MIXED REALITY GAME FOR SECONDARY FORM 3 STUDENT: METALS REACTIVITY EXPERIMENT

JECKSON ANAK DIAN

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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This report is submitted in partial fulfillment of the requirements for the Bachelor of [Computer Science (Game Technology)] with Honours.

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
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DECLARATION

I hereby declare that this project report entitled

MIXED REALITY GAME FOR SECONDARY FORM 3 STUDENT :METALS REACTIVITY EXPERIMENT

is written by me and is my own effort and that no part has been plagiarized without citations.

STUDENT : jeckson Date : 10/9/2021

(JECKSON ANAK DIAN)

I hereby declare that I have read this project report and found this project report is sufficient in term of the scope and quality for the award of Bachelor of [Computer Science (Software Development)] with Honours.

SUPERVISOR : Dr. Mohamad Lutfi Dolhalit, Pensyarah Kanan, Fakulti Teknologi Maklumat & Komunikasi, Universiti Teknikal Malaysia Melaka Date : 10/9/2021

(Mohamad Lutfi Dolhalit)

DEDICATION

This project is dedicated to our beloved parents, who have always been a source of inspiration and strength when I was on the verge of giving up, and who continue to support us morally, spiritually, emotionally, and financially.

To my brothers, relatives, mentors, friends, and classmates who, through their words of encouragement and support, pushed us to finish this project.

Finally, I'd like to thank my university for guiding me through this project, for answering my questions, and for providing us with a pleasant learning environment.

ACKNOWLEDGEMENTS

I'd like to express my gratitude to my supervisor, Dr. Mohamad Lutfi Dolhalit, for allowing me to work on this Mixed Reality Game For Secondary Form 3 Students: Metals Reactivity Experiment project. Thank you very much.

I'd also like to express my gratitude to my loving parents for their unwavering support and encouragement throughout my project, which was completed under tight deadlines.

ABSTRACT

Malaysia has been compelled to use the online learning technique as a result of Covid-19. This project is a Mixed Reality Simulation game in which the participant conducts a virtual experiment. Augmented Reality and Virtual Reality are the technologies used in this game. The player will act out a scenario in which they are performing an experiment. The player will interact with the marker and see the output while playing the game. Game Development Life Cycle is used to create the game. The goal of the game is for students to get a better knowledge of metal reactivity.

ABSTRAK

Malaysia telah dipaksa untuk menggunakan teknik pembelajaran dalam talian sebagai hasil daripada Covid-19. Projek ini adalah permainan Simulasi Realiti Campuran di mana peserta melakukan eksperimen maya. Augmented Reality dan Virtual Reality adalah teknologi yang digunakan dalam permainan ini. Pemain akan membuat senario di mana mereka melakukan eksperimen. Pemain akan berinteraksi dengan penanda dan melihat hasilnya semasa bermain permainan. Game Development Life Cycle digunakan untuk membuat permainan. Matlamat permainan ini adalah agar pelajar mendapat pengetahuan yang lebih baik mengenai kereaktifan logam.

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Chapter 1: INTRODUCTION

1.1 Project Background

The blending of real and virtual worlds to create new settings and representations is known as mixed reality. In this project, a new environment will be visualized in which the student will conduct the Reactivity of Metals Experiment that was taught in Secondary Form 3 Science. Malaysia has been compelled to use the online learning technique as a result of Covid-19. Even while students may view experimental videos from the book, Object Display via AR, with the new curriculum, it is more successful when students do the experiment themselves. Chapter 4.2.1 of the Science curriculum in secondary school teaches about the reactivity series of metals toward oxygen. It will conduct an experiment in which metal will be heated to examine the reactivity of each substance. In the simulation game, a player must observe certain safety procedures, such as wearing glasses and gloves. It is to guarantee that students' safety is always a top concern, even while they are playing the game.

