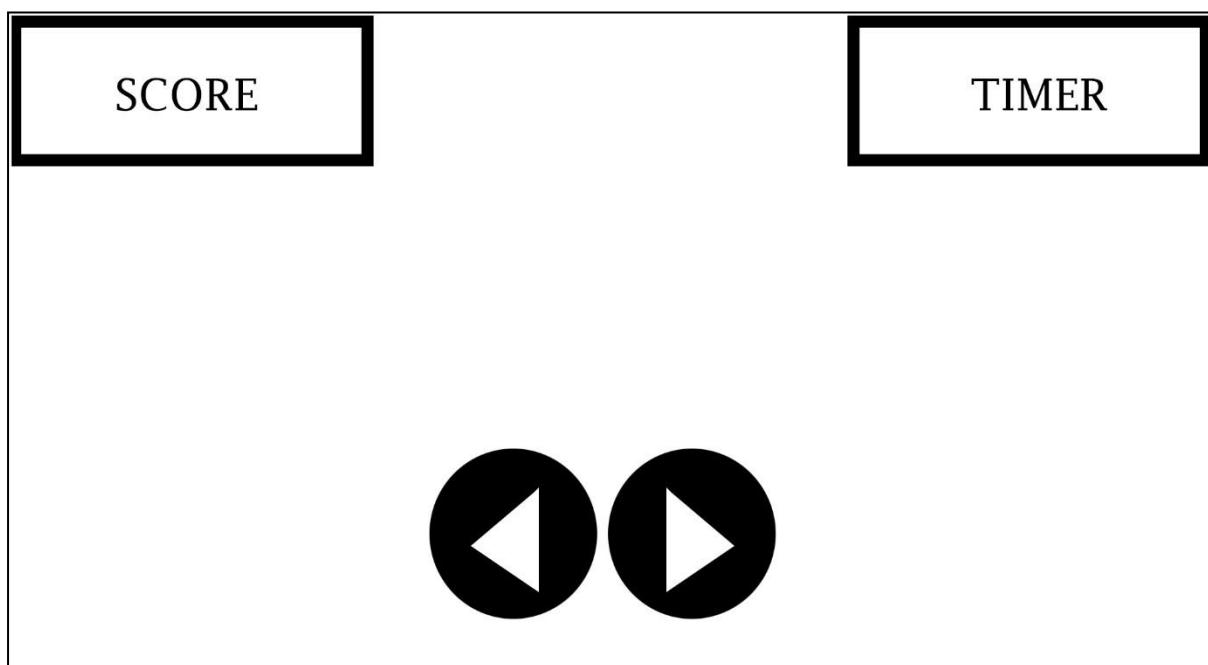


Figure 9: HUD during Gameplay



Figure 10: Leaderboard

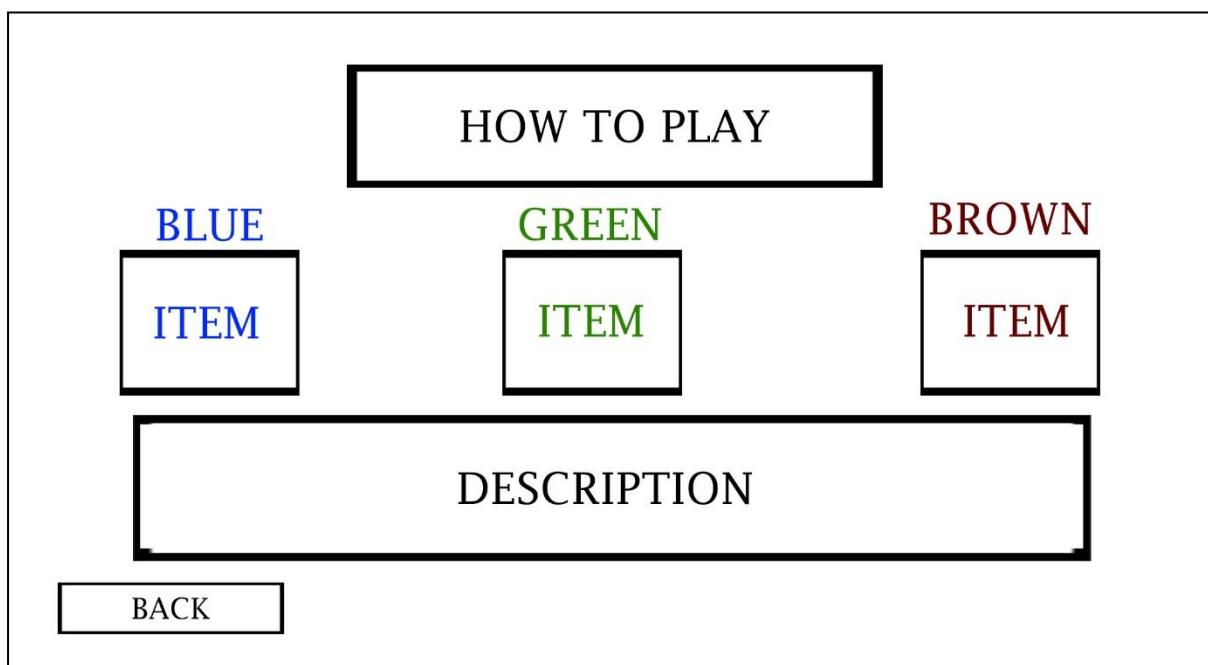


Figure 11: How-to-Play Menu

Credits

Position/Role
Name

Name of the
organization

Figure 12: Credit Scene

Game Progression Diagram

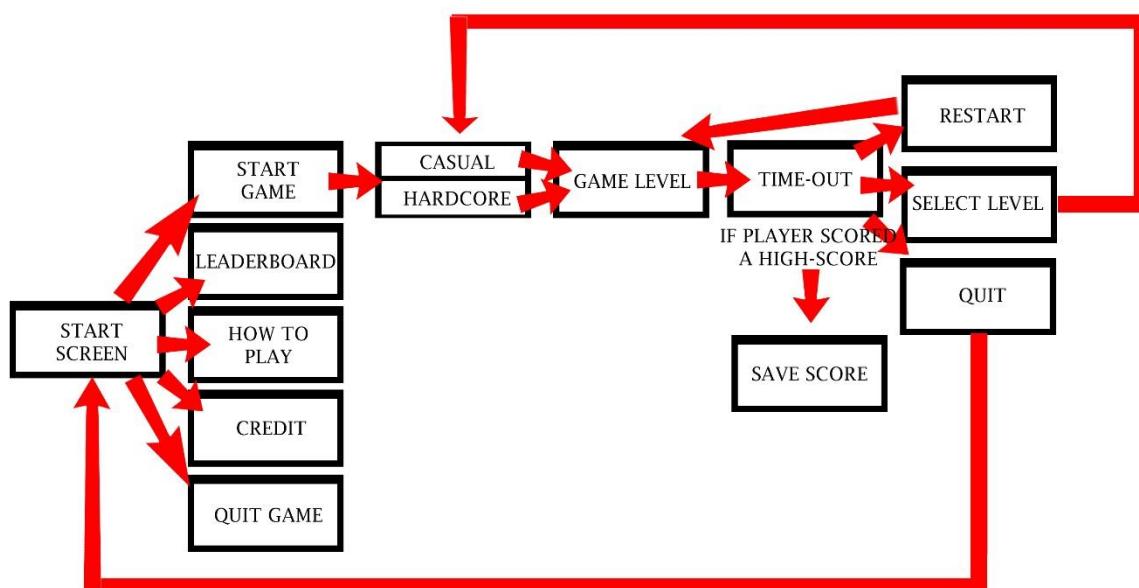


Figure 13: Diagram of Game's Navigation

This designs above are a rough diagram of how does the user interface works in the game.

PROJECT DEVELOPMENT METHODOLOGIES

WATERFALL METHODOLOGY

The methodology uses a sequential system to approach projects. Like a waterfall cycle flowing down one way, each stage in the model must proceed in order without any overlapping. Requirements should be clear throughout each stage of the development, and each stage will have a set of duration that must be completed before it can progress on to the next stage. For testing, it is carried out at the end of development stage so that it helps in keeping the flow of the project continuously.

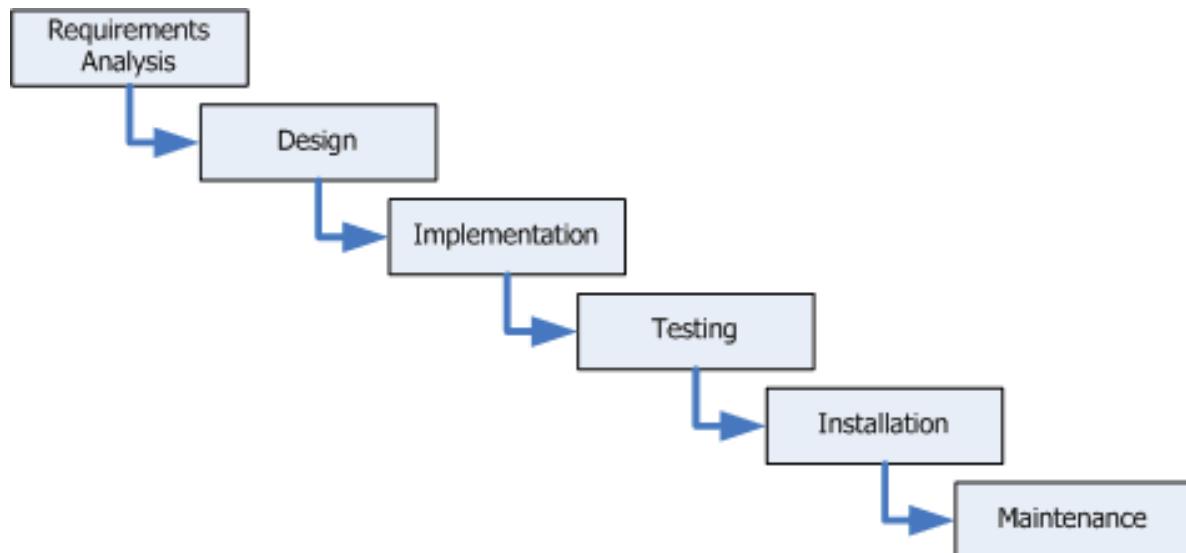


Figure 14: Waterfall System

Advantages

- At the start of each stage, the requirement is displayed clearly before it begins.
- Each stage must be completed within the specific amount of time to prevent the project being held back.
- The model does not require a lot of resources to implement.
- It is easy and quick to use, as the pattern of the model only flows one way.
- Since there is no testing after each stage of the development, this has reduced significant of time in each process.

Disadvantages

- Faults and bugs usually were found very late in this model as the test does not involve in every stage.
- Changes to the requirement during the middle of the development stage prove to be difficult to achieve.
- No prototypes are built during the development stage. Clients can only see the final product.
- Problems are never solved until test stage, which can end up even more time consuming and badly produced product.

AGILE METHODOLOGY

The phrase agile stands for ‘moving quickly’, which was introduced to integrate with today’s fast growing of the digital world. The way how agile works is by approaching each stage of the project into small steps, in a fast-constant cycle. Each release will have new performance whilst as previously built on components. Agile heavily relies on testing due to the fundamental of the model, to ensure customer satisfaction are satisfy with the quality of the product.

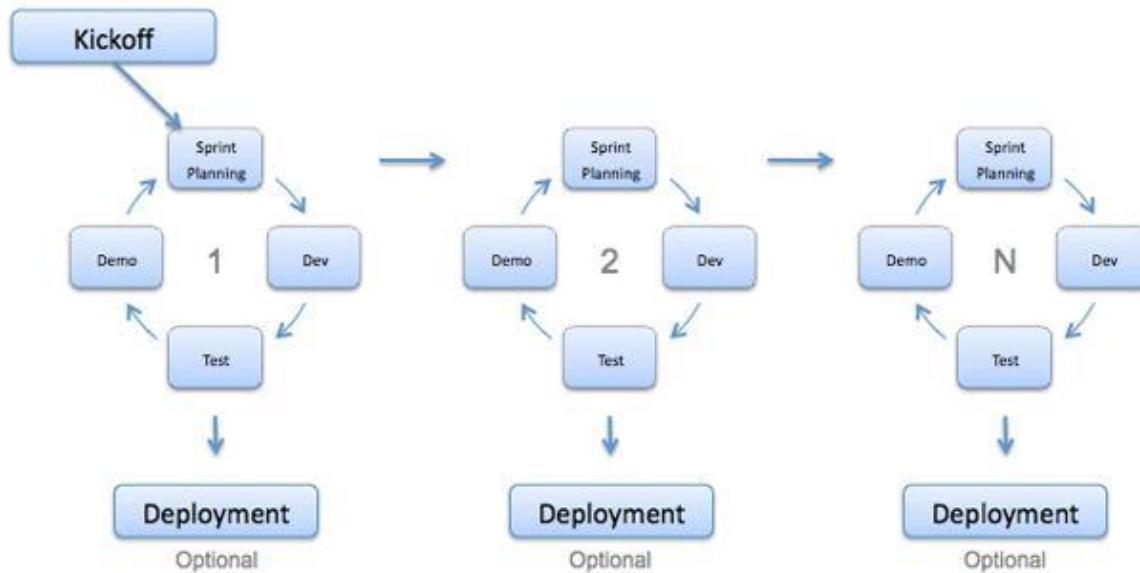


Figure 15: Agile System

Advantages

- Allow changes to be made any time in the development stage, even at the final stage.
- Constantly provided a newer version of the software to meet those changes, so improve customer satisfaction.
- Significant of tests are made every time when a new set of code is added to reduce bugs before testing in the final stage.
- It is quick and easy if use on small projects.

