ROBO ESCAPE
(SURVIVAL STATICS):
DEVELOPMENT OF A
THIRD PERSON SHOOTER
3D GAME TO LEARN STATICS

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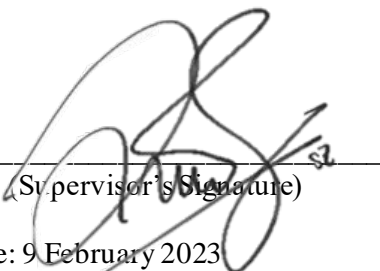
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ROBO ESCAPE (SURVIVAL STATICS):
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ABSTRAK

Permainan merupakan suatu bentuk berstruktur untuk bermain, biasanya dilakukan untuk keseronokan dan kadangkala digunakan sebagai alat pendidikan. Ia dicipta bertujuan untuk memberikan hiburan kepada pemain. Manakala permainan pendidikan ialah permainan yang direka untuk mengajar pemain subjek atau kemahiran tertentu dengan cara yang menghiburkan. Majoriti permainan pendidikan hari ini lebih menumpukan pada bahagian pendidikan dan kurang memberi perhatian kepada aspek hiburan. Oleh itu, permainan pendidikan selalunya tidak seimbang. Dengan menggabungkan pendidikan dengan permainan, ini akan menjadikan bahagian pendidikan lebih menarik dan interaktif. Oleh itu, tujuan utama projek ini adalah untuk membuat permainan pendidikan yang berkesan kepada pelajar. Selain itu, pembelajaran yang menarik dan interaktif dalam permainan berpotensi merangsang minat belajar pelajar. Kaedah Rapid Application Development (RAD) telah dipilih dalam pembangunan aplikasi ini. Terdapat tujuh fasa yang terlibat dalam model untuk memastikan bahawa mereka bentuk dan membangunkan aplikasi telah mencapai objektif yang dicadangkan. Permainan ini telah dinilai oleh pelajar universiti dan sekolah menengah serta pensyarah untuk melihat keberkesanannya. Keputusan penilaian tersebut menunjukkan bahawa pengguna memberikan maklum balas yang positif dan bersetuju bahawa permainan tersebut telah mencapai objektif projeck iaitu untuk menilai keberkesanan dan kefungsian.

ABSTRACT

Game is structured form of play, typically undertaken for enjoyment and sometimes used as an educational tool. It is created primarily for the purpose of providing entertainment to the players. While educational game is a game designed to teach players a specific subject or skill in an entertaining way. Majority of the educational game today is focusing more on the educational part than the entertain part. This makes the game not balance. By combining educational and normal game together, this will make the educational part way more engaging and interactive. Therefore, the main purpose of this project is to develop an educational game that is eeffective to the students. Besides, engaging and interactive learning in gaming could potentially stimulate student's interest of learning. Rapid Application Development (RAD) method has been chosen in development of this application. There were seven phases involved in the model to make sure that the designing and developing of the application has achieves the proposed objective. The application was evaluated by university and high-school students and lecturers to investigate its effectiveness. The result shoed that users give positive feedback and agreed that had achieved its objective to evaluate the effectiveness and functionality.

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LIST OF ABBREVIATIONS

2D	Two-Dimensional
3D	Three-Dimensional
GUI	Graphical User Interface
OS	Operating System
TPS	Third Person Shooter
PC	Personal Computer
GUI	Graphical User Interface
UI	User Interface
GB	Gigabyte
AI	Artificial Intelligence
RAD	Rapid Application Development
UAT	User Acceptance Test

CHAPTER 1

INTRODUCTION

1.1   Introduction

A game, according to the Oxford definition, is an activity that is done for entertainment or fun. For decades, video games have been a part of the entertainment business. A game that is played on a computer, a game console, a tablet, or a smartphone is referred to as a video game. It's a structured emotional object that's employed in a series of structured encounters. There are two types of games: two-dimensional (2D) and three-dimensional (3D). Game material, game mechanics, and game technology all make a video game component. Video games can be played solo, with a partner, or in a group. Video games were employed for educational reasons a few decades ago. As a result, video games are classified as either amusement or serious games. Serious games focus on the vital parts of learning, whereas entertainment games focus on having fun while playing (Susi, T., Johannesson, M., & Backlund, P., 2007). No matter how old a person is, learning is a process of acquiring information. It is an important process in life that assists a person in becoming a better person.

Students are important to the country's present and future success. Learning on complex or convoluted topics sometimes can turn off the student's mood to continue learning. Everyone, especially students, love and enjoy playing games since it allows them to relieve tension. Therefore, implementing games in education would be a good thing to help increase the student's motivation to learn certain subjects or topics to help evolve the perspective in education. Plus, it would increase student's motivation and engagement in learning. It is not a new concept to learn through video games. It began to emerge quite early in the history of computer science (Rebetez, C., & Betrancourt, M., 2007).Soldiers were trained and coached for combat via games, for example. With the rising video game business, "gamification" in education is becoming more popular.

Students are required to make wise decisions when playing educational games, which necessitates strategic thinking. This will aid in the development of student's problem-solving and critical-thinking abilities.

In this project, a game is developed for educational purposes, more specifically in the Static field, part of mechanical engineering topics. Plus, this project was an adaptation from a comic called "Survival Statics". This game should motivate and influence students to learn about statistics. This game can give the student a chance to boost their interest in learning Static. In addition, this game also does contain implementation on static topics from the comic. The genre for this game is a single-player, third person shooter, puzzle, and strategy game. In this game, there are 8 levels divided into 2 categories which test the player's agility and thinking skills.

1.2   Problem Statement

The purpose of this project is to develop an educational game which provides a learning approach other than the traditional learning techniques. One of the problems is that the traditional learning technique lacks effectiveness. **Table 1.1** Summary of problems faced by student in static engineering education summarized the problems faced by students in static engineering education.

Table 1.1 Summary of problems faced by student in static engineering education

No	Problem	Description	Effect
1	The traditional learning technique lack of effectiveness	The traditional learning techniques that mainly rely on text medium and explanation are less effective.	Students are having trouble comprehending what they are studying in class.
2	Students are less interested in statics engineering topics	The challenging in learning the topics can make the students lost interest to continue learning on the topics.	Student felt down and probably hard for them to continue learning.
3	Some topics in Statics Engineering are	Statics contains interrelated physics components and is one of	Due to the difficulties of understanding the idea process without

difficult to understand by students	the challenging topics to learn in mechanical engineering.	seeing the dynamic process and its mechanism, students frequently have misconceptions about the issue and show little interest.

1.3   Objectives

The objectives of the project are:

i.   To study the existing adventure survival game and understand the basic in statics engineering.

ii.   To design and develop an adventure survival game with implementation of statics topics that are influenced from a Survival Statics comic.

iii.   To evaluate the user acceptability and functionality of the adventure survival game from the player regarding the statics topics

1.4   Scope

There are three types of scopes which are user scope, system scope, and development scope. User scope describes the target users of the Survival Statics game. The game is designed for teenagers and above, it is highly recommended for University/College students, but primary school and high school students can also play if they are interested in the subjects. It is also available for teachers and family members that want to be a guide to their students or siblings with their learning.

System scope describes the systems that are required in the game. The genre of this game is platform-based. It is designed in 3D and a single player game that uses a third person view. The game is comprised of 5 levels, with each level presenting unique challenges. Four of these levels focus on education and are divided into two topics: equilibrium and moment of force. Each topic includes two types of levels: agility and thinking. Throughout all 5 levels, there will be a health bar, timer, and a scoreboard present.

Development scope describes the software and elements used while developing the game. The software that is used to develop this game is Unity, Blender, MagicaVoxel and Photoshop. There are several multimedia elements that are implemented in this game, for example like text, graphics, and animations.

1.5 Significance of Project

i. University Students

Students are free to learn in a more interactive and immersive way which can expand their commitment in learning. They can learn Statics in a more enjoyable way with interactive quizzes and games to help them understand it better.

ii. Teachers

Lecturers can implement a new method of teaching in their lectures or lab classes to influence the student's interest in learning.

iii. Family Members

Family members also could take part in teaching their siblings about Statics from their home.

1.6 Report Organisation

This report contains five chapters. Chapter 1 explains the overview of the project including the Introduction, Problem Statements, Objective of the project, Scope, and Report Organisation.

Chapter 2 concisely describes the literature review of three existing game applications, descriptions, and comparison of games with similar rules, mechanics, and design.

Chapter 3 focuses on the methodology that will be used in developing this project. RAD methodology is chosen to develop this project. The phases that are used in this project are Requirement planning, user design, construction, and cutover.

Chapter 4 explains the result and discussion based on development and testing of this project. This chapter briefly addressed all the outcomes achieved throughout

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development and implementation. These include software development, application testing, data collection, and project results.

Chapter 5 concludes all the results from this project. This chapter discusses the project's limitations and constraints, as well as the future development.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Chapter 2 is about the review of existing game applications. Three existing games that have the same design, mechanics and rules were explained in detail and compared. The comparison will focus on the Graphical User Interface (GUI), Operating System (OS), game genre, type of connection language provided, target audiences, size of application, functions provided, advantages and disadvantages of the game application. This comparison of the existing application suggests the strength and efficacy of the present application, allowing this project to build a superior version of the application.

2.2 Survival Statics

The comic is about 5 main characters who join a survival game that grants a very high cash prize to the survivor. Each of the main characters joined the game that they saw from a poster because each of them has their own personal financial problem and thought by joining the survival game, it could help them resolve their problem. During the game, they face 2 types of challenges which require them to use their knowledge on Statics to complete the challenges. Both challenges provide some sort of clue to help the player better understand the challenges.

There are two main topics that are focused on from the comic which are equilibrium and moments of the force:

2.2.1 Module 1: Equilibrium

Equilibrium is a state of rest or balance due to the equal action of opposing forces. In the comic the players need to climb a rope system to acquire a bucket of food

suspended on it. The players need to calculate the maximum weight that the rope system can handle before climbing.

2.2.2   Module 2: Moment of Force

The Moment of a force is a measure of its tendency to cause a body to rotate about a specific point or axis. In the comic the players need to cross to the other side over the abyss with two wooden boards on each side. The players need to calculate force to jump to the other side without making the board slip and fall.