1.2 Project Statement

Due to Pandemic Convid-19, students at school have little comprehension of the experiment and are not participating in it, therefore the whole learning process will be done online.

1.3 Objectives

- To identify the Mixed Reality Game component in the metal reactivity experiment.
- To develop a Mixed Reality game simulation for the metal reactivity experiment.
- To evaluate student's game experience toward metal reactivity experiment.

1.4 Goals And Genre

This is an educational simulation game with the student as the target player and the Simulation Genre Mixed Reality Virtual Experiment. A group of Secondary Form-3 students will test this game to see whether they have a better understanding of the experiment. This game should take no more than 15 minutes to complete. The game will be played in a setting that mimics the experiment. The participant will be asked to continue the experiment while wearing an eyeglasses headset with an Android phone installed inside. The Player will be needed to put a particular item in the scene and then fire up that thing inside the game environment. To determine if the player understands the element, the player must examine the project's output.

1.5 Conclusion

Finally, this chapter discusses the project's history, goal, and gaming features. Each component is explained in great depth. The Literature Review and Methodology utilized in the project will be discussed in the following chapter, Chapter2.

Chapter 2: LITERATURE REVIEW AND PROJECT METHODOLOGY

2.1 Introduction

The focus of this chapter will be on doing a literature review. The game genre as well as the project process will be thoroughly discussed. Existing games will be discussed and contrasted to the game being developed for this project. This chapter will also include a discussion of previous research or results.

2.2 Genre

Mixed Reality Game for Secondary Form 3 Student: Metals Reactivity Experiment is a technology that combines Virtual Reality with Augmented Reality. This project is a simulation game in which the player controls the experiment in the lab.

2.3 Existing Game

Mixed Reality System for Virtual Chemistry Lab

The Mixed Reality System for Virtual Chemical Lab (Xiaoyun Duan, 2020) is an example of a Virtual Reality Project that provides a novel educational experience in which students use an oculus helmet and controller to replicate a chemistry experiment in a virtual lab. It also creates a Mixed Reality application utilizing Google Cardboard (Google CardBoard, n.d.), a low-cost virtual reality device. It makes use of Google Cardboard and a smartphone to allow users to view the structural model of an atom in chemistry in the real world.

2.3.1 Comparison Of Existing Game

The Mixed Reality Game for Secondary Form 3 Students: Metals Reactivity Experiment was inspired by the Mixed Reality System for Virtual Chemical Lab (Xiaoyun Duan, 2020), where the programme realistically replicates a chemistry experiment by showing the form of an atom on the marker. Mixed Reality Game for Secondary Form 3 Students: Metals Reactivity Experiment, on the other hand, simulates one of the experiments in the Secondary Form 3 textbook (Hoong, 2018). These two applications used the same approach, with Google Cardboard being the cheapest MR technology on the market at the time, compared to other portable MR technologies like HoloLens 2 (Serl.io, 2021). Metals Reactivity Experiment is a Mixed Reality Game for Secondary Form 3 Students that focuses on just one experiment: the reactivity of a succession of metals toward oxygen. It will conduct an experiment in which metal will be heated to examine the reactivity of each substance.