Disadvantages

- Difficult to determine the time and effort are consumed if uses it on a large-scale project.
- This method only suitable for senior programmers as they can respond to those changes during the development process, which beginner programmers cannot do except with combined resources from senior.
- It is costly in time and resources.
- The development of the project can gradually become worse if the client is not clear with what the final project is going to be like.

Methodology to adopt

After the comparison between both methodologies (Waterfall and Agile), it seems that the Agile development method would be more beneficial to this project. Therefore, the method is very flexible. Test can be conduct every time a new functionality is added to the project, which helps if

changes need to make. Although the methodology is suitable for more advanced programmers, hence as this is a small project, which it can responds to rapid change.

4 IMPLEMENTATION

4.1 Level Creation

Using the design template and outlines from Game Design treatment, this is what the game (project) looks like. Every print screens of the game look alike from the design templates, except there are some changes with the order in the HUDs. Particle systems were also introduced in-game backgrounds, instead of using just assets.



Figure 16: Main Menu Implementation



Figure 17: Selecting a Stage



Figure 18: In Loading Progress



Figure 19: Finished Loading

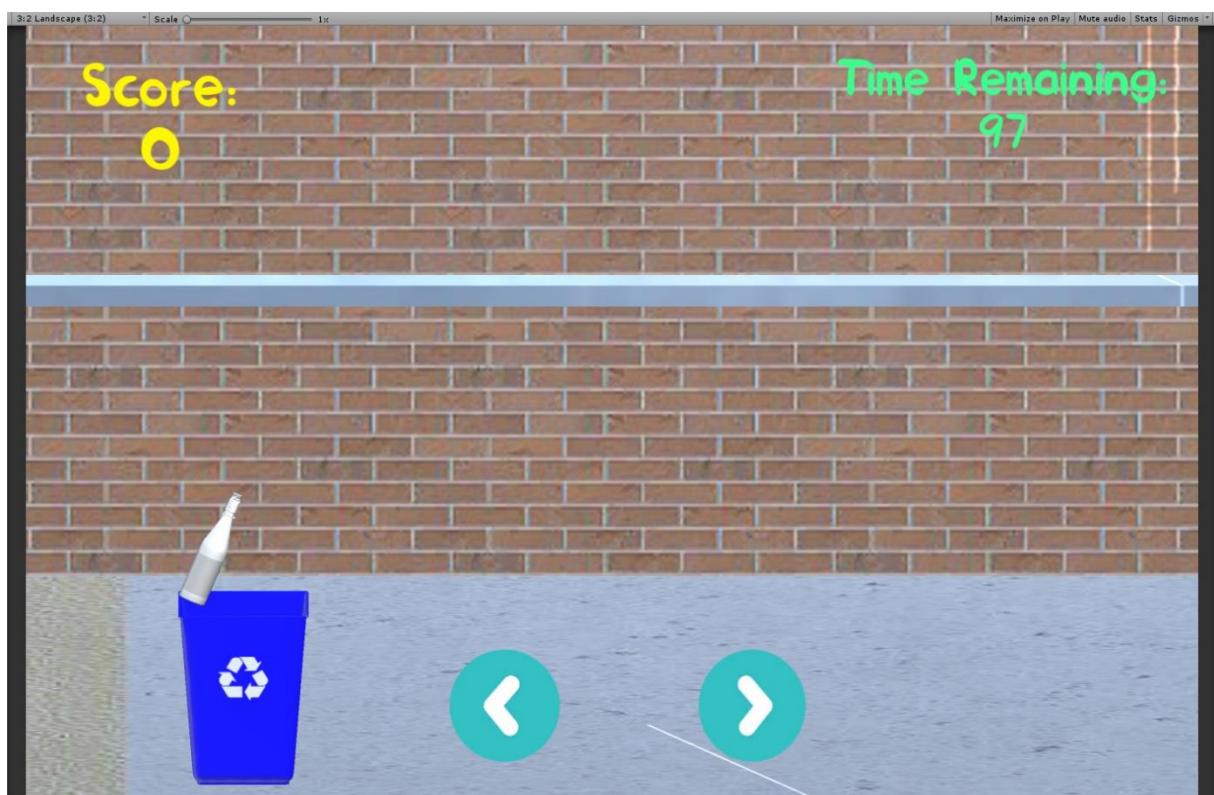


Figure 20: In the Game



Figure 21: Game Paused



Figure 22: Game Finished

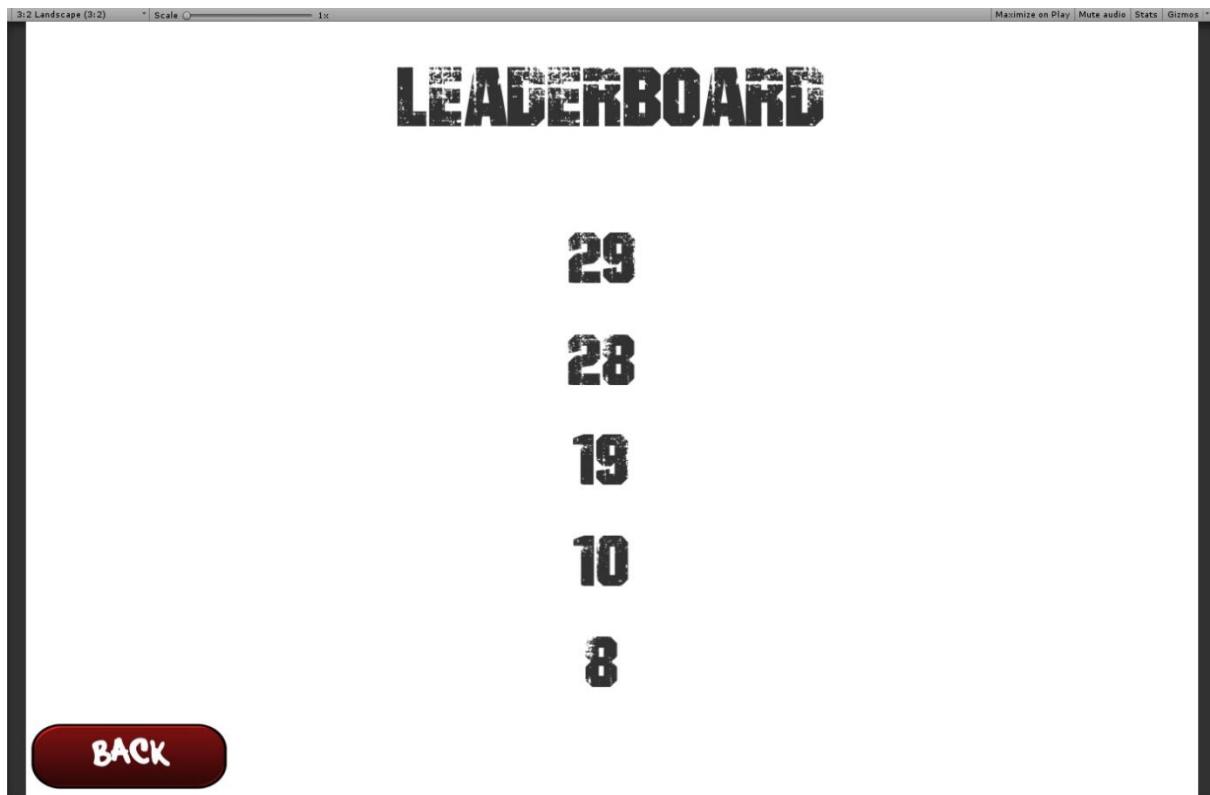


Figure 23: Leaderboard Implementation

4.2 Script

There is a total of 18 scripts that were implemented into this game, they include:

- Random item spawn
- Character controls
- Button navigation
- Sounds
- Point system

All scripts are built in Microsoft Visual Studio, using a scripting language called c-sharp. The reason to use Microsoft VS, due to the features it has when writing the code. Skins can be selected to suit your needs when creating codes, from the beginning when the engine is loading up. Also, it is much easier to identify an error instantly, with a red squiggly line, and provide solutions to help a user to fix it immediately.

4.3 Assets

In a total of 14 assets were used to build this game. Unfortunately, due to the limitation of my skills and knowledge using a modelling engine, all assets were downloaded from online. However, all assets are free to download and use for educational purposes. All assets are from TurboSquid and links will be available on the reference page.

4.4 Sounds

Only 1 background music and 2 sounds were used for this game. Sounds are also downloaded from online and are freely used for educational purposes. The sounds will be provided in the reference page with a link.

4.5 Particles System

Only 1 particle system was created for the game. The smokes effect in main menu scene was created with Unity starter pack. It was used to build a more realistic scenery in the scene. At below is a print screen of the particle.

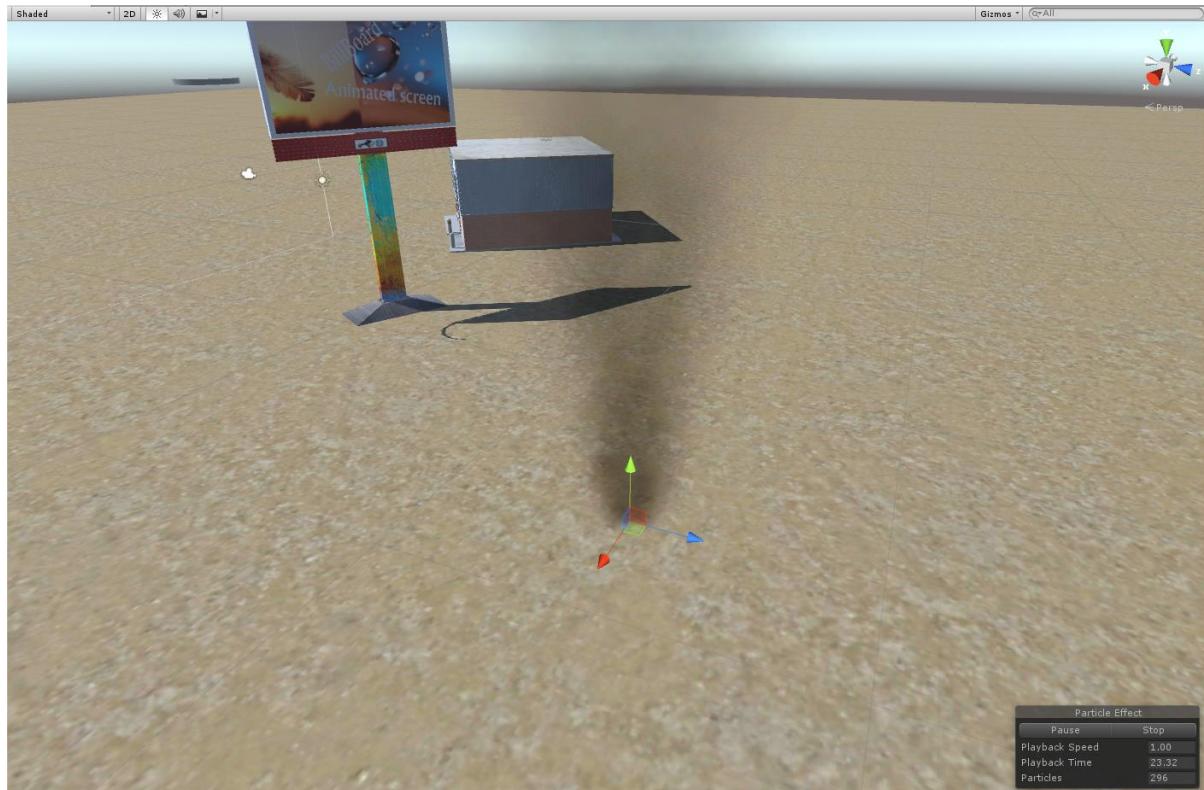


Figure 24: In Game Particles

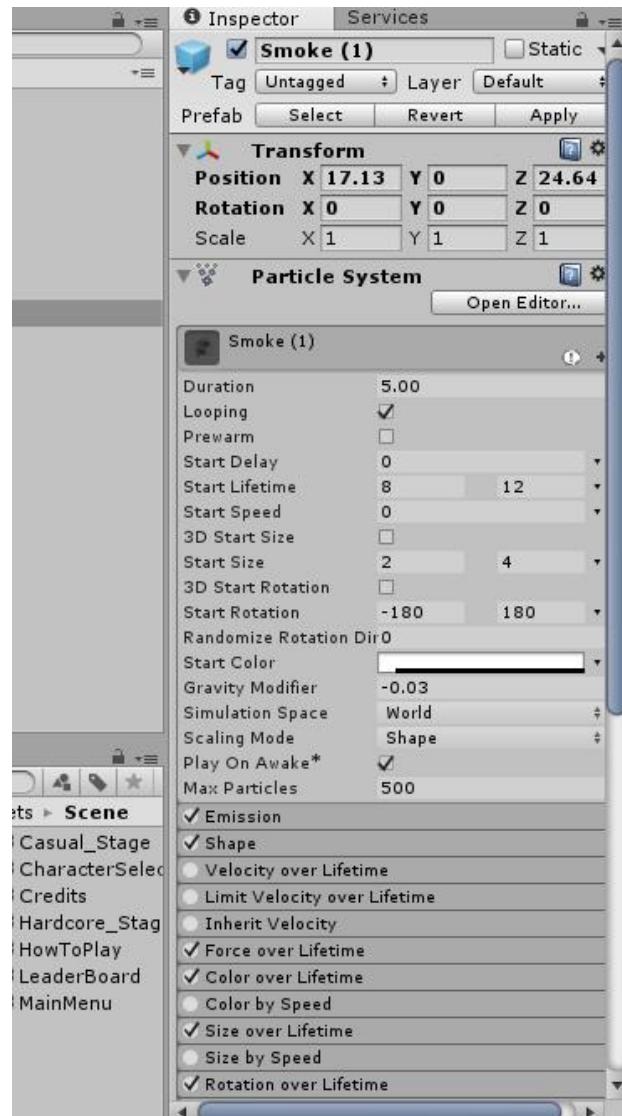


Figure 25: Particles System Inspector

4.6 Control

The control scheme remains unchanged from the design.