The game will take a little bit of the comic plot and storyline to be applied in the game storyline. Also, both modules from the comic will implement it as part of the levels in the games. In those levels, there will be implements of the topics in the challenges. The player needs to use their basic knowledge to complete the challenges and at the same time gain understanding of the basics of both topics.

2.3   Third Person Shooter (TPS) Game

TPS (third-person shooter) is a subgenre of 3D shooter games in which the primary gameplay element is shooting. It's like first-person shooters, except the player character is visible on-screen throughout the game. While 2D "shoot 'em" up games use a third-person perspective as well, the TPS genre is defined by the player's avatar being the major focus of the camera's vision.

2.4   Review of Existing Application

This section will review three existing game applications that have the same design, mechanics, and rules. These applications are Teardown, Poppy Playtime and Tom Clancy's Ghost Recon Advanced Warfighter 2.

2.4.1   Teardown

Teardown is a puzzle strategy video game. This game is available only for personal computer (PC). The price is RM41 on steam. Teardown comes with various game mechanics like timing, puzzles, levels, strategy, and planning. It is an offline, first person and a single player mode game. It also has a unique design theme called voxel with realistic physics and graphics renders.

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This game was developed by Tuxedo Labs. **Figure 2.1** Logo for Teardown shows the Teardown logo. In this game, the player needs to use their creativity and problem-solving skills to execute a perfect heist with given time. **Figure 2.2** Screenshot for Teardown gameplay shows the screenshot from the game. It features a fully destructible and interactive environment where players are free to play with their own style. Players can change the graphics and adjust the volume of music in settings.

Figure 2.1 Logo for Teardown

Figure 2.2 Screenshot for Teardown gameplay

2.4.2 Poppy Playtime

Poppy Playtime is a survival horror video game. This game is available for PC and mobiles. It cost RM12.50 on steam. Poppy Playtime mainly focuses on puzzles and strategy game mechanics with a horror aspect. The game has a "kid's toys" theme park influence design. It is an offline, first person and a single player game.

This game was developed by MOB Games, an American indie game developer. **Figure 2.3** shows the Poppy Playtime logo. In this game, the player needs to survive by thinking strategically to complete the puzzles to progress further in the games. The puzzles are designed so the players interact with the environment. **Figure 2.4** shows the screenshot from the game. Players can change the brightness and adjust the volume of music in the settings menu.

Figure 2.3 Logo for Poppy Playtime

Figure 2.4 Screenshot for Poppy Playtime gameplay

2.4.3 Tom Clancy's Ghost Recon Advanced Warfighter 2

Ghost Recon Advanced Warfighter 2 is a tactical shooter video game. This game is available on PC, PlayStation Portable, PlayStation 3, Xbox 360, and Wii. It is a classic shooting game with a storyline and mission. The theme for this game is war with a subtle futuristic implementation design. It is an offline, third person and a single player mode game.

This game was developed by Ubisoft. **Figure 2.5** shows the game logo. In this game, the player needs to follow the general's orders by eliminating the enemy's army. Complete the mission and the player will progress to the next mission continuing the storyline. Different missions come with different weapons and gears. **Figure 2.6** shows the screenshot from the game. Players can change the difficulty, graphics and adjust the volume of music in settings.

Figure 2.5 Logo for Ghost Recon Advanced Warfighter 2
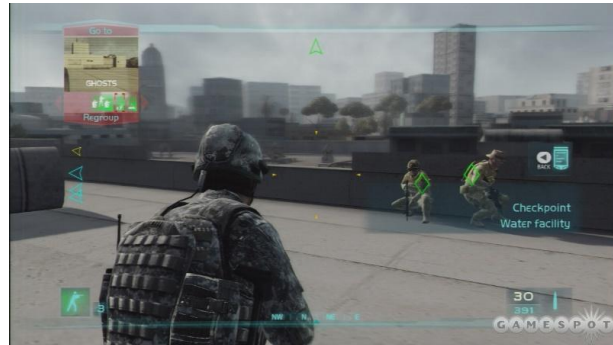
Figure 2.6 Screenshot for Ghost Recon Advanced Warfighter 2 gameplay

2.5   Comparison of Three Existing Game

The comparison will be divided into three categories with the three existing games which are Teardown, Poppy Playtime and Ghost Recon Advanced Warfighter. The three categories are game specification, game features and mechanics, also game advantages and disadvantages. **Table 2.1** Existing Game Specification shows the comparison of the game elements between all the three existing games.

Table 2.1 Existing Game Specification

Application Name/ Specification	Teardown	Poppy Playtime	Ghost Recon Advanced Warfighter 2
Graphical User Interface (GUI)	The interface is minimalist and fits the voxel theme. It is easy to understand.	The interface is simple with a pixel font that fits theme.	The interface is clean for a game that is released in 2016. Has futuristic elements that

			fits the war theme.
Operating System (OS)	Microsoft Windows	Microsoft Windows, Android, IOS	Microsoft Windows, PlayStation Portable, PlayStation 3, Xbox 360, and Wii.
Game Genre	Sandbox, puzzle, strategy,	Horror, puzzle, survival	Tactical shooter, survival,
Type of Connection	Offline	Offline	Offline
Modes	Single player	Single player	Single-player, Multiplayer
Language Provided	English	English	English
Target Audiences	7 years old above	8 years old above	16 years old above
Size of Application	2GB	10GB	3GB
Function	i. Provided a button to start the game. ii. Provided a button to pause the game. iii. Provided a button	i. Provided a button to start the game. ii. Provided a button to pause the game. iii. Provided a button to	i. Provided a button to start the game. ii. Provided a button to pause the game. iii. Provided a button

	to quit the game. iv. Provided a settings button for the player to change language and control the volume of sounds and effects. v. Provided buttons for players to choose the level they want to play.	quit the game. iv. Provided a settings button for the player to change the volume and brightness.	to quit the game. iv. Provided options button to control the music and sound effects. v. Provided a settings button for the player to choose the gender of the character.

Based on the features and mechanic comparison on the existing game, there are multiple qualities that contribute to the planning and idea for the proposed game. From the Teardown game, the voxel design and 1 minute time constraint for the challenges are the qualities to implement the proposed game. While, from the Poppy Playtime, the qualities are the different types of puzzles will be applied to each level. Lastly, all the artificial intelligence (AI) from the Ghost Recon will be assigned to the enemies in the proposed game. **Table 2.2** Existing Game Features and Mechanic shows the comparison of the game features and mechanics.

Table 2.2 Existing Game Features and Mechanic

Application Name/ Features & Mechanic	Teardown	Poppy Playtime	Ghost Recon Advanced Warfighter 2
Theme Design	High quality voxel (3D)	3D with horror theme	3D with war theme
View	First Person	First Person	First Person
Health System	Health bar (vehicles)	-	Health Bar
Time Constraint	1 minute (not all challenge)	-	-
Challenges	Plan to destroy the building, recover items in under 1 minute.	Different types of puzzles to unlock the next stage.	Destroy all enemies to complete the objective.
Enemy	-	Poppy (giant puppet monster)	Soldiers, terrorist, tank, helicopter
Artificial Intelligence (AI)	-	-	- Finite State Machine - Enemies change state from patrol to chase to shoot if the player is nearby. - Navigation Mesh - Place multiple waypoints for soldiers to scouting. - Pathfinding - Enemies follow the player while avoiding the obstacle.

Reward	• Mission completed. • Unlock more challenges. • New tools.	• Unlock the next stage. • New footage related to the storyline.	• Unlock new objectives. • New equipment. And weapon
Punishment	• Vehicles destroy if the health bar reaches zero. • Need to restart the challenge if the mission fails.	• The player dies if getting eaten by the monster by making the wrong decisions. • Need to restart the stage if the player dies.	• The player dies if the health bar reaches zero. • Need to restart from the last checkpoint if the player dies or the objective fails.

There are multiple advantages and disadvantages from the existing game that the player will gain while playing the game. **Table 2.3** Existing Game Advantages and Disadvantages shows the comparison of the game advantages and disadvantages.

Table 2.3 Existing Game Advantages and Disadvantages

Application Name	Teardown	Poppy Playtime	Ghost Recon Advanced Warfighter 2
Advantages	• Satisfying physic simulation • High quality graphics Test our thinking skills	Test our problem-solving skills, survive	• Aim and focus. • follow orders. survive
Disadvantages	• Repeated gameplay • Easy to get bored. • High quality graphics only	• Short storyline gameplay • Not suitable for younger audience	• Not suitable for younger audience • Repeated style gameplay

	available on high-end pc (raytracing)	• Need more level and puzzles	• Easy to get bored. • Multiplayer only available on the same device

CHAPTER 3

METHODOLOGY

3.1   Introduction

The methodology chosen for this project is the Rapid Application Development (RAD) model. The reason RAD was chosen is because in this project, one of the goals is to provide a minimal viable product in a reasonable amount of time. Another reason RAD was chosen is because of the game development, the game's needs may be continuously changing based on the feedback and testing. As a result, the User Design wonderfully embodied the process of repetition and discovering the game's essential material. The development process in RAD is broken down into four phases: requirement planning, user design, construction, and cutover.

3.1.1   Requirement Planning

During this phase, the developer will analyse the requirement that it fits with the targeted user to prepare the right game mechanics, rules, and features. Next, there will be a discussion with the supervisor on the list of requirements and the development tools for this project. If both the developer and supervisor agreed on the requirement, then it will move to the user design phase.

3.1.2   User Design

During this phase, the process will be carefully carried out to make sure the design fits with the targeted user. Also, most of the assets in this phase is a placeholder asset and will be updated with the better assets for the actual game in the development phase.

3.1.3   Building prototype

The prototype for the game is built based on the previous planned requirements to test the mechanics, features, and rules of the game. The prototype comprises the system that is introduced in the game.

3.1.4   Gather feedbacks

Later, the prototype is shown to the supervisor during the weekly meeting to receive all the necessary feedback. Plus, the prototype also will be shown to the appropriate user to receive different thoughts and opinions.

3.1.5   Refine

The requirements will be updated based on the comments obtained, and the cycle will repeat. For the following round of input, the prototypes are scraped or modified.

3.1.6   Construction

During this phase, all the features from the previous prototype were gathered and combined into the project. Following completion, internal testing was conducted among the developer social group. The project supervisor, family, and friends were all invited to see the games. Following that, numerous builds were carried out to repair bugs and refine the game's visuals.