2.4 Project Methodology

2.4.1 Game Development Life Cycle

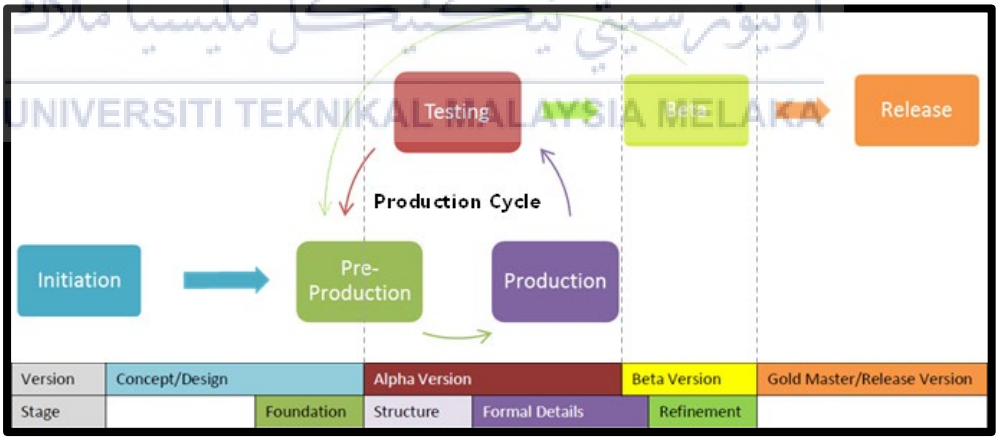

Figure 2.1 Game Development Life Cycle

Initiation

Brainstorming and generating ideas for the kind of game that will be created. The primary concept was inspired by a Mixed Reality System for a virtual chemistry lab (Xiaoyun Duan, 2020) where people may share the same technology by wearing Google Cardboard glasses.

Pre-Production

Game idea, goals, mechanics, game components, and assets are all included in the Game Design Document.

Production

Creating interfaces, coding mechanics, and putting the game together for testing and future development.

Testing

Repair and alter the game's problem and error.

Publish

The game is ready to be released to the general audience.

2.4.2 Game Design Document

Game Name

Mixed Reality Game for Secondary Form 3 Student: Metals Reactivity Experiment

Game Concept

To assemble all elements, the Mixed Reality simulation game used Google Cardboard, Vuforia as an Augmented Reality library, and Unity as a game engine.

Game Genre

Simulation Game

Target Audience

Secondary Student

Objectives

To identify Mixed Reality Game component in the metal reactivity experiment.

To develop Mixed Reality game simulation for the metal reactivity experiment.

To evaluate student's understanding of metal reactivity experiment.

Game Flow Summary

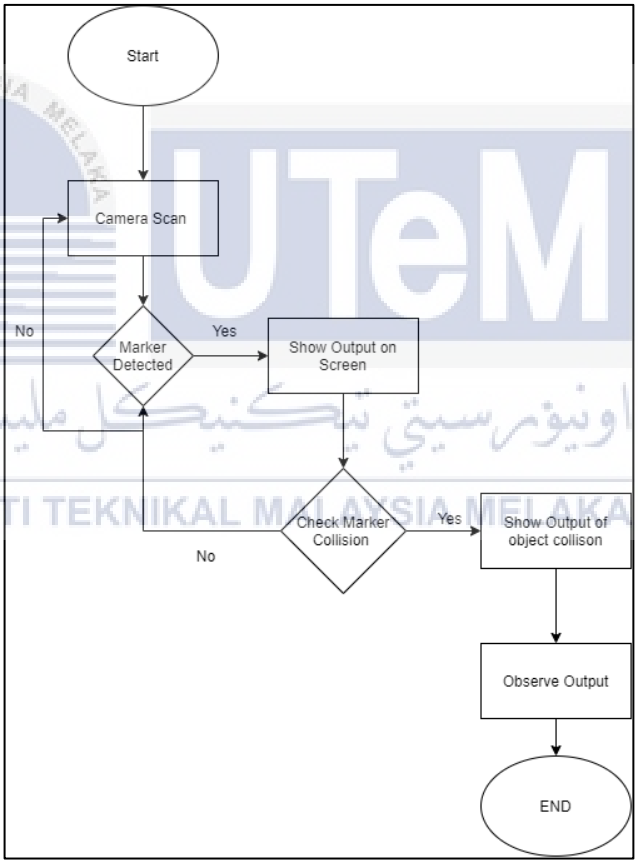

Figure 2.2: Game Flow Summary

Gameplay

According to the Lab Experiment (Hoong, 2018), the player must place the item inside the tube, metal – Cotton – Potassium, and then fire up the metal. The Player will be expected to keep an eye on the production.