4.7 Fonts

There are 4 different types of font were used for creating the game. All fonts are downloaded from online and are free to use for educational purposes. All fonts will be provided in the reference page with a link.

5. TESTING

5.1 Black Box Testing

Before the game is used for the interview, it is necessary to ensure that the game does not have many bugs and errors. Testing will be covered by using black box testing on the game. The following areas of the game are what will be tested:

1. Does the game compatible with the screen size in most of the smartphone devices?
2. Are all the buttons in the game functioning properly?
3. Are the controls working correctly?
4. Does a new high score will be saved and it will display on the leaderboard?
5. Is the loading of the game works probably?
6. Is the random rubbish spawn generator is working correctly?
7. Will the times Up menu pop out when the countdown reach to 0?
8. Does a sound play when it is clicked?
9. Will the score go to add or minus accord to the bin that the player is currently using and the rubbish that has just collected?

5.1.1 Screen Size

As today's smartphones, there are lots of different sizes of screen, which a game must be able to be compatible with most of the different screen sizes. In this testing, different screen resolutions are tested to assure the game can still play properly.

Low Screen Resolution



Figure 26: Main Menu Resolution: 400x320



Figure 27: Game Play Resolution: 400x320

Portrait Screen Resolution



Figure 28: Main Menu Resolution 600x1024

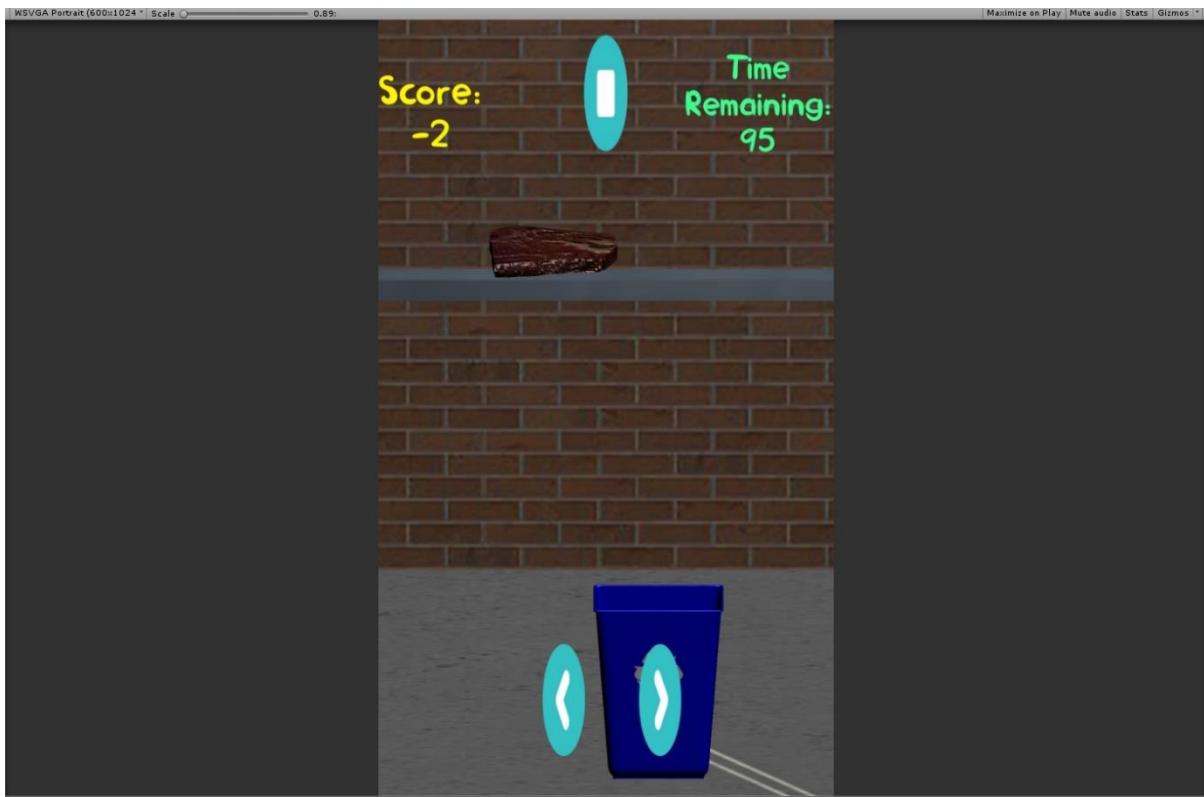


Figure 29: Game Play Resolution 600x1024

As expected, by placing the anchors on the GUIs at the correct position, all the game components are still operating in a correct behaviour. Although the GUIs and assets in the resolution of 600 by 1024 look crunched, but texts are still readable, game mechanics are working perfectly. Overall, using two most difficult screen resolution settings, the game is still able to play smoothly.

5.1.2 Buttons' functionality

To verify that all buttons are navigating correctly, a check will be carried out as for approval reasons.

Table 2: Black Box Testing on Buttons

Button	Tested?	Correctly?
Play Game	✓	✓
Leaderboard	✓	✓
How to Play	✓	✓
Credits	✓	✓
Quit (Main Menu)	✓	✓
Causal Stage	✓	✓
Hardcore Stage	✓	✓
Back (Stage Select)	✓	✓
Back (Leaderboard)	✓	✓
Back (How to Play)	✓	✓

5.1.3 Controls

The controls for the game are working smoothly throughout the test.

5.1.4 Setting a high-score

A gameplay will be performed to check whether the game notices that a new high-score is created. If noticed, the score should save in a local file of the game. When clicking on to the leaderboard, the script should run two for-loops. The first loop checks all five high-scores in an ascending order, and place the new high-score under those scores which are greater than it. The second loop displays the new set of high-scores ascendingly, in the leaderboard.

This is a most crucial test to do; therefore, it is one of the most important game elements that makes the game really challenging to play.

Before



Figure 30: Leaderboard Before Implement a High-score

After

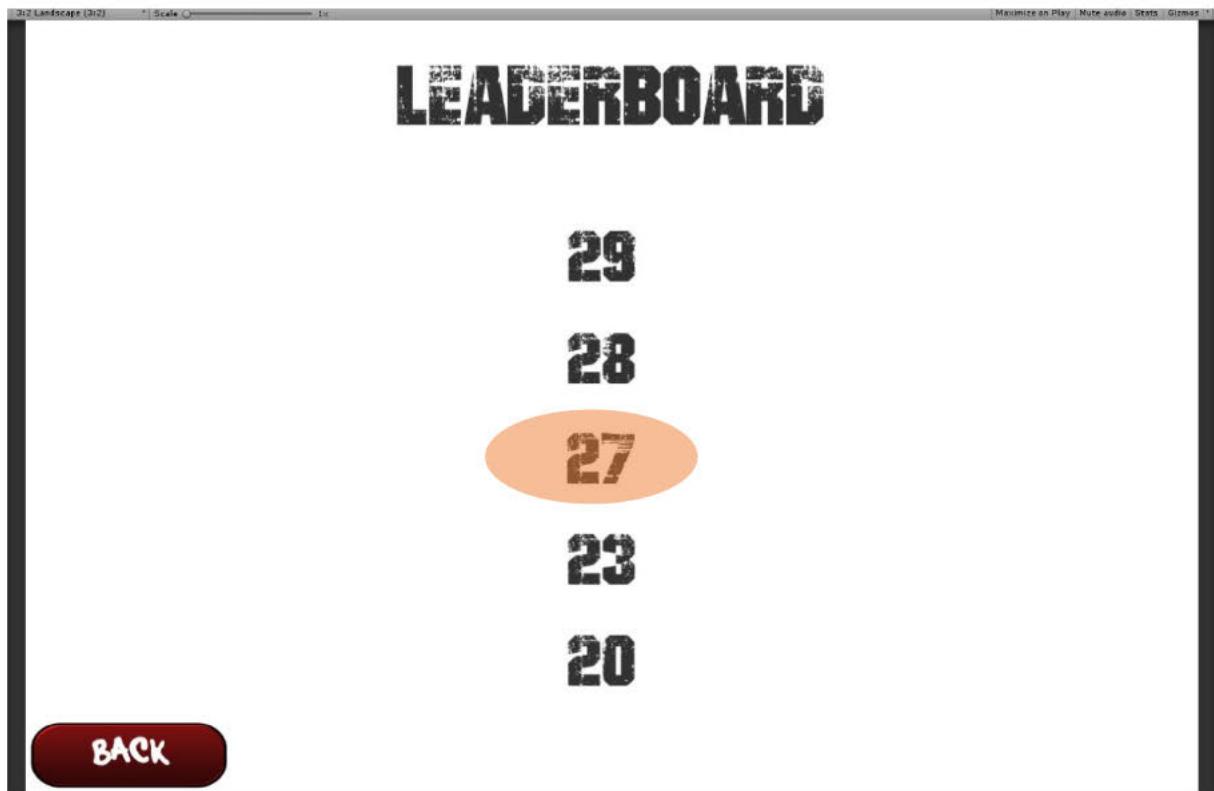


Figure 31: Leaderboard After Setting a New High-score

After playing the game and obtained a score of 27. As it predicted, the new score is displaying on the leaderboard, as well as the lowest high-score, 19, is knocked off from the leaderboard.

5.1.5 Loading Screen

From Implement Section, the print screens in Figure 3 and Figure 4 shows no sign of errors exist during the load up progress. To make sure that it is running correctly, several times of loading the game were tested. Thus, it ran smoothly and was expected no errors have occurred during the test.

5.1.6 Random Item Generator

The test will include several of restarts in the Unity Engine. By adopting this method, hopefully, it should see a different item is spawned and it spawned in a different location every time the game is restart.