3.1.7   Cutover

The stable project build will be containing a lot of feature's promises were release on the Window PC platform. A user acceptability test and a feedback survey will be conducted at the same time. It was predicted that 10 - 20 people would react. The survey will be examined when it has been completed. The survey's results and comments will be utilised to plan future projects.

3.2   Project Requirement

To develop the project, there are two types of requirements needed in the project which is functional and non-functional requirement. Therefore, the list of both requirement as well as constraint and limitation are being discussed in this.

3.2.1 Functional and Non-Functional Requirement

There are several functional and non-functional requirements that are used in this system such as:

Table 3.1 Functional and non-functional requirement

Functional Requirement	Non-Functional Requirement
Game must be played on Microsoft Windows PC.	User Interface – should be clean, simple, and compatible with screen size
Basic movement - WASD keys for W-up, A-eft, S-down, D-right to change the player's direction	Gameplay performance – Basic gaming PC that can render the game frame without frames dropping,
Health drop - This item will increase player's health	Modules design – Each modules need to have continuous design with slight changes.

3.2.2 Constraint and Limitation

There are several constraint and limitation that are used in this system such as:

Table 3.2 Constraint and limitation

Constraint	Limitation
Time constraint - Each module is limited to finished under the given time.	Game modules – There will be only 5 levels in total
Enemy – Player needs to destroy all enemy to proceed to the next level.	Platform – Can only be play on Microsoft Window PC
Win condition – to proceed to the next level player needs to collect all the item and destroy all the enemies on time.	Mode – Can only be played in single-player mode

3.3 Proposed Design & Interface

3.3.1 Context Diagram

In the **Figure 3.1** context diagram, there are 2 external entities which are Player and Game Managers.
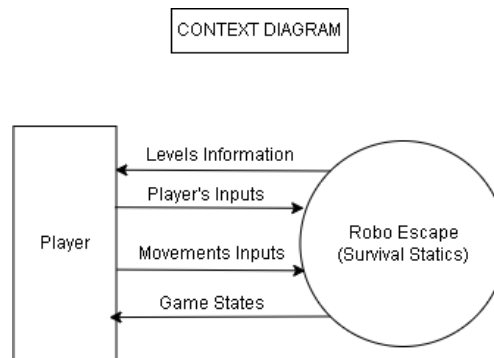

Figure 3.1 Context Diagram for Robo Escape (Survival Statics)

Player - The player can interact with the game by starting the game, giving some movements input (walk, run, jump, aim) and quitting the game.

Game Managers - It handles multiple things in the game such as the rule, mechanics, and user input of the game. It receives any of the game information and will pass the game states and level to the game to be displayed to the player.

3.3.2 Use Case Diagram

There is only one actor for the use case diagram and that is the player itself. There are multiple tasks that can be performed by the player beginning with starting the game then playing the displayed level. The player needs to collect items, destroy enemies, go to the next level if they satisfy the winning condition and quit the game.
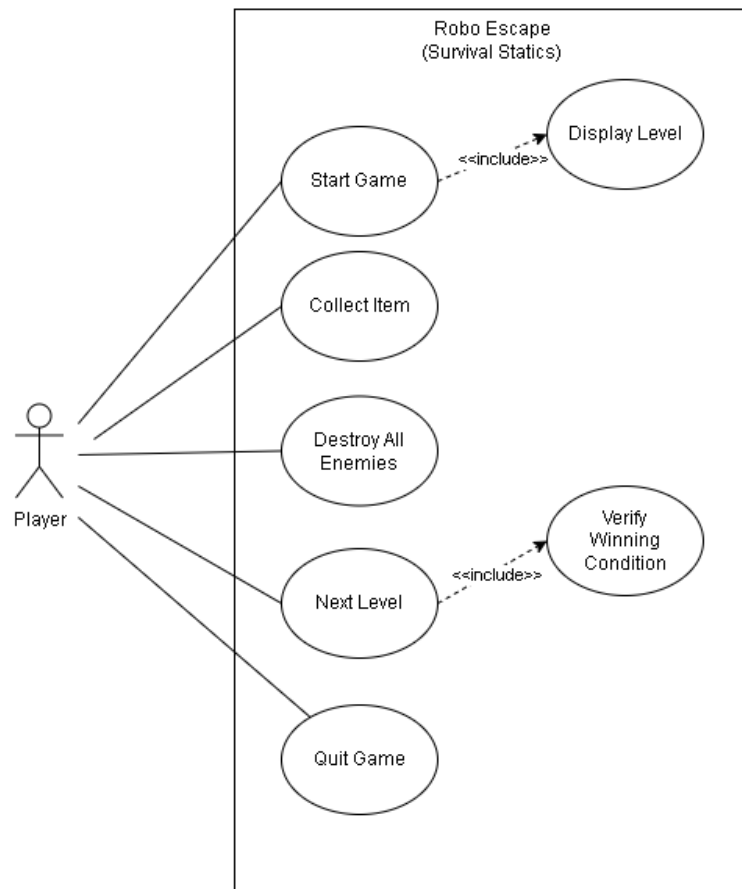
Figure 3.2 Use Case Diagram for Robo Escape (Survival Statics)

3.3.3   Game Design

3.3.3.1   Level Design

The main theme for the game design is inspired from the reviewed game called teardown which has a boxy and cube design overall. This type of design is called voxel. The map for each level is designed to look like an indoor space like facility or factory. There are 5 Level in total did not include the tutorial stage. 2 level to test player's agility, another 2 to test player's thinking skills and the last level is the final stage before the game ends. Each level is progressively different from the previous level in terms of the environment and enemies. The player can move around the space while playing the game.

3.3.3.2   Player Control

Player's character action and movements can be controlled by using either keyboard and mouse or a joystick controller. It is a basic third person game with movements like walk, run, jump and crouch. The player character actions are shooting lasers and open shields like mentioned earlier.

3.3.3.3   Enemy

Chapter There are several different types of enemies in the games. Each enemy has a different design in terms of looks, attack styles and behaviour. The enemy's behaviour is controlled by different types of AI. The AI are finite state machines to manage their states like walking, chasing or attacking, navigation mesh to allow them to move around the map and path finding to let them find the shortest path to the wanted location.

3.3.4   Reward and Punishment

3.3.4.1   Reward:

The player will receive the reward if the player finishes the level under the times, destroys all enemies and switches, then goes to collect the upgraded part. The "You Win" will appear on the screen indicating that the player has finished the level and proceeded to the next level.

The player receives upgraded parts by completing the agility levels and gains knowledge on statics by completing thinking levels.

The player can collect the health-drop by walking or running through it to increase their health. Also collect some puzzle items that will help in finishing the puzzles. Both are available around the map.

3.3.4.2   Punishment:

The player will receive a punishment if they are not finishing the game under the given time or getting destroyed by the enemies. The "Game Over" will appear on the screen and the player must restart playing the level again.

The health of the player can be decreased if they are getting shot by the enemy's laser. The player will lose if their health bar is empty.

3.3.5 Assets

2D Assets: The interface full of 2D assets like buttons, health bar, crosshair and text to display level objectives and timer.

3D Assets: The player character, all the enemies, health-drop, all the environment and the upgraded parts are in 3D modelled using a 3D.

Audio: The background sound for the game is "hype-up" music to keep the player energetic while playing. The music is not too distracting as it is not too loud. There are other sounds like the player's footsteps, shooting lasers and destroying all switches.

3.3.6 Flowchart

Figure 3.3 shows the flowchart for this project. It started with a main menu that asked the player if they wanted to start the game. If yes then it will proceed to the tutorial and finish it , then proceed to the first level. Complete the levels then it will proceed to the next level. Finish all the levels and it will go back to the main menu. If the players want to stop then the process ends.
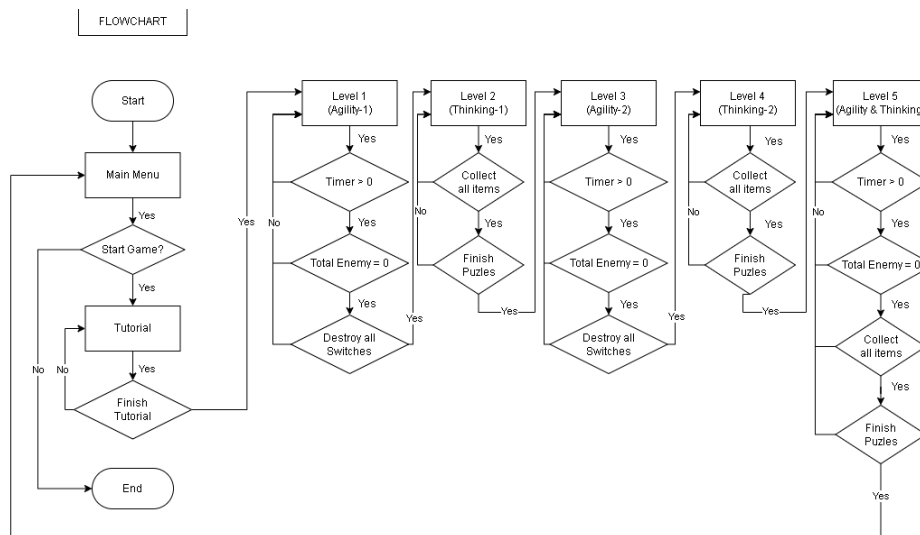

Figure 3.3 Flowchart for Robo Escape (Survival Statics)

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3.3.7 Storyboard

This section shows the storyboard to understand the game timelines better. The scene started with Robo (the player's character) waking up to a notification from the laptop. Turns out the notification is an advertisement for a "Survival Game" and Robo is interested to join.