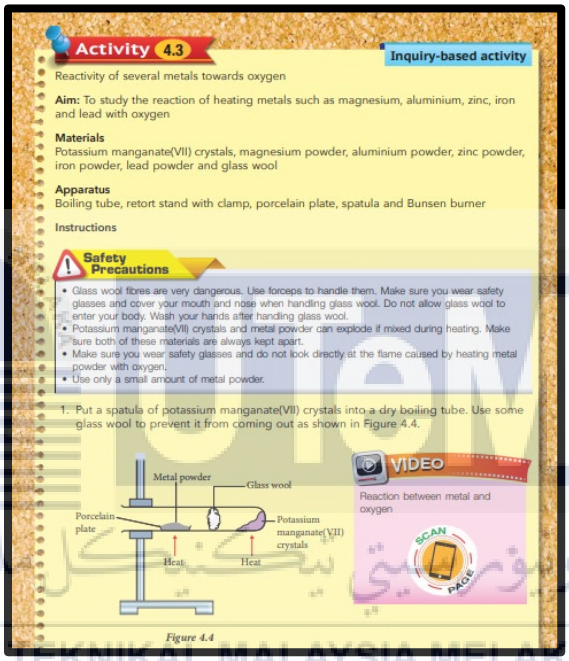

Figure 2.3 Experiment Of Metal Reactivity

Mechanic

The player will be supplied with a marker which will symbolize each item. Test tube, metal, potassium, cotton, and a fire source are all included in the kit.

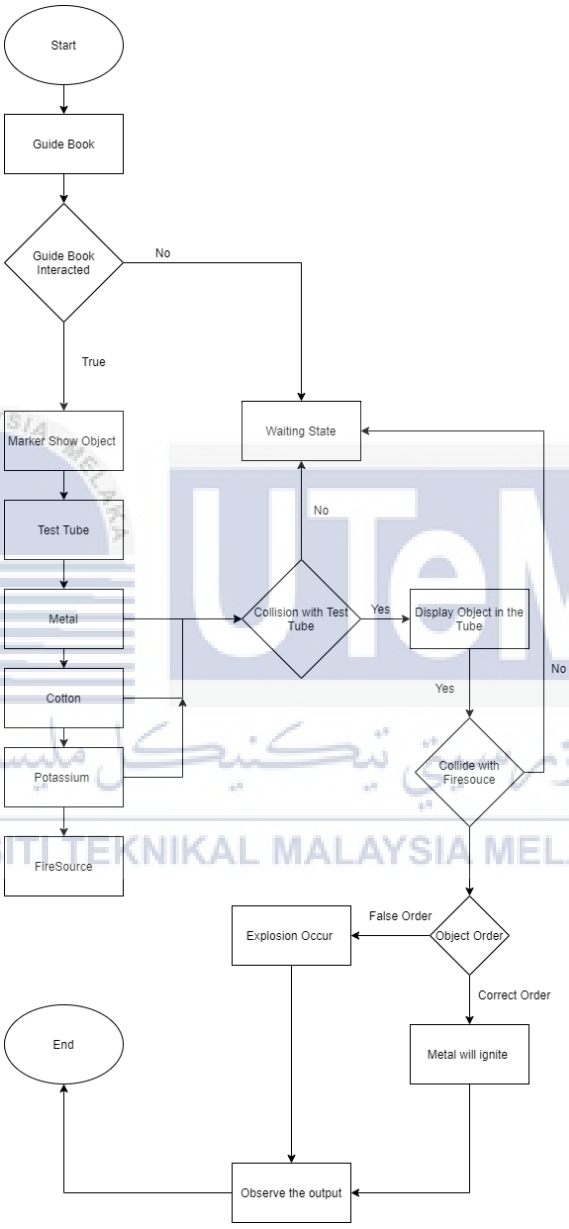

Figure 2.4 Flow Chart of Game Mechanic

Game World

Mixed Reality Environment that immerses player with real-life and Environment (Augmented Reality)

Characters

The player as a student will explore with the virtual environment. The Player will interact with the marker given.