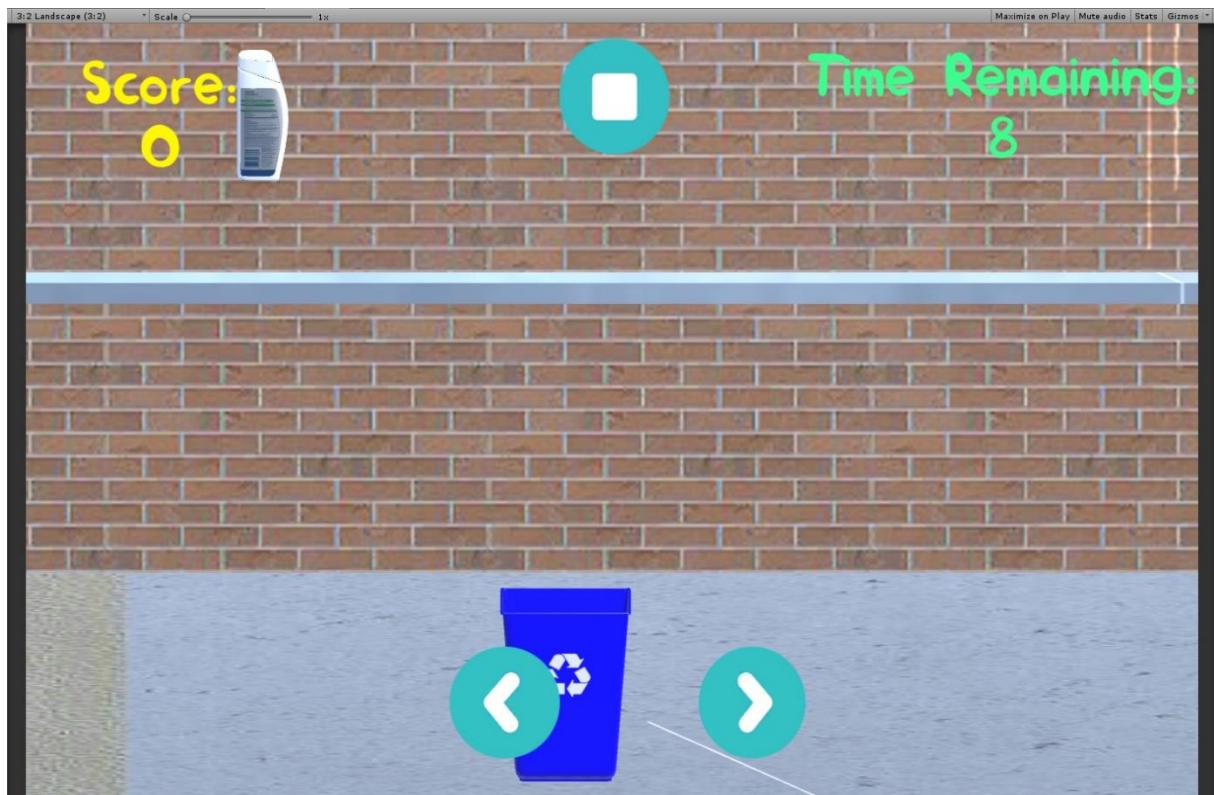


Figure 32: Restart 1

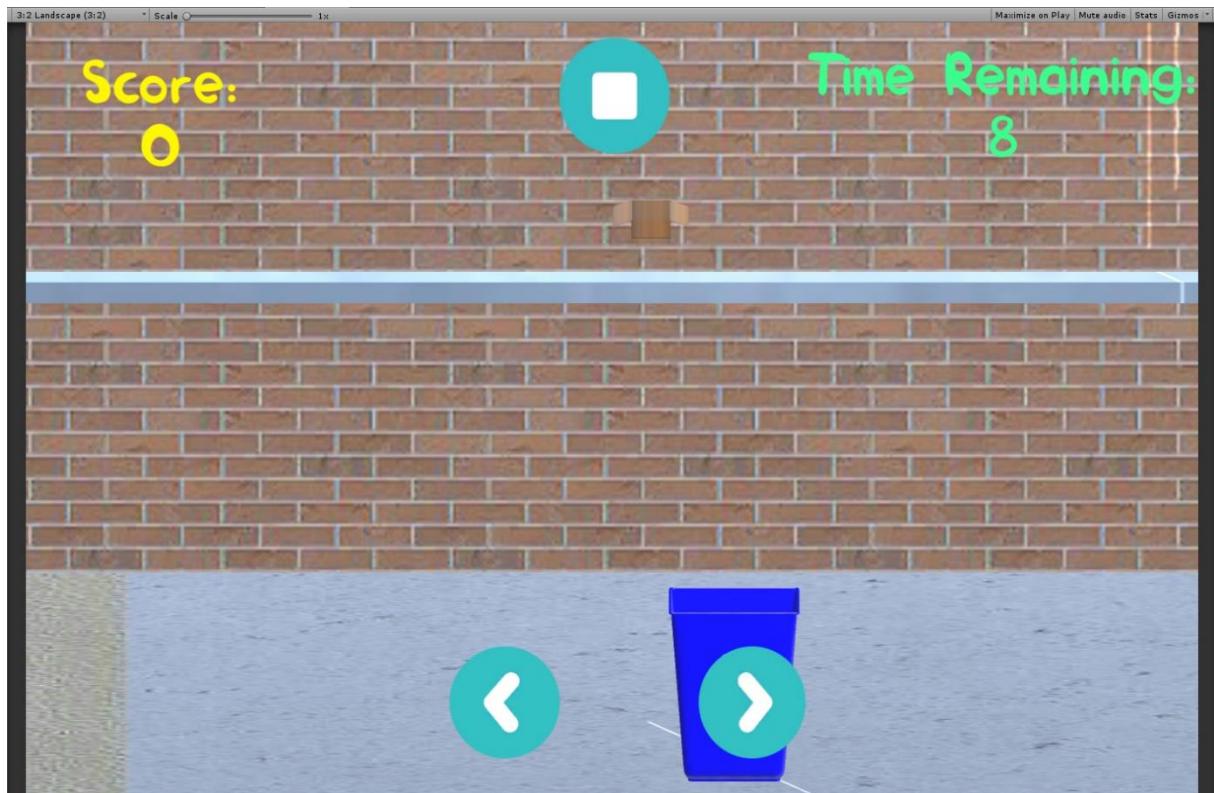


Figure 33: Restart 2

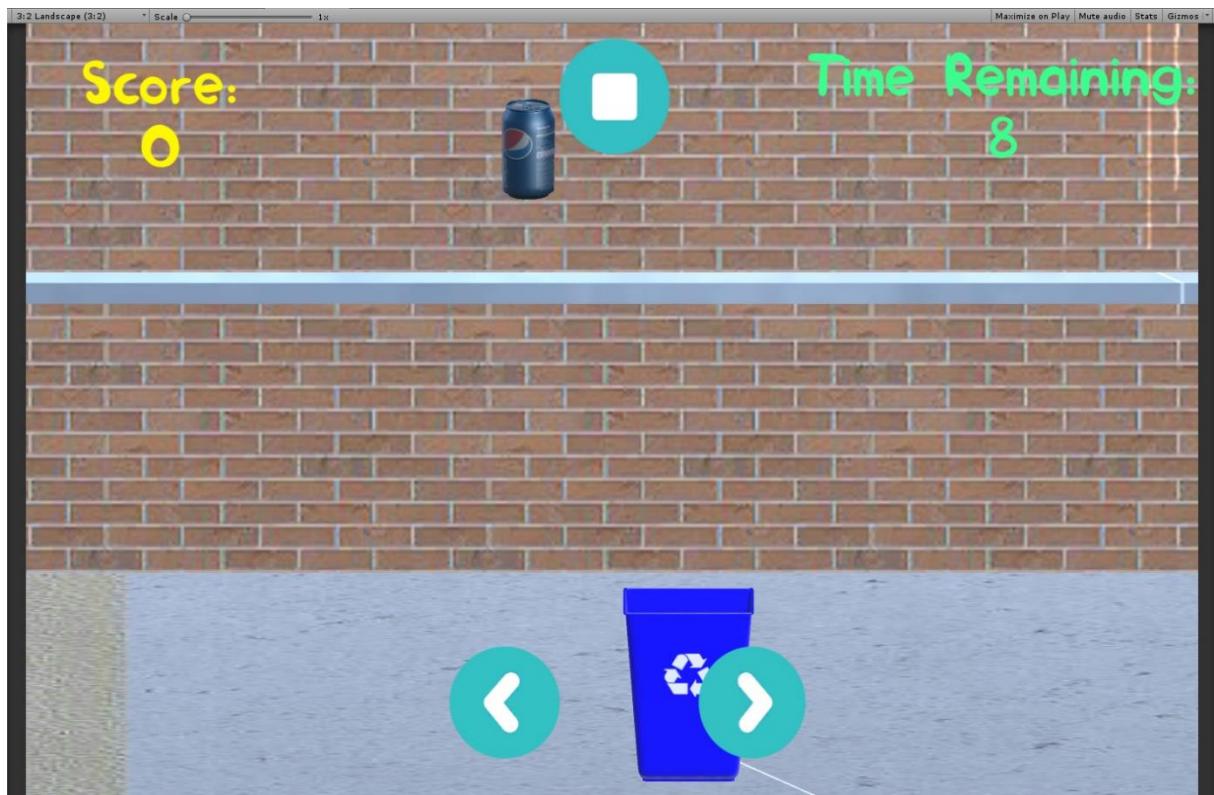


Figure 34: Restart 3

In a total of 3 restarts was made for the test. As expected, rubbish was different every time and the location of spawn was also changed when the game is restart.

5.1.7 Time Up Menu Pop-up

In this test, a mini game play is made to verify that the Times Up menu will set to visible once the timer reaches to 0; also, the random item generator should stop spawning items out in the game.

Before reaches to 0

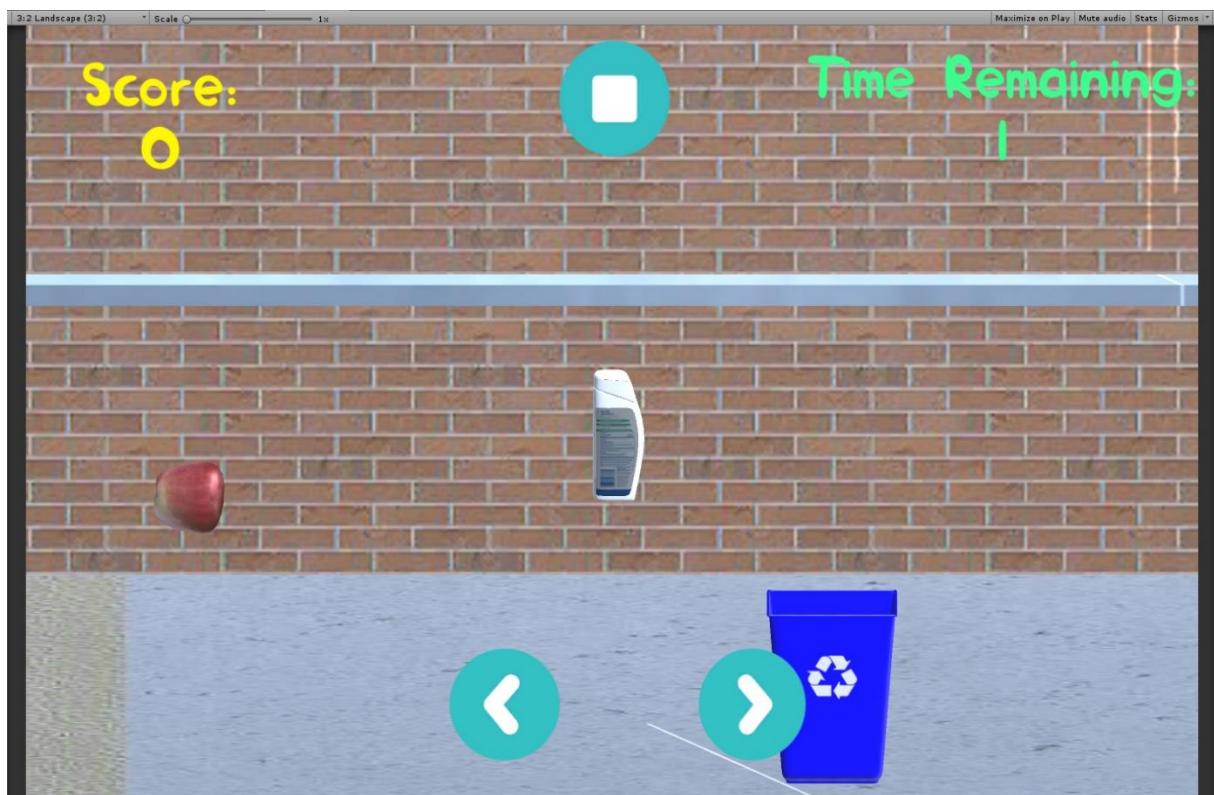


Figure 35: 1s Remaining

When reached to 0



Figure 36: 0s Remaining

As expected, when the game reaches to 0, the Times Up menu is showed (Figure 8) and no more rubbishes are spawned in the game.

5.1.8 Clicking Sound

This was tested during when verifying the buttons' functionality are working properly. A sound was played every time when a button was clicked.

5.1.9 Add/Monus Scoring System.

A black box testing is adopted to check will a point is added up when collecting a rubbish with the correct bin; in addition to a point is deducted if a rubbish was collected with the incorrect bin. Checks are applied to all rubbishes to see will the score add or minus correctly when is collected by one of the recycling bins; in addition, the same process goes the same with the other two bins.

6. INTERVIEW

6.1 Purpose

The main purpose of having this interview is to find out how good the playability of this game is and to determine whether introducing recycling games on smartphones can promote recycling more effectively than other social medias.

6.2 Design the Questions

The design of the questions will be a focus on the aims and objectives of this report. There will be two questionnaires, but both will be very different. The first questionnaire is to test how good the playabilities are, in the game. The second questionnaire is to determine whether there is a potential to promote recycling in the mobile game market.

6.2.1 First Questionnaire Procedures

1. Participants will be given a questionnaire from the start. They can only read the questions and cannot answer them until they have tested the game.
2. Participants will be asked to go on the How-to-Play mode before they start the test.
3. To ensure data has gathered accurately, all participants will test the game on hardcore stage.
4. Once participants have finished the game, then they can start the questionnaire.

6.2.2 Second Questionnaire Procedures

1. Participants will be given a questionnaire from the start. They must fill in the first four questions before playing the game.
2. Participants will be asked to go on the How-to-Play mode before they start the test.
3. To ensure data has gathered accurately, all participants will test the game on hardcore stage.
4. Once participants have finished the game, they must fill in the other four questions in the questionnaire.

6.3 What Participants can do?

- Pay attention to the instructions given by the interviewer as proceeding the game.
- Read through the questions carefully, before answer it.
- Read through the Participant information sheet carefully.
- Play the game like you would normally with other games.
- Notify the interviewer anytime during the test with a hand wave sign.
- The participant must try to answer all the questions in the questionnaire.

6.4 Gathering the Results

To ensure that the answers are reliable, participants are randomly selected regarding their knowledge with recycling and experience with gaming. However, if the participant fails to provide truthful answers during the test for any reason, those answers allow to discarded without the need to inform the tester, and they will be removed to prevent further unreliable results before the analyse at the evaluation stage.

6.5 Final Design of the questionnaires

Questionnaire

1. On a scale of 1 – 5, where 1 is poor and 5 is great, how do you feel about the controls in this game?
1 2 3 4 5
2. How easy did you find when trying to collect the rubbish into the bin? If not, why?

3. Was it easy to distinct the rubbish as they are falling? (Circle only one answer)
Very Hard
Hard
Fine
Easy
Very Easy
4. Was it easy to switch between the recycling bins, during the gameplay?
Yes / No
5. To increase the challenge for this game, which of the following options would you say you enjoy the most?
Increase the time.
Increase the number of rubbish falling.
Having a special rubbish to earn big points.
Throwing rubbish from left and right, as well as falling from the top
6. By introducing leaderboard in the game, did it make the overall gameplay much more competitive? If not, why?

Figure 37: Questionnaire 1

Figure 1 is a screenshot of questionnaire 1 final design. The design in the questions is mainly focused on the overall game experience, which results will be used to improve the game later in the stage. Once the game has altered, it will be used for the next interview.

Questionnaire

The following questions are answered before the participant have played the game....

1. How did you know about recycling?
 - At School
 - Television Advertisement
 - Articles
 - Newspaper
 - Internet
 - Other: _____
2. Have you play any recycling game before?
Yes / No
3. From a scale of 1 – 5, how would you say about yourself know recycling?
1 2 3 4 5
4. Which type of rubbishes goes into which recycling bin (please answer as the best you can):
 - Brown Bin: _____
 - Blue Bin: _____
 - Green Bin: _____

The following questions are answered after the participant have played the game....