Figure 3.4 Storyboard for Scene 1

This is the second scene, right after Robo reads the advertisement, the scenery will cut off to Robo standing in front of a building to register in the survival games. There will be an NPC telling Robo to finish 2 types of tests to qualify to join the survival games. The 2 tests are an agility test and thinking test.
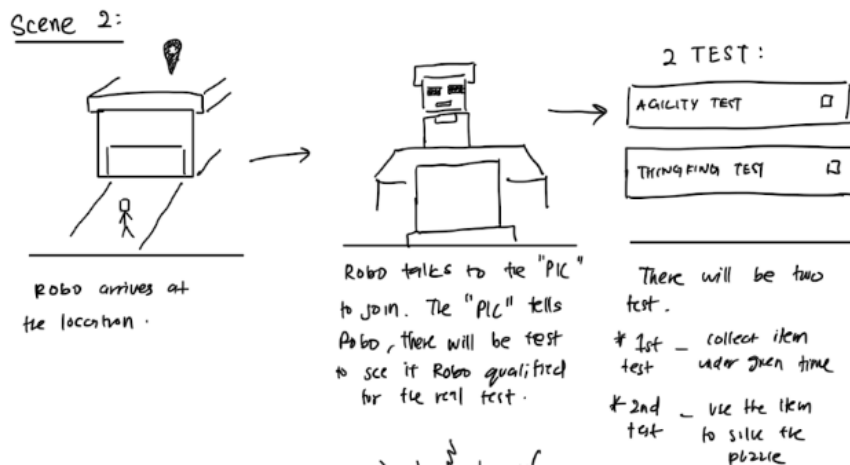

Figure 3.5 Storyboard for Scene 2

This is the third scene in which Robo completed both tests and went back to the building to complete the registration. Then the scene cuts to Robo in a facility to start the real survival test.
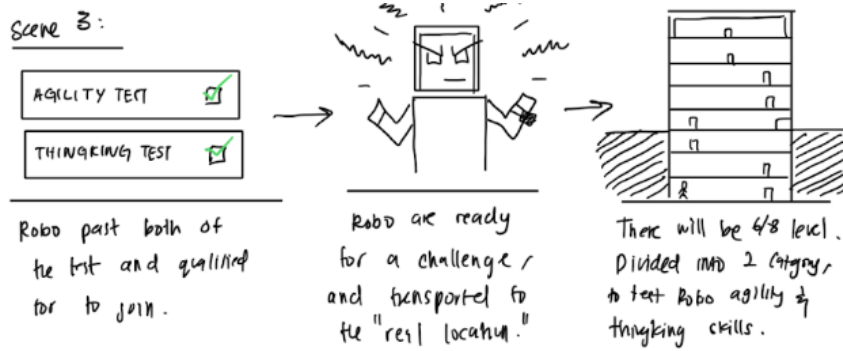
Figure 3.6 Storyboard for Scene 3

This is the fourth scene, which is the last scene, after Robo completes all the levels and wins the game. The screen will go back to the Main Menu.

Figure 3.7 Storyboard for Scene 4

3.4 Proof of Initial Concept

Here is all the screenshot from the prototype. Which consist of two types of levels which are Agility level and Thinking level. **Figure 3.8** shows the screenshot for the main menu interface. In This interface there is a logo and two buttons.

Figure 3.8 Prototype screenshot for Main Menu

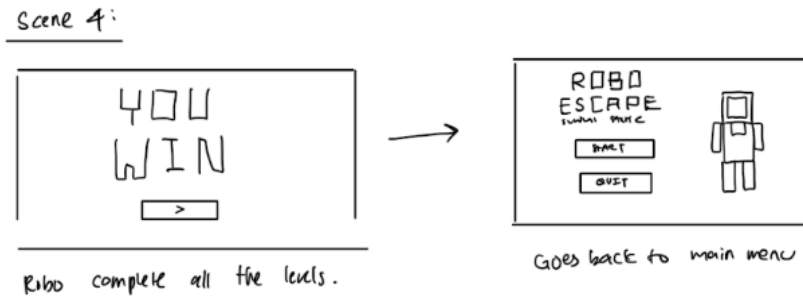This is the next scene after the main menu. **Figure 3.9** shows the screenshot of the gameplay for agility level. In this interface, there is a level's objective, player health bar, total enemy and timer.

Figure 3.9 Screenshot of the gameplay for Agility Level

This is the next scene after the agility level. **Figure 3.10** shows the screenshot of the gameplay for thinking level. In this interface, there is a level's objective, player health bar and timer.

Figure 3.10 Screenshot of the gameplay for Thinking Level

This is the scene when the player completes all the level objectives. **Figure 3.11** shows the screenshot of the winning interface. In this interface, there is only a picture of "YOU WIN". It will appear for about 3 seconds then proceed to the next scene depending on the level.
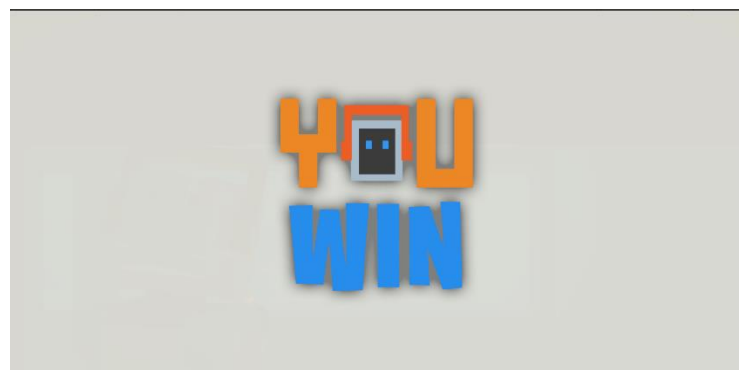

Figure 3.11 Screenshot of the gameplay when winning

This is the scene when the player fails to complete the objectives under the time given or the health bar reaches 0. **Figure 3.12** shows the screenshot of the losing interface. In this interface, there is only a picture of "GAME OVER". It will appear for about 3 seconds then proceed to restart the level.

Figure 3.12 Screenshot of the gameplay when losing

3.5 Potential Use of Proposed Solution

Educational fields - Since this is an educational game, it will be convenient to be used in educational fields for educational purposes such as university , college or any other educational institution.

Teaching Material - Teachers or lecturers can use this game application as their teaching material to teach their students about Equilibrium and moment of force.

Learning Material - Students can use this game application as their learning materials to study or revision on the Statics topics.

Public Educational Game - Anyone or student who is interested in learning the Equilibrium and Moment of Force could also play this game.

CHAPTER 4

IMPLEMENTATION, RESULTS & DISCUSSION

4.1 Introduction

Chapter 4 discussed the development, implementation and testing of Robo Escape (Survival Statics) Game Application. This application is implemented to the University/College students. The testing application was performed to identify the possible error and fixed it immediately.

4.2 Development tools

There are multiple tools that are needed in order to develop the application. **Table 4.1** Development tools software shows all the software tools that are used in developing the game application.

Table 4.1 Development tools software

No.	Tools	Purpose
1.	Unity	Create the game mechanics and organize the scene.
2.	MagicaVoxel	3D model of the game assets.
3.	Blender	Adjust the 3D model and convert the file type.
4.	Microsoft Visual Studio 2019	Scripting/code.

4.3   Implementation

The implementation process is to keep track of every step in developing Robo Escape (Survival Statics) Game Application. This implementation includes the process of designing the game application assets, development of animations, design of the gameplay and development and arrangement of the scene.

4.3.1   Design of game application assets

Some of the 3D model assets were made using software and some were downloaded from the internet. The main character "Robo" was downloaded from a website called Sketchfab, as shown in **Figure 4.1**. While the other 3D model was made using MagicaVoxel software, as shown in **Figure 4.2**, then exported as obj file format. Blender is used sometimes to make some light adjustment and convert the file type from obj to fbx.
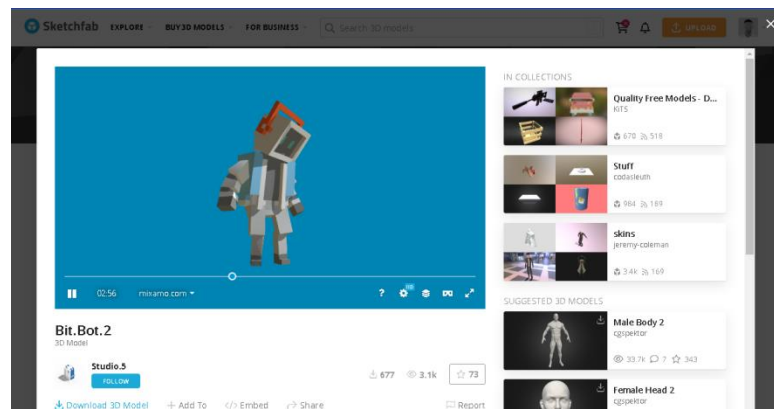

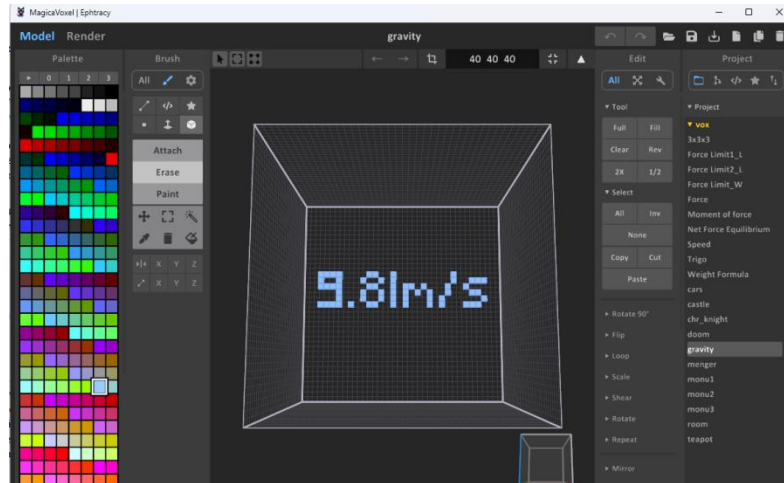**Figure 4.1 3D model of Robo from Sketchfab**