5. Which type of rubbishes goes into which recycling bin (please answer as the best you can):
 - Brown Bin: _____
 - Blue Bin: _____
 - Green Bin: _____
6. After playing on the game, from a scale of 1 – 5, how well do you know about recycling now?
1 2 3 4 5
7. Did you feel that after playing on the recycling game, you understand recycling more than it is being taught at school, newspaper, television advertisement, etc.?
Yes / No
8. Was overall of the game (mechanism, leaderboard, background music) encouraging you to try recycling more?
Yes / No

Figure 38: Questionnaire 2

Figure 2 is a screenshot questionnaire 2 final design. As mentioned before, there are two parts which require the participant to fill in the answers before and after playing the game. Questions mainly focus on the influence of the outcomes after the participant has played the game, i.e. will participants have a better understanding of the bins' colour code, after they played the game, or not?

6.6 Results

6.6.1 Questionnaire 1

Question 1: On a scale of 1 – 5, where 1 is poor and 5 is great, how do you feel about the controls in this game?

Participant 1: 5 out of 5

Participant 2: 4 out of 5

Participant 3: 5 out of 5

Participant 4: 4 out of 5

Participant 5: 3 out of 5

Question 2: How easy did you find when trying to collect the rubbish into the bin? If not, why?

Participant 1: It's OK

Participant 2: Bins are too small

Participant 3: Bins are too small

Participant 4: Rubbish keeps fall out of the bin

Participant 5: Very hard to collect the rubbish

Question 3: Was it easy to distinct the rubbish as they are falling? (Circle only one answer)

Participant 1: Easy

Participant 2: Fine

Participant 3: Easy

Participant 4: Easy

Participant 5: Fine

Question 4: Was it easy to switch between the recycling bins, during the gameplay?

Participant 1: Yes

Participant 2: No

Participant 3: Yes

Participant 4: No

Participant 5: No

Question 5: To increase the challenge for this game, which of the following options would you say you enjoyed the most?

Participant 1: Having a special rubbish to earn big points.

Participant 2: Increase the number of rubbish falling.

Participant 3: Having a special rubbish to earn big points.

Participant 4: Throwing rubbish from left and right, as well as falling from the top

Participant 5: Throwing rubbish from left and right, as well as falling from the top

Question 6: By introducing leaderboard in the game, did it make the overall gameplay much more competitive? If not, why?

Participant 1: Yes

Participant 2: Yes

Participant 3: Yes

Participant 4: Yes

Participant 5: Yes

6.6.2 Questionnaire 2

Question 1: How did you know about recycling?

Participant 1: At school, Television Advertisement, The Internet.

Participant 2: From household bins

Participant 3: At School

Participant 4: At School, The Internet

Participant 5: At School

Participant 6: Television Advertisement, Newspaper, The Internet

Participant 7: At School

Participant 8: At School, The Internet, Newspaper

Question 2: Have you played any recycling game before?

Participant 1: Yes

Participant 2: No

Participant 3: Yes

Participant 4: Yes

Participant 5: Yes

Participant 6: No

Participant 7: No

Participant 8: No

Question 3: From a scale of 1 – 5 (poor – great), how would you say about yourself know recycling.

Participant 1: 3 out of 5

Participant 2: 5 out of 5

Participant 3: 4 out of 5

Participant 4: 4 out of 5

Participant 5: 4 out of 5

Participant 6: 3 out of 5

Participant 7: 3 out of 5

Participant 8: 3 out of 5

Question 4: Which type of rubbish goes into which recycling bin (please answer to the best you can).

Participant 1: Brown Bin: Plastic, Blue Bin: Paper, Green Bin: General Waste

Participant 2: Brown Bin: Plastic/Cans, Blue Bin: Cardboard/Paper, Green Bin: Food/ General Waste

Participant 3: Brown Bin: Glass, Blue Bin: Cardboard, Green Bin: Garden Waste

Participant 4: Brown Bin: Bottles/Tins, Blue Bin: Paper, Green Bin: Garden Waste

Participant 5: Brown Bin: Glass, Blue Bin: Cardboard/Paper, Green Bin: Biodegradables

Participant 6: Brown Bin: Plastic, Blue Bin: Glass, Green Bin: General Waste

Participant 7: Brown Bin: Paper, Blue Bin: Glass, Green Bin: General Waste

Participant 8: Brown Bin: Books/Cardboard, Blue Bin: Bottles, Green Bin: Food Waste

Question 5: Which type of rubbish goes into which recycling bin (please answer to the best you can).

Participant 1: Brown Bin: Plastic, Blue Bin: Paper, Green Bin: General Waste

Participant 2: Brown Bin: Plastic/Cans, Blue Bin: Cardboard/Paper, Green Bin: Food/ General Waste

Participant 3: Brown Bin: Plastic, Blue Bin: Paper, Green Bin: Food

Participant 4: Brown Bin: Tin, Blue Bin: Plastic, Green Bin: General Waste

Participant 5: Brown Bin: Tin, Blue Bin: Paper, Green Bin: General Waste

Participant 6: Brown Bin: Plastic, Blue Bin: Paper, Green Bin: Food Waste

Participant 7: Brown Bin: Plastic/Tin, Blue Bin: Cardboard, Green Bin: Food Waste

Participant 8: Brown Bin: Glass, Blue Bin: Paper, Green Bin: Food Waste

Question 6: After playing on the game, from a scale of 1 – 5, how well do you know about recycling now?

Participant 1: 5 out of 5

Participant 2: 5 out of 5

Participant 3: 5 out of 5

Participant 4: 4 out of 5

Participant 5: 5 out of 5

Participant 6: 5 out of 5

Participant 7: 5 out of 5

Participant 7: 4 out of 5

Question 7: Did you feel that after playing on the recycling game, you understand recycling more than is being taught at school, newspaper, television advertisement, etc.?

Participant 1: Yes

Participant 2: Yes

Participant 3: Yes

Participant 4: Yes

Participant 5: Yes

Participant 6: Yes

Participant 7: Yes

Participant 8: Yes

Question 8: Was overall of the game (mechanism, leaderboard, background music) encouraging you to try recycling more?

Participant 1: Yes

Participant 2: Yes

Participant 3: Yes

Participant 4: Yes

Participant 5: Yes

Participant 6: Yes

Participant 7: Yes

Participant 8: Yes

7. Evaluation

7.1 Questionnaire 1

7.1.1 Question 1

Although the game can introduce the tilt left and right control features, but it seems that most participants did not feel frustration when using the touchscreen to control the game. Only participant 5 gave a score of 3 for the controls, though this is still good since it is an average score. The control will not be going to change since almost all participants are happy to use the touch screen for the controls.

7.1.2 Question 2

It seems there is an issue with the bins, which are being too small when try to catch the falling rubbish. Participant 4 has mentioned that “Rubbish keeps fall out of the bin” when trying to catch it.

To improve the game, perhaps increase the size of the bins by a tiny amount bigger can make the game more acceptable to play. Also, a collision script can be added to the bins, so the rubbish is less likely to slip off the wrong side.

7.1.3 Question 3

The results showed significant participants can distinct the rubbish while they are falling. This proofs the speed of the rubbish are falling is acceptable since the participants can see it falling and have time to decide whether to catch it or avoid it. Thus, no necessary changes will be made.

7.1.4 Question 4

It appears that more than half of participants stated the switching between different recycling bins during in gameplay was not easy to do. Most participants are confused, when they are trying to switch to a correct bin despite the fact there are no notifies to inform the participant which bin is coming next, only arrows are used to switch between previous and next bins.

7.1.5 Question 5

From the result, it seems there is a clash between having a special rubbish to earn big points and throwing rubbish also from the left and right side too. Both features are unique in their individual perspective to make the game much exciting to play. However, if have choose one, throwing rubbish from left and right side will be better. Therefore, players must be more caution with rubbish throwing from sides. Although having a special rubbish to earn big idea is not a bad idea, but the concept of game memorise what rubbishes go to what recycling bin. So, introducing the special rubbish feature will only make people focus on that specific type of rubbish, but not the other rubbish that goes into the same bin.

7.1.6 Question 6

All participants agree that having a leaderboard can make overall of the gameplay more competitive. This is good since players are likely to spend more time to master the level to gain higher scores than others. This is likely to develop a habit of memorising each rubbish to go into which one of the recycling bins; in addition, people are likely to know the difference of the 3 recycling bins.

7.2 Changes in the Game

After gathered the results from Questionnaire 1, it seems there are a few playabilities in the game need to improve. Changes must be all made before moving on to Questionnaire 2 as it determines whether promoting recycling in 3D mobile-based app is more efficient than in other platforms.

7.2.1 First change

In question 2, many participants mentioned that they find it difficult to catch the falling rubbish into the bin because the size of the bins is too small. To solve this problem, all bins will increase by a small amount of portion, so that players will have better chance to catch a rubbish. The reason of not scale down the size of the rubbish as participants can distinct the rubbishes easily, if scale the sizes down may cause it difficult to see.

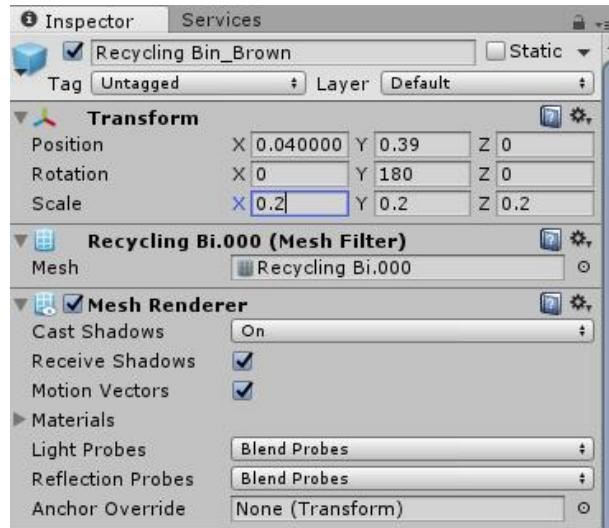


Figure 39: Before: Brown Bin Inspector

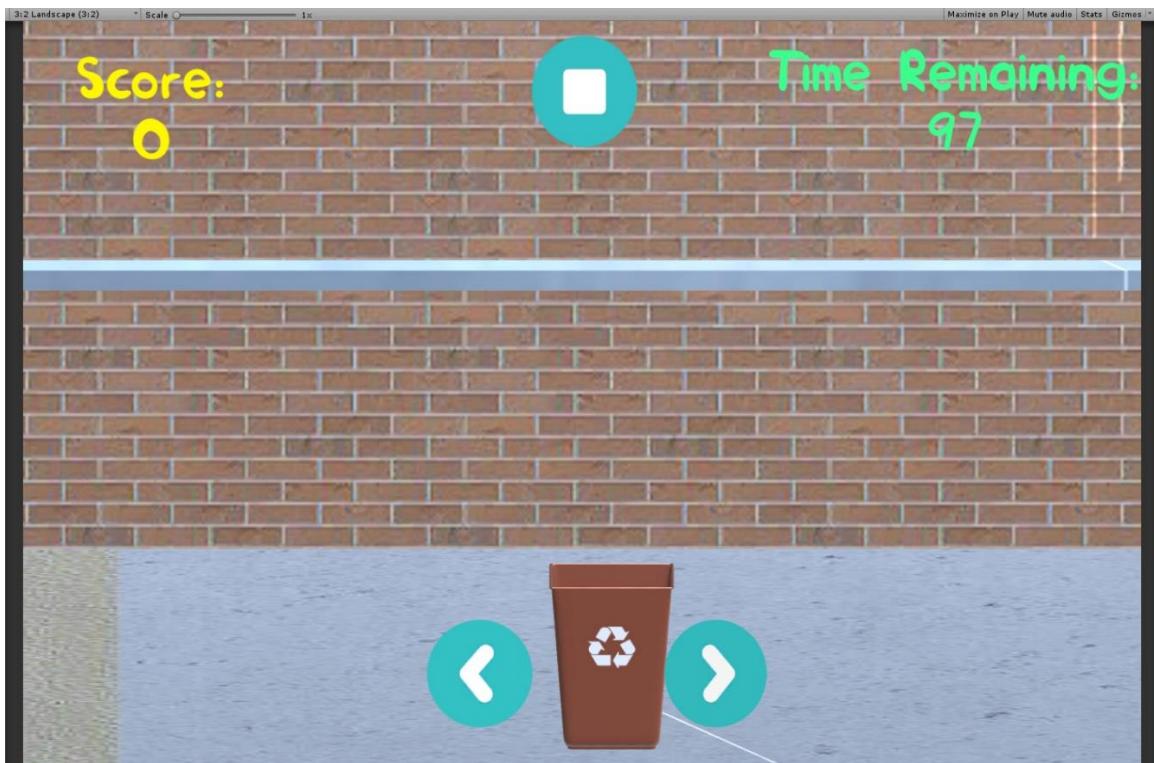


Figure 40: Before: Brown Bin in Game Level



Figure 41: After: Brown Bin Inspector

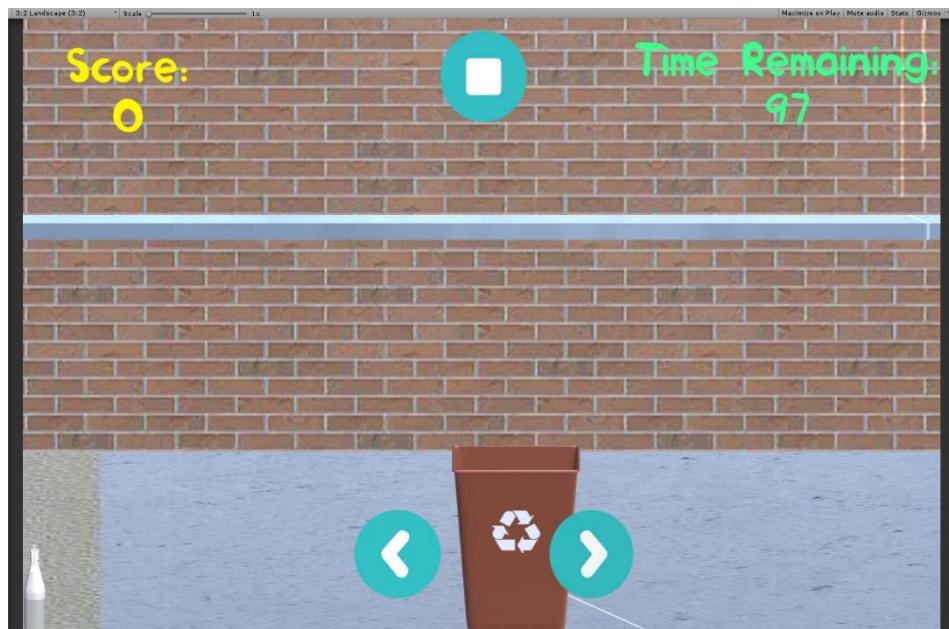


Figure 42: After: Brown Bin in Game Level

Comparing with *Figure 2* and *Figure 4*, the brown recycling bin has increased by 0.05 on the scale, which the increase is very small. Increasing the size too much may, thus, making the game too easy and no challenge to motivate players to carry on.

7.2.2 Second Change

Another change was introduced by question 5 when asking participants which of the following features they will want to see in the game, and the decision was to go for "*Throwing rubbish from left and right, as well as falling from the top.*"

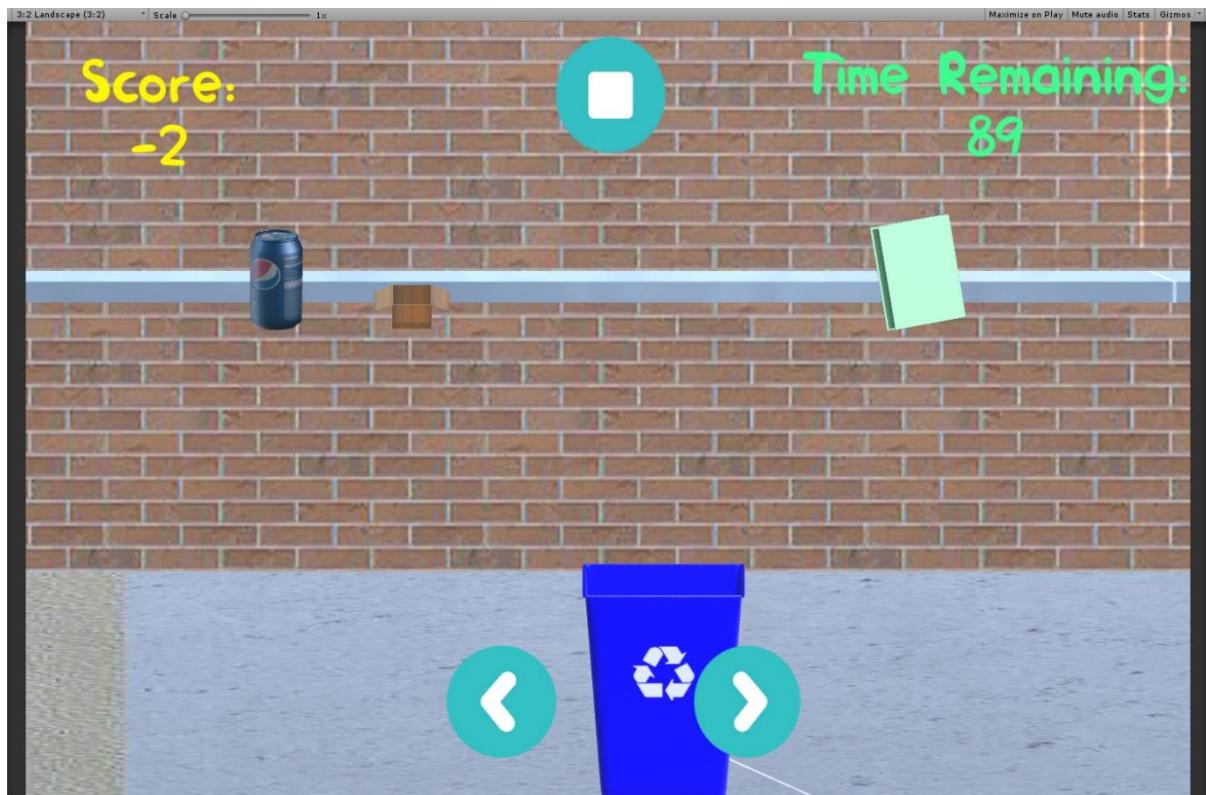


Figure 43: Rubbish throwing from left and right

Figure 5 is a print screen of the gameplay after it has implemented a script that can spawn rubbish from left and right. Like generate the rubbish system where it spawns from the top of the screen, but the new script throws a rubbish at both sides. The generator also has a random time before throws a rubbish out again.

7.3 Questionnaire 2

7.3.1 Question 1

Almost all the participants learned about recycling were during at school. This is understandable as schools mainly use recycling bins rather than normal bins since they are trying to encourage pupils to develop a habit of recycling. Results have also shown that a significant number of participants learnt about recycling with more than one method.

7.3.2 Question 2

There are exactly 50% of the participants in the interview said that they have played some sort of recycling games before. This is a surprising figure as this shows there are exist recycling games, through the activities in school or online.

However, the rest of the 50% stated they have never played a recycling game before. This implies to the availability of resources. Although there are other resources, such as internet and newspaper, but if recycling was also promoted as a mobile-based game, then the awareness may increase even further.

At this stage, no discoveries are made until participants give their thoughts and views after they have played the game.

7.3.3 Question 3

Most of the participants said that their knowledge about recycling is in the average level, 3 out of 5. Though some of them mentioned that they were taught by schools, but they do not think that they know enough about recycling. This suggests promoting recycling at school may not be necessary the leading way, as people will forget in the end.

Another way is to educate people how to recycle through the play of a game. Therefore, as mentioned in Literature Review, educational games take the fun out of learning and place it into a game. Furthermore, since the gaming market is rapidly increasing in mobile and people go on their smartphone most of the time, this could be a new opportunity to promote recycling as a game in the mobile market. However, this cannot be proofed until participants have played the game.

7.3.4 Question 4

Although some stated in question 3 that their knowledge about recycling was in a level between average to good (average of 3 out of 5), but evidence shown that most participants able to distinct the types of rubbish go into which colour of recycling bins.

Almost all the participants able to responded with a correct answer when asked to state one type of rubbish that goes in the Green Bin. This respond is reasonable since green recycling bin are commonly known for general waste (e.g. food) in the community.

On the other hand, some of the participants were a little confused between the brown bin and blue bin. When analysing the incorrect answers that those participants have provided, they look very similar. Participant 7 and 8 answered incorrectly due to a little mixed up between the two bins, whilst participant 6 only made one error by given an incorrect type of rubbish for the brown recycling bin. But, hopefully, these answers will be changed after participants have played the game.

7.3.5 Question 5

Although many answers were same as before, but the ones who got the answers incorrect have realised their mistakes and have provided a correct answer for each individual bin after playing the game. This is a good result, as there are pieces of evidence of people showing more awareness of recycling after they have played the game. Furthermore, it proofs promoting recycling as a mobile game can be efficient as other resources.

7.3.6 Question 6

The confident of the participants has slightly gone up after playing the game. Almost all the participants stated a 5 out of 5 score and only participant 4 and 7 gave a 4 out of 5 scores. Comparing with Question 3, it verified that participants can understand the topic more after they have played the game, as they gained more confidence while they were engaging with the game.

7.3.7 Question 7

All participants have said that they understand recycling much better after playing the game. This is an excellent result. By combining all research from Literature Reviews and implemented it to the game, it seems the game is educating people very effectively. This shows the correct components added to the game, it can turn learning into fun. Also, it could be a new opportunity for promoting recycling.

7.3.7 Question 8

Overall, all participants did enjoy the recycling game and would like to play the game again. This is reasonable since the game was tested before the interview stage, the game should have no error or

bugs. However, it seems that the leaderboard and background music did make the game a little more encouraging to play.

8. CONCLUSION

8.1 Problems and Issues

There were many problems occurred throughout the time working on this project. Most of the problems largely occurred during at developing stage to testing stage when creating the project. One major bug occurred was when implementing the script for spawning rubbish at the sides. When spawning a rubbish out, the script will randomly select a rubbish from the array then spawn it out to the game. However, since the gravity of the prefabs (rubbish) are not multiplying with the force, which no matter how many forces were added, it would not throw itself into the game. But instead, it will just fall vertically down and missed the view of the camera.

Another major problem was building the game on to the mobile and testing on it. Although switching the prototype from Windows version to mobile version was simple, since the Unity will automatically convert all the files when switching to a different platform. However, when trying to publish the game out, it requires few components before it can let tester to put the game into a mobile and test it, which they are: SDK and JDK. Before downloading the SDK, it is necessary to find out which android version are used for testing as it saves time to redownload the correct version. For JDK, different SDK file and Unity engine work with different JDK, which may require downloading different JDK before it can build the prototype onto the mobile.

8.2 Personal Preference

Overall, I feel that the report was very successful. Therefore, it has met what does it need to investigate, and it has satisfied most aims and objectives at the beginning of this report, in the **Terms of Reference**. The project was also developed very successful, despite the game was first time created on the mobile platform, which it will be unique. Plus, participants in the interview enjoyed the game very much, which was mentioned in the **Evaluation Stage**.

Throughout the report and project, other than studying some topics about recycling, I discovered how educational and serious games can motivate a player to learn while playing on it. What game elements can increase the game more competitive to play and how you can take the fun out of something boring and turn it into something fun to do while making a player to learn. Also, I learned how to build a game on the mobile platform, with the correct implement of SDK, JDK and anchors (for resolution purposes).

However, if I have to do the project again, perhaps introduce avatars during the levels. Every time when the player collects a certain amount of points, the avatar will give an expression or a comment as an encouragement feedback. Second changes, since virtual reality was introduced a few years ago and its market is still at the growing stage, perhaps this is another new opportunity to promote recycling so that it has a larger range of diverse promotion.

8.3 Summary

After investigate on why recycling game is very unpopular in the educational market, this project was created to discover whether this is an opportunity for recycling to promote itself as a 3D game in mobile-based app more effectively. Throughout developing this project, aims and objectives have considered from the report to ensure an excellent product is delivered in most of the aspects. Significant of testing and interview were also applied during the development stage of the

prototype. If require a much reliable result in the future, the number of participants can increase with the same tests used in this report.

Bibliography

1. http://www.manchester.gov.uk/info/200084/bins_rubbish_and_recycling/6026/see_which_recycling_bin_to_use
2. <https://www.recyclingbins.co.uk/recycling-facts/>
3. <https://www.turbosquid.com/>
4. <http://www.bbc.co.uk/education>
5. <https://www.freesound.org/>
6. <http://www.dafont.com/>

REFERENCES

1. BBC Bitesize (2014) *The Recycling Game*, [Online], [Accessed on 24th October] <http://www.bbc.co.uk/schools/barnabybear/games/recycle.shtml>
2. Juul J. (2003) *The Game, the Player, the World: Looking for a Heart of Gameness*, [Online], [Accessed on 23rd October 2016] http://ocw.metu.edu.tr/pluginfile.php/4471/mod_resource/content/0/ceit706/week3_new/JesperJuul_GamePlayerWorld.pdf
3. Jonassen D.H. (2008). *Integrating learning strategies to courseware to facilitate deeper processing*. In David H. Jonassen (Ed.), *Instructional Designs for Microcomputer Courseware* (pp. 151-181). Hillsdale, New Jersey: Erlbaum.
4. Bowman, R.F. 1982. A Pac-Man theory of motivation. Tactical implications for classroom instruction. *Educational Technology* 22(9), 14-17
5. Malone, T.W. 1980. What makes things fun to learn? A study of intrinsically motivating computer games. (Report CIS-7). Palo Alto, CA: Xerox Palo Alto Research Center.
6. Heinich, R., Molenda, M., Russell, J.S., & Smaldinom, S.E. 1996. *Instructional media and technologies for learning*. (5th Ed.). Englewood Cliffs, NJ: Prentice Hall.
7. Papert, Seymour A. 1981. *Mindstorms: Children, computers and powerful ideas*. Brighton: Harvester Press.
8. Jason Allaire, PhD., associate professor of psychology at North Carolina State University and co-director of the Gains through Gaming Lab.
9. BigFishGame *Most Popular Mobile Game Genres*, [Online], [Accessed on 28th October 2016] <http://www.bigfishgames.com/blog/stats/most-popular-mobile-game-genres/>
10. ESA (2014) *Essential facts about the computer and video game industry*, [Online], [Accessed on 28th October 2016] http://www.theesa.com/wp-content/uploads/2014/10/ESA_EF_2014.pdf
11. Clark A. (2009) *Virtual Worlds, Simulation, and Games for Education: A Unifying View*, [Online] [Accessed on 29th October 2016] <http://nsuworks.nova.edu/cgi/viewcontent.cgi?article=1007&context=innovate>
12. Gayla S.K. (2011) *Educational Games*, [Online], [Accessed on 25th October 2016] <http://teachinglearningresources.pbworks.com/w/page/35130965/Educational%20Games>
13. E-learning Faculty Modules (2015) *Educational Games*, [Online], [Accessed on 12th October 2016] http://elearningfacultymodules.org/index.php/Educational_Games#Main_Contents

14. Designing Digitally (2013) *What is a serious game, gamification*, [Online], [Accessed on 14th January 2017] <http://www.designingdigitally.com/blog/2013/08/gamification-or-serious-game-whats-difference>
15. Eui Jun Jeong. Dan J. Kim. Michigan State University. USA. "Chapter 1.26 Definitions, Key Characteristics, and Generations of Mobile Games". Page 290.
16. Johannes Fromme, Research in Educational Science, Game Studies, Computer Games as a Part of Children's Culture. Page 5
17. S. Balaji. Dr. M. S. Murugaiyan. (2012), "WATEERFALLVs V-MODEL Vs AGILE: A COMPARATIVE STUDY ON SDLC", [Online], [Accessed on 3rd February]

BBC Bitesize (2014) *Gut Instinct; Questionaut*, [Online], [Accessed on 12th December]
<http://www.bbc.co.uk/bitesize/ks2/games/>

APPENDICES

Terms of Reference

The document did explain what this project attempts to investigate. The aims and objectives. Design a structured timetable with a reasonable prediction of deliverables. A list of outline all possible resources that may need for the project. A study of a game that already existed.