Figure 4.2 3D model in MagicaVoxel Software

4.3.2 Development of the Environment

Every scene there would be an environment, this includes all the level's scene, cutscene and transition scene. Here are some of those environments:

    i.   Environment Designs

There are six different environments in this game as shown in **Figure 4.3** to **Figure 4.8.** The first one is the tutorial environment which is the default environment from the "Starter Assets". The other three environments were designed and created using MagicaVoxel. While the last two environments were using the 3D object from the starter asset by rearranging them inside unity.
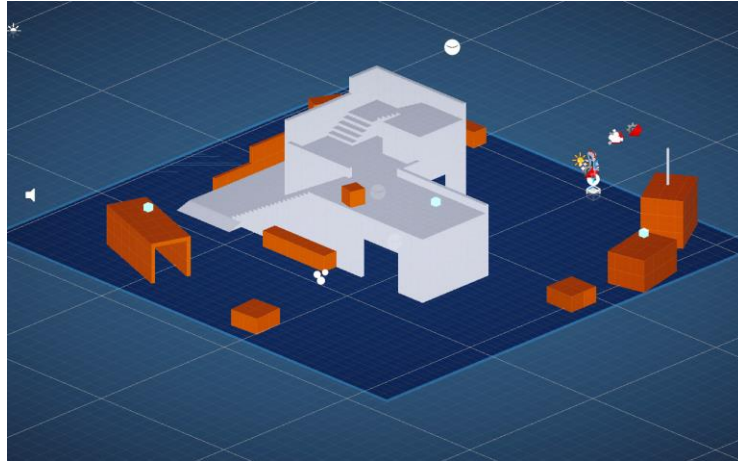
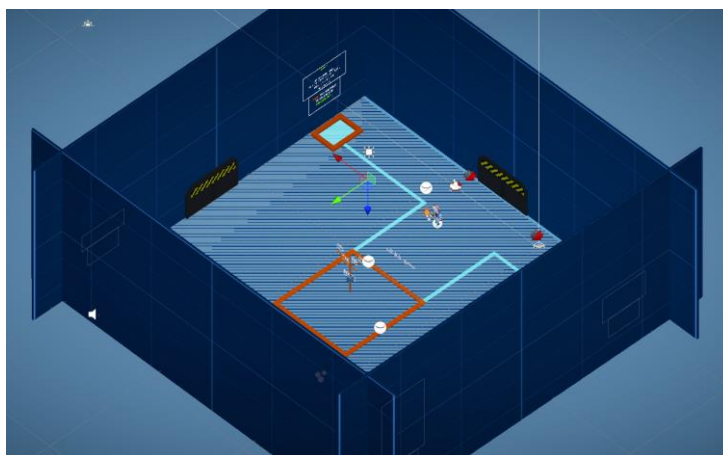**Figure 4.3 Tutorial Environment**

Figure 4.4 Level 1 Environment

Figure 4.5 Level 2 Environment

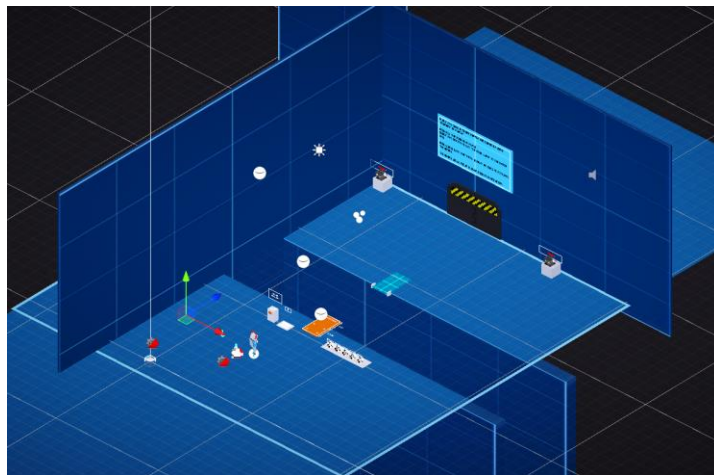**Figure 4.6 Level 3 Environment**

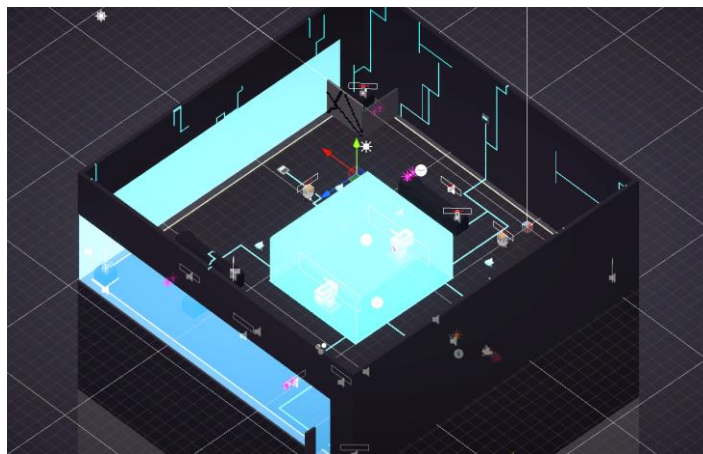**Figure 4.7 Level 4 Environment**

Figure 4.8 Level 5 Environment

ii. Environment Animations

The animation for small things like the tube, door, heart and camera was made inside Unity as shown is **Figure 4.9**. Click on any object, then press create animation on the animation tab and press the record button. By moving the object position, rotation or scale, it will record all the changes and save it as the object's own animation.
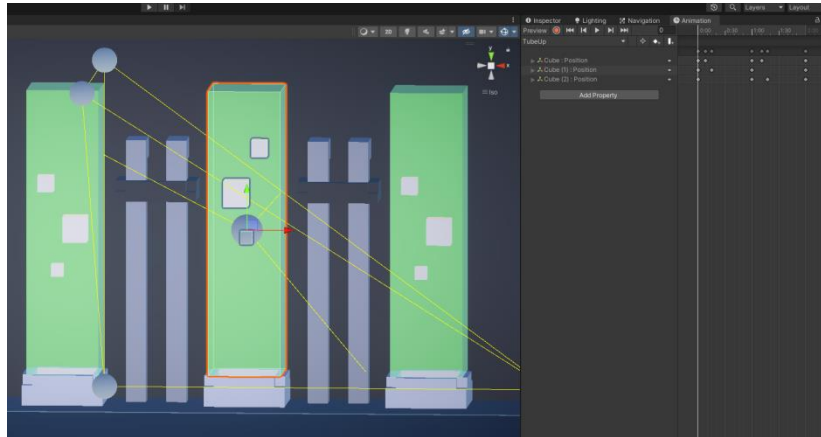
Figure 4.9 Tube animation view

4.3.3   Development of the Main Character

There are two main steps in developing the main character which are:

i. Main Character Inputs

One of the crucial components of any game is to be able to play it. This game only supports computer input methods, which are keyboard and mouse. **Figure 4.10** shows the game input interface in unity. In order to bind a key input to any movement, first click the + actions, then tick the "Keypad/Mouse" . Next click path and click on listen to let Unity listen to any key that is pressed on keyboard and mouse. Once the listen button is clicked, tap any key then it will automatically detect the key and bind it to that movement.
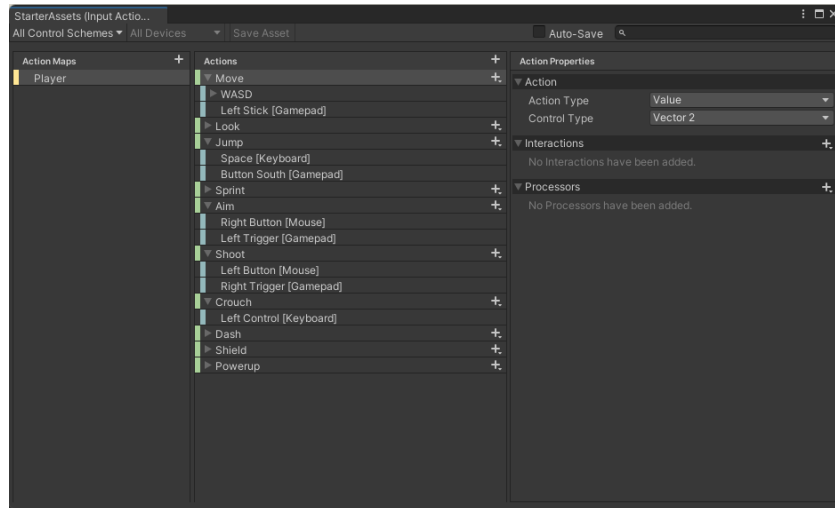
Figure 4.10 Game Input

ii. Main Character Animations

"Starter Assets - Third Person Character Controller". Inside the asset there is a pre-made animation like walking, running, jumping and crouching. **Figure 4.11** shows the Starter Assets for Third Person Character Controller that has been used in this project.
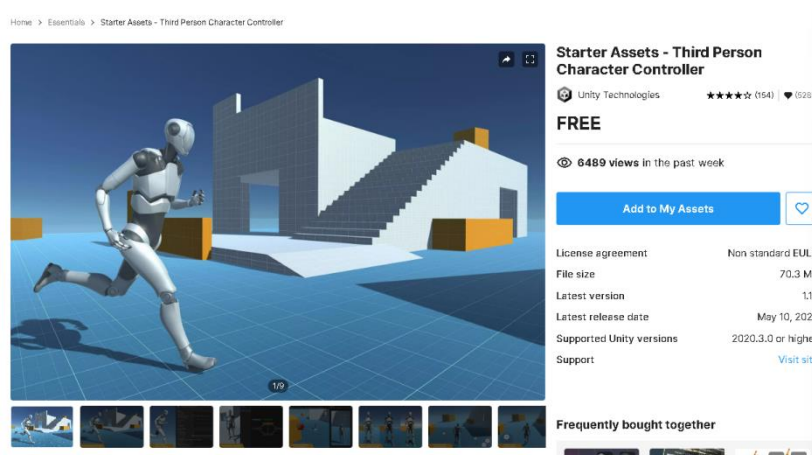
Figure 4.11 Third Person Animation Assets from Unity asset store