Learning Outcomes

- Examine mobile games, different game genres, the revolution of gamers and existing games, to develop a more appropriate game that educates people the importance of recycling.
- Reviews on mobile games and game engines to gain a good insight on how to develop a mobile game.

Research that was gathered will focus on the first bullet point of learning outcome. All researches have covered most of the topics that are listed to develop this project. Most research was covered in more depth as others since it holds more relevant information. While other research was covered as an extra topic, but it is still related to the problem that is trying to address to.

The second bullet point address on deliver the game on to a mobile. The research was conducted during at the implement and testing stage, to ensure suitable packages are installed into the game engine correctly before build the APK file.

All bullet points in the learning outcomes are very crucial; therefore, this is how it makes this project successful. Educational games are bringing the fun into learning. Unlike other genres, educational games are created for a specific purpose. Since games were introduced into the mobile game market, it has revolutionised the way people think about games. As now, some businesses and schools use games to make their people engage an activity. By combine with this two concept and apply it to the game, this can promote recycling more effectively. Both points are also suitable to target future projects, i.e. other less popular education games.

Risk Management

An attempt to design 3D models in Autodesk Maya modelling engine, and then implement them into the game. However, due to the limited skills which I have for designing models in Maya, it will take

longer to produce the models in the development stage of the game. In place of a contingency plan, instead of producing all the models manually, it will be created by a special software called Autodesk 123 Catch. It is a simple software to use and which I am familiar with, as I have used it before in the second-year assignment. Another alternative backup is finding the assets from free and educational purposes websites; however, this is the final backup if I cannot use the first contingency plan.

Following, an attempt to create the mobile game using Unreal Engine 4. Although using it will deliver the game in much more powerful and better quality, in term of the game's graphics, in the mobile app, but the older version of OS and iOS may not support the latest Unreal Engine or there is a big demand on the smartphone CPU. As a fall-back position, the game maybe created in Unity 3D, due to it has more features that can optimise the game a little to support most necessary needs, in a mobile app. However, overall I am happy with both game engines as I have used them before in previous projects.

Aim(s)

The aims of this project are to gain a good insight about games and recycling before design and develop an effective recycling game that is used to evaluate how effective if recycling was promoted in the mobile game market. Also, to cover how does the playability and usability work in games before testing it during the interview.

Objectives

Bullet points have outlined in the **Introduction** chapter; explaining how will I am going to achieve the aims using my objectives.

Timetables and Deliverables

Monthly	Deliverables
October 2016	<ul style="list-style-type: none"> • Terms of Reference • Research for suitable game engines, design software and contingency plan
November 2016	<ul style="list-style-type: none"> • Literature Reviews • Fill all the ethic forms
December 2016	<ul style="list-style-type: none"> • Analyse the resource from Literature Reviews • Produce a Design Documentation
January 2017	<ul style="list-style-type: none"> • Develop a prototype of the game • Black Box Testing • Produce an Implementation Document
February 2017	<ul style="list-style-type: none"> • Design the questionnaires • Setup the Interview
March 2017	<ul style="list-style-type: none"> • Make changes to the game based on the result • Prepare for the next questionnaire
April 2017	<ul style="list-style-type: none"> • Evaluate the results from the interviews • Finalize the conclusion and Appendices • Prepare for presentation

Table 2: Summary of the deliverables

Resources Used

Throughout the project, a different number of software and packages were used to develop the game, these are:

- Unity
- Photoshop
- Java JDK
- Android SDK

All software stated at the top are available for free downloads. However, there is some software will not work on the university computers due to versions of the software are slightly higher. Playability and usability testing will be conducted with a questionnaire and do not require any usability equipment as all the questions are included in the questionnaire. Some questions will ask participants to provide a more detailed answer. But before the testing start, a black box testing will be made to check for bugs and compile errors in the game.

Interim Report

The report has already defined what are the aims and objectives during the Introduction chapter for this project. Almost all the aims and objectives of this report are achieved. All the research, testing, results are gathered and have been analysed during the evaluation stage for this report. Also, what are the learning outcomes, which can be found in the Terms of Reference.

At below the bullet points will explain how did I achieve the objectives.

- ***Decisive analyse and critical evaluation to achieve effective results for the report.***

Throughout the research for **Literature Reviews**, the materials were carefully chosen before analyse. The critical evaluation was also achieved by developing an effective product base on the analyse from the research.

- ***Perform researches through the use of questionnaires and exist researches before carry out the evaluation.***

Questions were designed through critical analyse during the investigation, as well as when develop and implement the game. All research has been carefully examined in depth and evaluated at Literature Reviews Stage.

- ***Reviews by investigate what type of games can educate a player while playing the game.***

During the investigation for the project, I discovered that there were few types of games that aims to educate players while playing a game, these are: Educational Based Games and Serious Games. Information can be found on Literature Reviews.

- ***Create the recycling game through the use of an applicable mobile game design engine.***

In the abstract and introduction, I have clearly stated that the game will be built on the mobile platform. The implementation also showed the stages of what the game is looked like when implemented into a phone.

- ***Using an effective plan, i.e. Gantt Chat, to handle the time more efficiently.***

Gantt Chat was carefully designed and developed during the introduction. Although there were a few times where I was going off track as some stages take more time than others but with the help of the risk management I able to get on the right track in some of the stages.

- ***Analyses a suitable software development methodology to create the game.***

The project development methodologies were carefully reviewed and outline all the possible advantages and disadvantages for each of the methodologies, before deciding which is suitable to use for the project.

- ***Perform numerical techniques to the project.***

The techniques that attempted to use were mentioned in the design documentation. There are some design templates for visualising how the game will look like. In Implementation stage, it shows how do the techniques look in the actual game.

- ***Frequently of testing when building the game.***

Testing was made regular due to the nature of Agile Methodology, which is design, implement and testing. Evidence of testing is shown in the usability/playability testing.

- ***Regular back-ups in place of contingency plan for the product and the report.***

It is stated how will the project is backed up in Terms of Reference. However, backups were executed in the personal computer, USB/portable hard-drive and clouds (Microsoft OneDrive), to make sure project is safe.

Online Game Download Assets

As mentioned above in the **Implementation**, all assets are free for downloads and for educational purposes only.

Models

Table 3: Models

Name	Accessed on	Creator	Available on
Fish	15 th Jan	Krustacio	https://www.turbosquid.com/FullPreview/Index.cfm/ID/621824
Billboard	15 th Jan	Innor	https://www.turbosquid.com/FullPreview/Index.cfm/ID/870852
Factory	16 th Jan	JHoagland	https://www.turbosquid.com/FullPreview/Index.cfm/ID/762121
Meat / Apple	15 th Jan	Vinrax	https://www.turbosquid.com/FullPreview/Index.cfm/ID/740569
Box	16 th Jan	Graphex.cz	https://www.turbosquid.com/FullPreview/Index.cfm/ID/864035
Head & Shoulder Shampoo	16 th Jan	Iskren87	https://www.turbosquid.com/FullPreview/Index.cfm/ID/922187
Food Can	15 th Jan	Heliocabale	https://www.turbosquid.com/FullPreview/Index.cfm/ID/517215
Water bottle	17 th Jan	UnitStudio	https://www.turbosquid.com/FullPreview/Index.cfm/ID/751609
Recycling Bin	17 th Jan	Theflyingtim	https://www.turbosquid.com/FullPreview/Index.cfm/ID/1110432
Book	15 th Jan	CGBeast	https://www.turbosquid.com/FullPreview/Index.cfm/ID/925834

Pepsi Can	16 th Jan	Mihai Panait	https://www.turbosquid.com/FullPreview/Index.cfm/ID/546207
-----------	----------------------	--------------	---

Sounds

Table 4: Sounds

Name	Accessed on	Creator	Available on
Button Click	21 st Jan	multimax2121	https://www.freesound.org/people/MultiMax2121/sounds/156859/
Collect Item	21 st Jan	wagna	https://www.freesound.org/people/Wagna/sounds/325805/
BGM	21 st Jan	guru12192	https://www.freesound.org/people/guru12192/sounds/337751/

Fonts

Table 5: Fonts

Name	Accessed on	Creator	Available on
Alin Kid	19 th Jan	Haslinda Adnan	http://www.dafont.com/alin-kid.font
Bad Grunge	19 th Jan	Jayde Garrow	http://www.dafont.com/bad-grunge.font
Hardcore Pen	19 th Jan	Alien foundery	http://www.dafont.com/hardcore-pen.font
Soft Marshmallow	19 th Jan	Galdino Otten	http://www.dafont.com/soft-marshmallow.font

Smartphone Specification for Testing

Table 6: Phone Specification

Body	Dimensions	139.7 x 71.3 x 9.1mm
	Weight	153g
Display	Type	TFT capacitive touchscreen, 16M colours
	Size	5.0 inches (~69.2% screen-to-body ratio)
	Resolution	1080 x 1920 pixels (~441ppi pixel density)
Platform	OS	Android 4.4.2 (KitKat)
	Chipset	Qualcomm APQ8064T Snapdragon 600
	CPU	Quad-core 1.9 GHz Krait 300
	GPU	Adreno 320
Sound	Loudspeakers	Yes – Voice 72dB / Noise 66dB/ Ring 78dB
	3.5mm jack	Yes
	Audio Quality	Noise -96.1dB/ Crosstalk-96.0dB
Battery		Removable Li-Ion 2600mAh battery
	Stand-by	Up to 312h
	Talk time	Up to 17h

ETHICS FORM

Checklist

ETHICS CHECKLIST

This checklist must be completed **before** commencement of **any** research project. This includes projects undertaken by **staff and by students as part of a UG, PGT or PGR programme**. Please attach a Risk Assessment.



Please also refer to the [University's Academic Ethics Procedures](#); [Standard Operating Procedures](#) and the [University's Guidelines on Good Research Practice](#)

Full name and title of applicant:		
University Telephone Number:		
University Email address:		
Status:	<p>All staff and students involved in research are strongly encouraged to complete the Research Integrity Training which is available via the Staff and Research Student Moodle areas</p> <p>Undergraduate Student <input checked="" type="checkbox"/></p> <p>Postgraduate Student: Taught <input type="checkbox"/></p> <p>Postgraduate Student: Research <input type="checkbox"/></p> <p>Staff <input type="checkbox"/></p>	
Department/School/Other Unit:	Computing, Mathematics & Digital Technology	
Programme of study (if applicable):	Computer Games Technology	
Name of DoS/Supervisor/Line manager:	Matthew Crossley	
Project Title:	KT.04 – 3D Mobile-app based Recycling Game	
Start & End date (cannot be retrospective):	19th September - 24th April 2017	
Number of participants (if applicable):		
Funding Source:	None	
Brief description of research project activities (300 words max): The report will attempt to investigate why recycling games are very unpopular in the educational game market and what other recycling games are out there in the game market, through the use of questionnaires to the numbers of participant and collecting any existing data that are relevant to this proposal. There will be an attempt to use a suitable game engine and modeling and animation software to develop a 3D based game.		
		YES
Does the project involve NHS patients or resources? If 'yes' please note that your project may need NHS National Research Ethics Service (NRES) approval. Be aware that research carried out in a NHS trust also requires governance approval. Click here to find out if your research requires NRES approval Click here to visit the National Research Ethics Service website To find out more about Governance Approval in the NHS click here		<input type="checkbox"/>
Does the project require NRES approval? If yes, has approval been granted by NRES? Attach copy of letter of approval. Approval cannot be granted without a copy of the letter.		<input type="checkbox"/>