To add a different animation to the character, it can be obtained from the Mixamo website as shown in **Figure 4.12**. From there, download all the other animations like aiming, shielding and dashing. Then all the

downloaded animations will be combined with the premade animation in Unity.
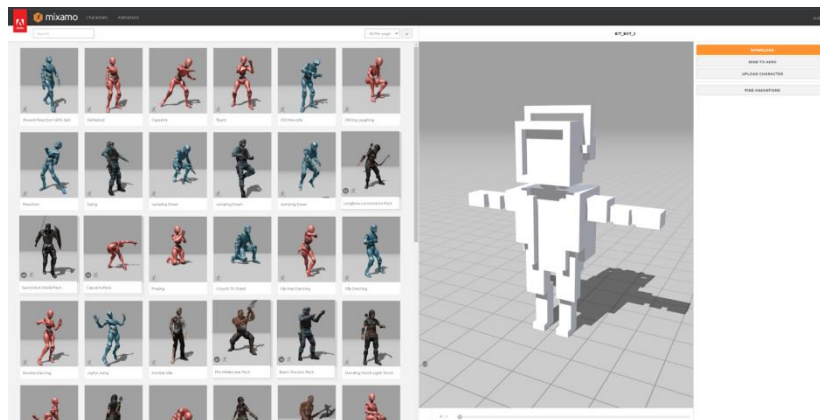
Figure 4.12 Various animation from Mixamo
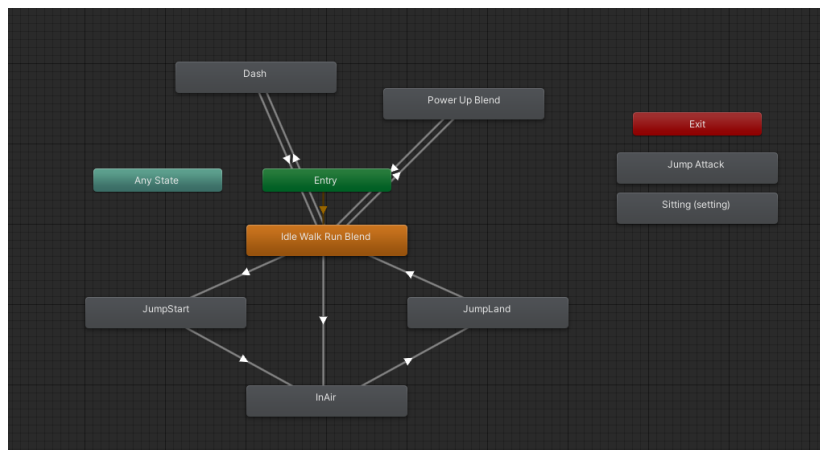
Figure 4.13 Main character animation controller

Inside the starter assets, the main character already comes with. Basic movement that binds with the key on the keyboard. To change or add the animation, simply drag the downloaded animation into the animator window. Then, right click on the new animation and click make transition and connect it to the animation tree.

To bind the animation with a key, open the "Input Action Assets", click add actions, insert the action name, choose the key, then add a new line of code inside the "Starter Assets Inputs" to create a link between the key and the new animation.

4.3.4 Development of the gameplay

In order to make the gameplay works, this are the main part that is needed for this game application:

i. Enemy

All the enemies in this game were created using the MagicaVoxel. There are three types of enemies which each of them behaves differently. The first enemy is called Robo Lasers and will shoot lasers when players are close to them. Next is Robo Boom will chase and explode once the player comes closer to them. Lastly, Robo Car which will patrol the environment, it will chase and shoot if it sees the player. Each behaviour was coded into a different script and assigned to each of them.

ii. Health Bar

The health bar was assigned to the player and enemy. It will display the amount of health on top of their head. There are also colours to indicate the amount of the character's health. Green means their health is still high, yellow means medium and red is low. Every character that is assigned with a health bar can be destroyed once their health bar is empty. Each of them has a different amount of health.

iii. Puzzle and Challenges

The challenges on agility level are simply to destroy enemies and switches as well as collecting the right formula that will be used in the next level. While the puzzle on the education level was inspired from the "Survival Static" comic. This puzzle was designed to challenge the player's thinking skill on the static topics. In order to do that, the puzzle needs to have time constraints and strategies to solve them. This will let the player adapt to the challenges and find a way to solve them.

iv. Graphics

This game is built using 3D assets which are developed and designed using software called MagicaVoxel and imported into the Unity game engine. The game engine also features lighting and post-processing effects, which make the game look and feel better.
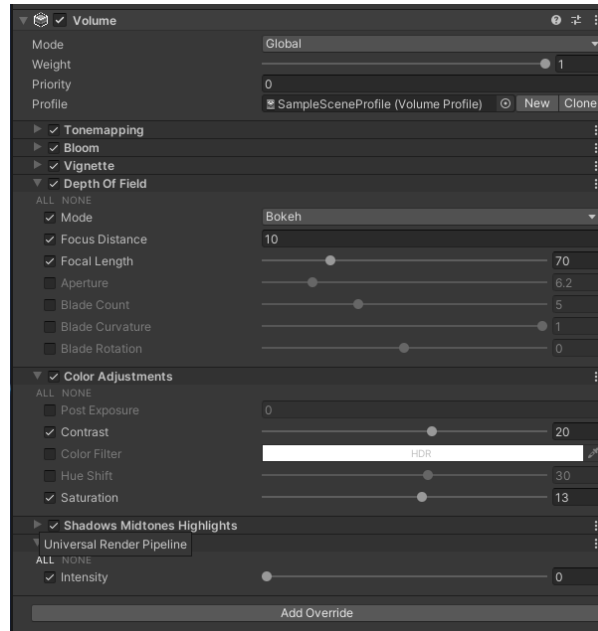
Figure 4.14 Post Processing Volume Setting
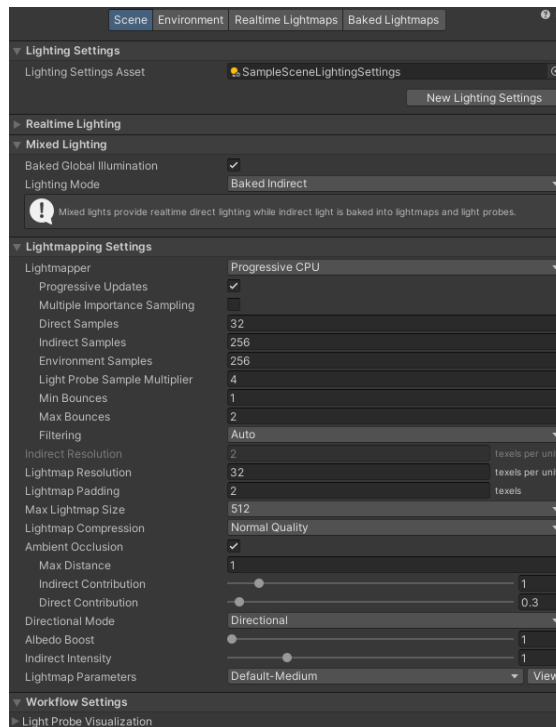
Figure 4.15 Lighting Setting

v. Sound

The sound effects are not just being played straight out of the speaker, but instead the game engine could insert noises into the 3D environment, which will change the volume based on how far away your character is from the sound.

vi. Script

C# scripts are included with the Unity 3D game engine for a variety of functions, like starting the game with the player in a particular position, animating the cameras, setting the enemy behaviour and state, adjusting the light and post-process volume, and a whole host of other features.

4.3.5 Development of User Interface

The user interface layout is standardized on every level. The interface consists of text and images. On the left side there are level's objectives. On the right side there are the player's health bar, total enemy and timer. While in the middle there is the player's

crosshair. There are also hidden canvases like "You Win" and "Game Over" that display when the player finishes the level.
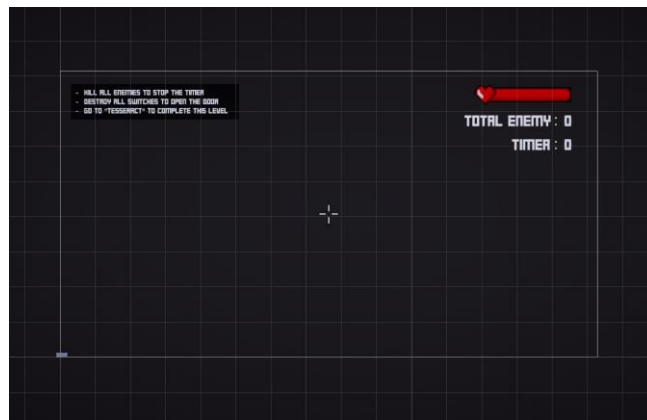
Figure 4.16 User Interface in development

Figure 4.17 Player's Interface while playing the game

Figure 4.18 Player's Interface when finish the level

4.3.6 Development and arrangement of the Scene

The development of the scene can be divided into two different category which is:

    i.   Gameplay Scene

The gameplay scenes are when the player has control on their own character and complete certain objectives to progress. This includes the tutorial stage, agility, thinking and final levels. All these scenes need to be organized by placing the right environment, enemies, pickup items and game rules.

Figure 4.19 One of the gameplay scenes
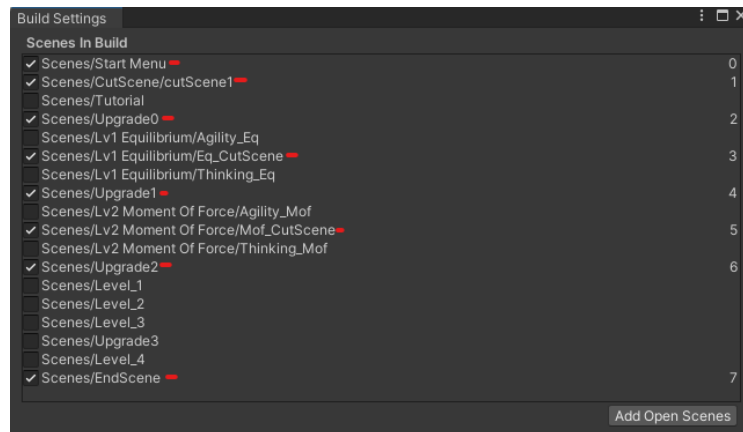
Figure 4.20 All the playable scenes

ii. Transition Scene

The transition scenes are more of a shift between the gameplay scenes. This includes the cinematic and all the transition scenes. The cinematic scene is a collection of camera movements combined into one cinematic to tell a story to the player. The scene contains explanations of the player's upgrades, enemy and the levels. In the transition scene there is not much

of 3D objects but rather more of user interface (UI) assets like text and buttons.

Figure 4.21 One of the transition scenes
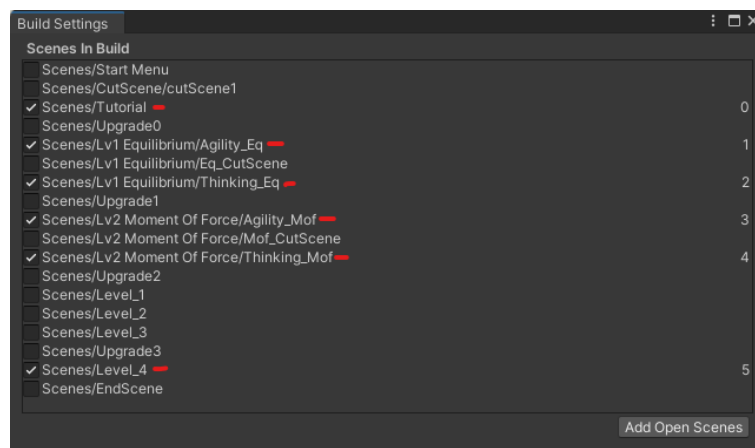
Figure 4.22 All the unplayable scenes

4.4   Result and Discussion

After the development of the game application is complete, the game application was deployed to "itch.io" as in **Figure 4.23** Robo Escape (Survival Statics) deployed in itch.io, so user can download the game and test it from their computer. Testing is done to the target user to assess the gaming application's efficacy as well as its usability and functioning. Testing is done by providing a User Acceptance Test (UAT) to the user. They will play the game and then answer some questions and give their opinion about the game application. This test is being carried out on Google form to ensure all the game features operate correctly and satisfy the user at the same time. The survey starts with

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some questions about the responder, 12 questions about the game's levels, 6 questions about the game as a whole and ends with asking their suggestions and improvements. Refer to **APPENDIX A** USER ACCEPTANCE TEST (UAT) for the Google form for the UAT survey and **APPENDIX B** USER GUIDE & ANSWER SHEET for User Guide.
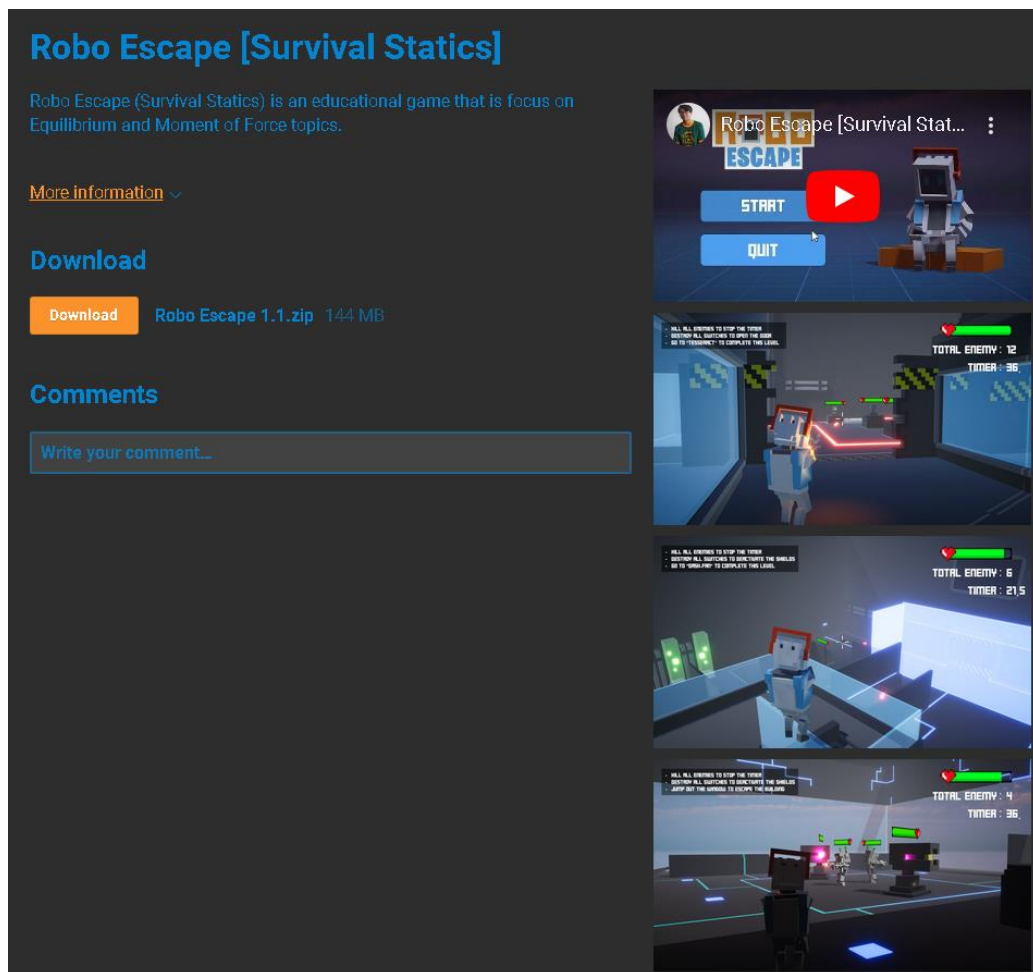
Figure 4.23 Robo Escape (Survival Statics) deployed in itch.io

4.4.1 Participants

Users can do the testing on their own personal computer or laptop by downloading the game application through Itch.io website. **Figure 4.24** Participant's ageand **Figure 4.25** Participant's institution, role and genderFigure 4.25 Participant's institution, role and gendershows the participants demographic. There were 15 participants ,12 males and 3 females. One of them is a lecturer and the rest are students. 11 of the participants have

studied the Statics topic. **Figure 4.26** Result of user's responseshows the result from all the user's responses and feedback.

Age
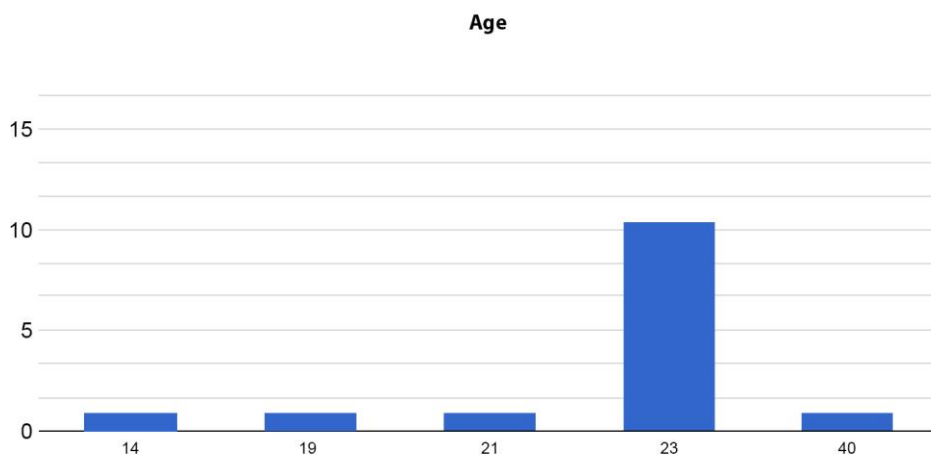
Figure 4.24 Participant's age
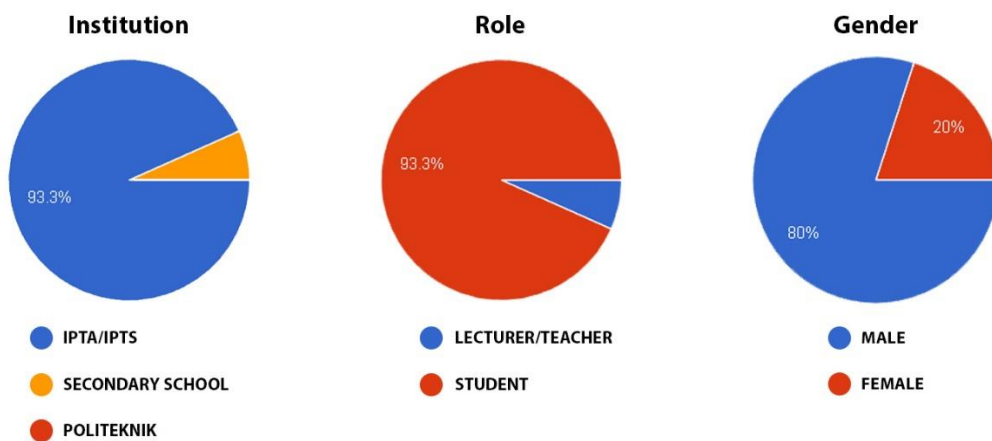
Figure 4.25 Participant's institution, role and gender

4.4.2 Result

USER FEEDBACK
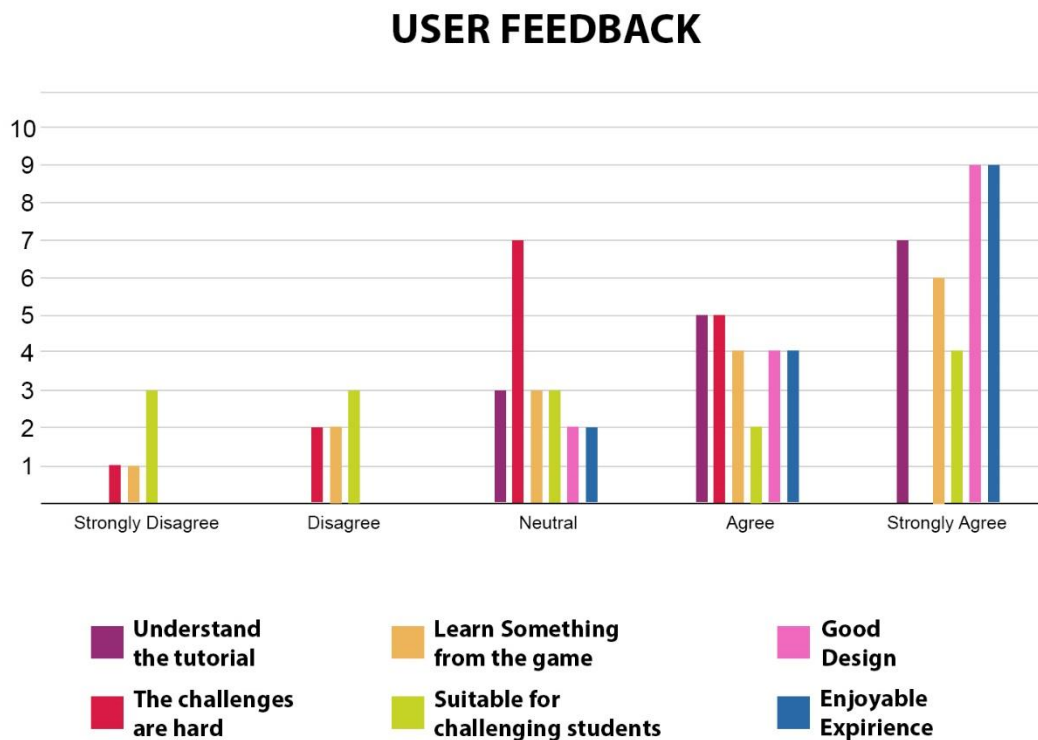
Figure 4.26 Result of user's response

Based on the graph in **Figure 4.26** Result of user's response, (46.7%) of users, strongly agree that they could understand the tutorial. Whereas the other (33.3%) and (20%) rated agree and neutral. When the users were asked to rate the difficulty of the challenges, (33.3%) of them agree that it was "Hard", (46.7%) rate that it was "Normal", (13.3%) rate for "Easy" and (6.7%) rate for "Very Easy". Next question is "the game suitable for challenging student on Equilibrium and Moment of force topic". (26.7%) rate strongly agree, (13.3%) rate for agree and (20 %) rate for neutral. The other 20% rate for disagree and another (20%) rate for strongly disagree. When ask about the game design (60%) of the user strongly agree that it is a very good design. (26.7%) agree that it was a good design and (13.3%) rate for neutral. Finally, the users were asked to rate for overall game experience. (60%) of them strongly agree and , (26.7%) agree it was enjoyable. While the other (13.3%) rate for neutral. Therefore, it can be concluded that the game application was well-received by the users.