Figure 44: Checklist 1 out of 3

NB Question 2 should only be answered if you have answered YES to Question 1. All other questions are mandatory.		YES	NO
1. Are you are gathering data from people?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
For information on why you need informed consent from your participants please click here			
2. If you are gathering data from people, have you:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
a. attached a participant information sheet explaining your approach to their involvement in your research and maintaining confidentiality of their data?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
b. attached a consent form? (not required for questionnaires)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Click here to see an example of a participant information sheet and consent form			
3. Are you gathering data from secondary sources such as websites, archive material, and research datasets?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Click here to find out what ethical issues may exist with secondary data			
4. Have you read the guidance on data protection issues?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
a. Have you considered and addressed data protection issues – relating to storing and disposing of data?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
b. Is this in an auditable form? (can you trace use of the data from collection to disposal)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
5. Have you read the guidance on appropriate research and consent procedures for participants who may be perceived to be vulnerable?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
a. Does your study involve participants who are particularly vulnerable or unable to give informed consent (e.g. children, people with learning disabilities, your own students)?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
6. Will the study require the co-operation of a gatekeeper for initial access to the groups or individuals to be recruited (e.g. students at school, members of self-help group, nursing home residents)?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Click here for an example of a PIS and information about gatekeepers			
7. Will the study involve the use of participants' images or sensitive data (e.g. participants personal details stored electronically, image capture techniques)?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Click here for guidance on images and sensitive data			
8. Will the study involve discussion of sensitive topics (e.g. sexual activity, drug use)?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Click here for an advisory distress protocol			
9. Could the study induce psychological stress or anxiety in participants or those associated with the research, however unlikely you think that risk is?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Click here to read about how to deal with stress and anxiety caused by research procedures			
10. Will blood or tissue samples be obtained from participants?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Click here to read how the Human Tissue Act might affect your work			
11. Is your research governed by the Ionising Radiation (Medical Exposure) Regulations (IRMER) 2000?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Click here to learn more about IRMER			
12. Are drugs, placebos or other substances (e.g. food substances, vitamins) to be administered to the study participants or will the study involve invasive, intrusive or potentially harmful procedures of any kind?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Click here to read about how participants need to be warned of potential risks in this kind of research			
13. Is pain or more than mild discomfort likely to result from the study? Please attach the pain assessment tool you will be using.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

Figure 45: Checklist 2 out of 3

Click here to read how participants need to be warned of pain or mild discomfort resulting from the study and what do about it.		
14. Will the study involve prolonged or repetitive testing or does it include a physical intervention? <input type="checkbox"/> <input checked="" type="checkbox"/>		
Click here to discover what constitutes a physical intervention and here to read how any prolonged or repetitive testing needs to managed for participant wellbeing and safety		
15. Will participants to take part in the study without their knowledge and informed consent? If yes, please include a justification. <input type="checkbox"/> <input checked="" type="checkbox"/>		
Click here to read about situations where research may be carried out without informed consent		
16. Will financial inducements (other than reasonable expenses and compensation for time) be offered to participants? <input type="checkbox"/> <input checked="" type="checkbox"/>		
Click here to read guidance on payment for participants		
17. Is there an existing relationship between the researcher(s) and the participant(s) that needs to be considered? For instance, a lecturer researching his/her students, or a manager interviewing her/his staff? <input type="checkbox"/> <input checked="" type="checkbox"/>		
Click here to read guidance on how existing power relationships need to be dealt with in research procedures		
18. Have you undertaken Risk Assessments for each of the procedures that you are undertaking? <input checked="" type="checkbox"/> <input type="checkbox"/>		
19. Is any of the research activity taking place outside of the UK? <input type="checkbox"/> <input checked="" type="checkbox"/>		
20. Does your research fit into any of the following security sensitive categories: <ul style="list-style-type: none"> • commissioned by the military • commissioned under an EU security call • involve the acquisition of security clearances • concerns terrorist or extreme groups <input type="checkbox"/> <input checked="" type="checkbox"/>		
If Yes, please complete a Security Sensitive Information Form		

I understand that if granted, this approval will apply to the current project protocol and timeframe stated. If there are any changes I will be required to review the ethical consideration(s) and this will include completion of a 'Request for Amendment' form.

- have attached a Risk Assessment
 have attached an Insurance Checklist

If the applicant has answered YES to ANY of the questions 5a – 17 then they must complete the [MMU Application Form](#)

Signature of Applicant [REDACTED] Date: 27/10/16 (DD/MM/YY)

Independent Approval for the above project is (please check the appropriate box):

Granted

- I confirm that there are no ethical issues requiring further consideration and the project can commence.

Not Granted

- I confirm that there are ethical issues requiring further consideration and will refer the project protocol to the Faculty Research Group Officer.

Matthew Crossley Digitally signed by Matthew Crossley
Date: 2016.11.14 20:51:53 Z Date: 14/11/16 (DD/MM/YY)

Print Name: Matthew Crossley Position: Lecturer

Approver: Independent Scrutiniser for UG and PG Taught/ PGRs RD1 Scrutiniser/
Faculty Head of Ethics for staff.

Figure 46: Checklist 3 out of 3

Risk Assessment

Version 1.0

July 2011

The MANCHESTER METROPOLITAN UNIVERSITY
Faculty of Science and Engineering
RISK ASSESSMENT COVER SHEET

REFERENCE NUMBER: NPC / 171016 / JDE1.49			
SCHOOL: Computing, Mathematics & Digital Technology			
TITLE OF WORK: CMT Projects involving software development and acceptability testing			
LOCATION OF WORK: John Dalton Building computing facilities, computers at student's own home etc.			
INTENDED ACTIVITIES (attach methods sheets (e.g. standard operating practices) and work schedules to this form): General use of computers to develop and test software, using other participants and feedback sheets / programs. Method sheets and work schedules not applicable.			
PERSONS AT RISK (list names of all individuals (including status e.g. staff/student), and/or unit(s) / course(s) undertaking the activity. For students please indicate course and level, for staff give contact email / phone number): Undergraduate students and the participants they recruit.			
HAZARDS (provide a summary of the hazards anticipated and attach detailed assessments with appropriate risk control methods to this form): Repetitive Strain Injury – work related upper limb disorder Back injury resulting from improper posture Eye strain Fatigue Stress Possible risk from 240v electrical mains supply Normal dangers of moving about the University to attend testing sessions. <i>Are these hazards necessary in order to achieve the objectives of the activity?</i> Yes			
Hazard Rating (delete as appropriate): Low			
HAZARDOUS SUBSTANCES/MATERIALS USED AND HAZARD CLASSIFICATION (appropriate COSHH data sheets / risk assessments must be attached to this form): ALL CONTAINERS OF HAZARDOUS SUBSTANCES SHOULD BEAR CORRECT HAZARD WARNING LABELS.			
NAME OF MATERIAL <i>Please provide also approximate quantity and concentration if applicable.</i>	HAZARD CLASS	HAZARD LABEL	DISPOSAL <i>Hazardous materials must not be removed from laboratories. List disposal arrangements for all materials listed below in the location where the work will be</i>

Figure 47: Risk Assessment 1 out of 2

			<u>carried out:</u>
RISK CONTROL METHODS (provide a summary of the hazards anticipated and attach detailed assessments with appropriate risk control methods to this form): The hazards identified above are controlled by: Facilities review when laboratories are commissioned Induction session on H&S given to students by Technical Services Manager School H&S information given in Student handbook Posters in laboratories PAT testing of equipment after three years Annual H&S inspections <i>The laboratory workstations, whilst not legally required to be DSE compliant, (the continuous usage is too low to present risk) are fully compliant with current legislation. Monitors and keyboards are adjustable, chairs are adjustable and the lighting designed for both computer usage and associated reading activity. In each laboratory, there is an adjustable desk, suitable for wheelchair users, usually located in the next to the door.</i>			
Hazard Rating with Control Methods (delete as appropriate): Low Will any specific training be required (if YES give details)? N/A Are there any specific first aid issues (if YES give details)? N/A			
PROCEDURE FOR EMERGENCY SHUT-DOWN (if applicable): In the event of fire, flood or other emergency, evacuation of the laboratory would take place and the technical staff would subsequently make an assessment of the necessity of switch-off. As overall system control is vested in a separate server room, there would be little physical harm to any device in directly cutting the power to the mains for each individual lab. Re-start of the lab may present problems of a technical nature but would not affect the personal safety or health of any individual.			
IF OFF-SITE INDICATE ANY OTHER ISSUES (e.g. associated with: individual's health and dietary requirements (obtain off-site health forms for all participating individuals and indicate where this information will be located); social activities, transportation, ID requirements; permissions for access and sampling). Not applicable – this form applies only to the laboratories listed			
	NAME	STAFF/STUDENT No.	DATE
Originator	Nicholas Costen	01900261	171016
Supervisor	N/A		
Technical Manager	David Higson	99901727	171016
Divisional / School Health and Safety Coordinator (p.p. HoS)	 Digitally signed by Nicholas Costen DN: cn=Nicholas Costen, o=MMU, ou=SCMDT, email=n.costen@mmu.ac.uk, c=GB Date: 2016.10.18 12:51:08 +01'00'		
DATE TO BE REVIEWED BY: September 2017			

Figure 48: Risk Assessment 2 out of 2



Research Insurance Checklist



Overview

Manchester Metropolitan University holds insurance policies to cover claims for negligence arising from the conduct of the institution's normal business. This includes research undertaken by undergraduate and postgraduate students as part of their academic qualification as well as research carried out by staff.

If you are an undergraduate student, postgraduate student or staff researcher at the institution, you must complete all relevant sections of the checklist on the following pages to identify whether your application requires referral to the university's Insurance Officer.

Completing and submitting the checklist will ensure that your research study has appropriate insurance cover in place **before** it begins. Please submit your completed Research Insurance Checklist along with your Ethics Checklist and/or Application for Ethical Approval to your Faculty Research Officer.

Referral to the Insurance Officer

If your research falls into any of the categories listed in Section 2 and/or Section 3 of the checklist, the Faculty Research Officer will send the following information to the Insurance Officer at insurance1@mmu.ac.uk:

- Insurance Checklist
- Ethics Checklist and/or Application for Ethical Approval Form
- Participant Information Sheet(s) (if applicable)
- Participant Consent Form(s) (if applicable)
- Risk Assessment

The Insurance Officer will liaise with the insurers to gain approval. Please note some types of research may require additional insurance, which may incur an additional cost to the Faculty.

Research studies must not commence until insurance and all other relevant authorisations and/or approvals are given.

Travel Insurance

Manchester Metropolitan University has a policy to provide worldwide travel insurance for members of staff and students travelling in connection with their course or on an approved University trip. This includes travel undertaken in connection with undertaking a research study. You must complete the online travel insurance form to register for travel insurance and should do this at least two weeks before your departure date.

Please visit the [Financial and Legal webpage](#) for details.

High Risk Countries

Please visit the [AIG Travel Guard website](#) to identify whether the overall rating for the country you are travelling to is 'High Risk' or more severe. Please contact your Faculty Research Officer for guidance on accessing the relevant information on the website.

ADMINISTRATIVE DETAILS

Lead Investigator Name

Mr [REDACTED]

(Title/Forename/Surname)

Contact Email Address

[REDACTED] mmu.stu.ac.uk

Full Title of the Research

3D Mobile-app based Recycling Game

SECTION 1 – TECHNIQUES, TESTING AND INTERVENTIONS

Does your research study involve:

Physically invasive techniques?

This refers to any test in which the skin of the participant is broken or an implement is inserted into any opening of the human body (e.g. eyes, ears, nose, mouth, lungs, stomach, rectum, vagina and urethra) or involves the taking of body samples such as saliva, hair, urine, faeces, sputum, skin, nails, or taking biopsies of any form for any purpose, or any form of scanning such as DEXA scans, Ultrasound scans, MRI, fMRI, CT, or PET scanning.

Ingestion of food stuffs or drugs?

This refers to the consumption of any substance which may impact on psychological or physical state. Substances may include but are not limited to food, beverages or drugs.

Physical testing?

This refers to any test in which a participant must perform an action resulting in the use of any muscle of the body and/or involves the use of scanning procedures, eye-trackers, mounted body cameras, sensors or electrodes, or the taking of swabs from any cavity of the body, respiratory challenge testing or recording of peak flows, EEG, ECG, Exercise ECG, Treadmill work.

Psychological intervention?

This refers to any test which purposely alters the mood of the participant or involves administering personality inventories, or any other form of psychological test.

OR

I confirm that my research does not fall into any of the above categories (*please go straight to Section 3*)

SECTION 2 – CLINICAL TRIALS INSURANCE

Please complete this section only if you ticked one of the boxes in Section 1.

Does your research study involve:

- Pregnant persons as participants with procedures other than blood samples being taken from them?
- Children aged five or under with procedures other than blood samples being taken from them?
- Activities being undertaken by the lead investigator or any other member of the study team in a country outside of the UK? *If 'Yes', please refer to the 'Travel Insurance' guidance on Page 1 of this form.*

OR

- I confirm that my research does not fall into any of the above categories

SECTION 3 – OTHER HAZARDS

Does your research study involve:

- Working with Hepatitis, Human T-Cell Lymphotropic Virus Type iii (HTLV iii), or Lymphadenopathy Associated Virus (LAV) or the mutants, derivatives or variations thereof or Acquired Immune Deficiency Syndrome (AIDS) or any syndrome or condition of a similar kind?
- Working with Transmissible Spongiform Encephalopathy (TSE), Creutzfeldt-Jakob Disease (CJD), variant Creutzfeldt-Jakob Disease (vCJD) or new variant Creutzfeldt-Jakob Disease (nvCJD)?
- Working in hazardous areas or high risk countries? *Please refer to the 'High Risk Countries' guidance on Page 1 of this form.*
- Working with hazardous substances outside of a controlled environment?
- Working with persons with a history of violence, substance abuse or a criminal record?

OR

- I confirm that my research does not fall into any of the above categories