CHAPTER 5

CONCLUSION

5.1   Introduction

Chapter 5 will discuss the summarization of development of Robo Escape Survival Static application for university and college mechanical students in order to achieve the objectives and overcome the problems that have been stated in the problem statement in Chapter1.

Traditional education mostly uses text as a teaching and learning tool, and explanation is less effective. It's possible that students do not fully understand what they are learning in class. This gaming application may be used as an optional technique to encourage students to study the Static topic by stimulate their interest.

This application was created using Blender, Microsoft Visual Studio 2019, MagicaVoxel, and Unity. This gaming application was created using the Rapid Application Development (RAD) technique, which delivers a minimally viable product in a reasonable period while adapting to user input and testing to meet the game's evolving requirements.

This game application was tested by university and college students and some lecturers in order to determine its effectiveness and functionality. Based on the results of the evaluation, the respondent mentioned that overall, the game is well received with good visual and gameplay mechanics. There are also several suggestions from them to improve the game such as to provide a setting page, a step-by-step tutorial and a storyline to the game. This shows that this game application had achieved its objective to evaluate the effectiveness and functionality of the adventure survival game from the player.

5.2   Limitation

The constraint while developing this project are:

    i.   Implementation from theory to game

Implementing theory of Static topics into the game is the main part of this project. It is necessary to learn and understand the topics first before preparing the problems for the player to solve in the game. Besides that, converting the topics into an interactive challenge in this game is also quite difficult since it requires to differentiate what part of the topics that needs to be the game's objective and interactive.

    ii.   Scripting Error

The development of the gaming application requires scripting. There are situations when script errors occur. The gaming programme cannot test or operate when there is an error. All the errors must be fixed for the gaming application to operate.

5.3   Future Works

There are several features that can be added or improved for the future of Robo Escape (Survival Statics).

    i.   Developers can add more modules, puzzles, challenges, enemies and abilities.

    ii.   Developers can enhance the game application in terms of graphics, visuals and animations.

    iii.   Developers can adapt to multiple platforms like Mac, mobile and console.

    iv.   Developers can deploy the application to Steam, App Store and Game Store where everyone can install it.

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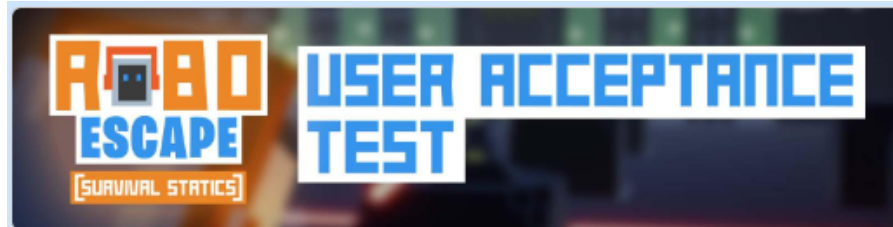
Robo Escape (Survival Statics) UAT

Dear all,

This is a **User Acceptance Test** for the **ROBO ESCAPE (Survival Statics) Game.** Robo Escape (Survival Statics) is an educational game that is focus on Equilibrium and Moment of Force topics.

Trailer Video: Robo Escape

This UAT is to fulfill the requirement for my Final Year Project (FYP) for Sarjana Muda Sains Komputer (Teknologi Grafik & Multimedia). Do take part in this testing stage.

1. Go to this link to download the game:
Robo Escape (Survival Statics)
2. Download Now > It's Free!
3. Extract the file > Robo Escape [PC Build] > PC Build > Robo Escape
4. Play the game
5. Complete the User Acceptance Test (UAT)

Game Guide for non-mechanical sutdents (Open it on a seperate screen or your phone)

Thank You!

CD19146 MUHAMMAD WILDAN BIN MOHD AZMAN
SARJANA MUDA SAINS KOMPUTER (TEKNOLOGI GRAFIK & MULTIMEDIA)

Supervised by:
TS. DR. NOR SARADATUL AKMAR BINTI ZULKIFLI
FACULTY OF COMPUTING
UNIVERSITI MALAYSIA PAHANG

muhd.wldn3@gmail.com Switch accounts

*Required

Email *

Your email address

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DEMOGRAPHIC

Institution *

◯ IPTA/IPTS

◯ POLITEKNIK

◯ SECONDARY SCHOOL

◯ Other: _____

Institution Name *
(Example: Faculty of Computing, UMP)

Your answer

Role *

◯ Lecturer / Teacher

◯ Student

◯ Other: _____

Gender: *

◯ Male

◯ Female

Age: *

Your answer

Have you studied Statics topic? (Equilibrium & Moment of Force) *

◯ Yes

◯ No

User Acceptance Test (UAT)

Is the tutorial easy to understand and follow? *

	1	2	3	4	5	
Very Hard	○	○	○	○	○	Very Easy

After playing the tutorial, are you still confused or do you quickly grasp how to play the game? *

○ Nope I got it 🥳

○ Still Confused 😵

Is the instructions/objective on LEVEL-1 is clear and easy to understand? *

	1	2	3	4	5	
Not Clear	○	○	○	○	○	Very Clear

Rate the Timer on LEVEL-1 *

	1	2	3	4	5	
Very Short	○	○	○	○	○	Very Long

Is the instructions/objective on LEVEL-2 is clear and easy to understand? *

	1	2	3	4	5	
Not Clear	○	○	○	○	○	Very Clear

Rate the Timer on LEVEL-2 *

	1	2	3	4	5	
Very Short	○	○	○	○	○	Very Long

Is the instructions/objective on LEVEL-3 is clear and easy to understand? *

	1	2	3	4	5	
Not Clear	○	○	○	○	○	Very Clear

Rate the Timer on LEVEL-3 *

	1	2	3	4	5	
Very Short	○	○	○	○	○	Very Long

Is the instructions/objective on LEVEL-4 is clear and easy to understand? *

	1	2	3	4	5	
Not Clear	○	○	○	○	○	Very Clear

Rate the Timer on LEVEL-4 *

	1	2	3	4	5	
Very Short	○	○	○	○	○	Very Long

Is the instructions/objective on LEVEL-5 is clear and easy to understand? *

	1	2	3	4	5	
Not Clear	○	○	○	○	○	Very Clear

Rate the Timer on LEVEL-5 *

	1	2	3	4	5	
Very Short	○	○	○	○	○	Very Long

Is all the challenges are EASY or HARD to complete? *

	1	2	3	4	5	
Very Easy	○	○	○	○	○	Very Hard

Did you learn something (Equilibrium & Moment of Force) after playing this game? *

	1	2	3	4	5	
Nothing	○	○	○	○	○	Yes

Rate the overall experience of this game *

	1	2	3	4	5	
Boring	○	○	○	○	○	Enjoyable

Rate the overall design of this game *

	1	2	3	4	5	
Very Bad	○	○	○	○	○	Very Good

Do you think this game is good enough to challenge student on Equilibrium & Moment of Force topics? *

	1	2	3	4	5	
Very Good	○	○	○	○	○	Very Bad

Would you recommend this game to other students that had already learned Equilibrium & Moment of Force? *

○ Yes for sure! 👌

○ No thank you... 🧡

Do you have any suggestions to improve the gameplay/experience of this game?

Your answer

USER GUIDE & ANSWER SHEET

Robo Escape [Survival Statics] Guide & Answer Sheet

1. Level Objectives
2. Health-Bar
3. Total Enemy
4. Countdown Timer

Button	Movement
W	move forward
A	move left
S	move right
D	move back
WASD + Shift	Walk
Right Click	Aim
LeftClick	Shoot

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read the instruction & objective
switch location : follow the glowing line that are connected to the door/shield

_____

Level 2 (Equilibrium):

Step1 - Shoot **cos** and **sin**

Step2 - Drop "**F1 + F2 + F3** = 0" formula

Step3 - Shoot **F3>F1>F2**

Step4 - Drop "**w = mg**" formula

_____

Level 4 (Moment of Force):

<u>1st Iteration</u>
Place **4kg**, **1kg**, **7kg** and **6kg** on A,B,C,D **(GREEN PLANE)** on the board (order does not matter)

Then, place **13kg** on the Jump Area **(RED PLANE)**

Shoot the Button

#*Now the Total Weight = 13kg*

<u>2nd Iteration:</u>
Place **4kg**, **1kg**, and **6kg** on A,B,C or D **(GREEN PLANE)** on the board (order does not matter)

Then, place **7kg** on the Jump Area **(RED PLANE)**

Shoot the Button

#*Now the Total Weight = 13 + 7 = 20kg*

<u>3rd Iteration:</u>
Place **4kg** and **6kg** on A,B,C or D **(GREEN PLANE)** on the board (order does not matter)

Then, place **1kg** on the Jump Area **(RED PLANE)**

Shoot the Button

#Now the Total Weight = 13 + 7 + 1 = 21kg

4th Iteration:
Place **6kg** on A,B,C or D **(GREEN PLANE)** on the board (order does not matter)

Then, place **4kg** on the Jump Area **(RED PLANE)**

Shoot the Button

#Now the Total Weight = 13 + 7 + 1 + 4 = 25kg

Now Jump to the other side!