Levels

In the game, there were two levels where the user could see two distinct kinds of metal reactions.

Visual System

The text will be intended to assist the player in identifying each item.

Control System

While playing the game, the player will completely interact with the marker.

Audio System

A few sound effects, such as item placement and burning, will be added to the game to notify the player of the game's progress.

Help System

They'll have a particular marker to show the gamer what they need to accomplish throughout the game.

2.5 Conclusion

Finally, this chapter covered the game idea, game mechanics, and gameplay, as well as the method that I used to build the game.

Chapter 3: ANALYSIS

3.1 Requirement Analysis

3.1.1 Project Requirement

This session covered all of the information needed for the development process, including a comparison of comparable games, hardware, software, and other needs.

Player Roles

The player will be the one to watch the output from the supplied marker in both apps. The Mixed Reality System for Virtual Chemistry Lab, for example, depicts how an atom appears. While Metals Reactivity is a Mixed Reality Game for Secondary Form 3 Students. Simulate an experiment in which the player will interact with the Game Objects.

Gameplay

Both apps had distinct gameplay, but the end result was the same: output was shown on top of the marker. The atom, as well as the infusion of an atom (Xiaoyun Duan, 2020), are shown in mixed reality for a virtual chemistry lab. The Mixed Reality Game for Secondary Form 3 Students: Metals Reactivity Experiment, on the other hand, needed some player involvement. For instance, a player could be asked to place metal in a test tube.

Victory Condition

Both application simply needed the player to see the output. So the winning criterion was player need to follow the right sequence, For example, the combination of atom and Placement order for Metal, potassium and cotton.

Core Mechanic

The identification of the marker and the display of the item on top of it is the Mixed Reality System for virtual Chemistry (Xiaoyun Duan, 2020). The Mixed Reality Game for Secondary Form 3 Students: Metals Reactivity Experiment, on the other hand, requires the player to interact with the marker by using the object's collision.

User Interface

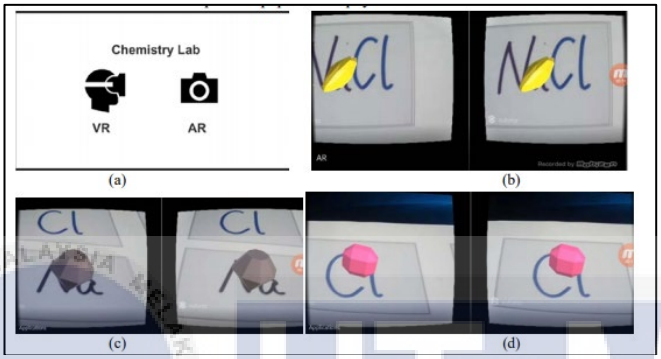

Figure 3.1 GUI from Mixed Reality System from Virtual Chemistry

Camera Models

Both apps utilize the same camera model, with the camera input coming from the device's camera and the camera interaction depending on the rotation and location of the camera device.

3.1.2 Technical Requirement

Hardware

Table 3.1 Hardware Requirement

Hardware	Description
Laptop	CPU:4CPU Storage :500GB RAM :8GB
Android Devices	CPU : Intel Atom® Processor Z2520 1.2 GHz, or faster Storage : 5gb above RAM :2gb above
Android VR Gear	Size : 140 x 195 x 110 (W x L x H) Video Input : Cell Phone

Software

Table 3.2 Software Requirement

Software /Technology	Description
Unity	Game Engine tools for development process
C#	Programming Code Language
Vuforia	Framework for Augment Library
Git	Version management and backup tool
Microsoft Visual Studio	Programming Code Editor Software

3.2 Project Schedule and Milestone

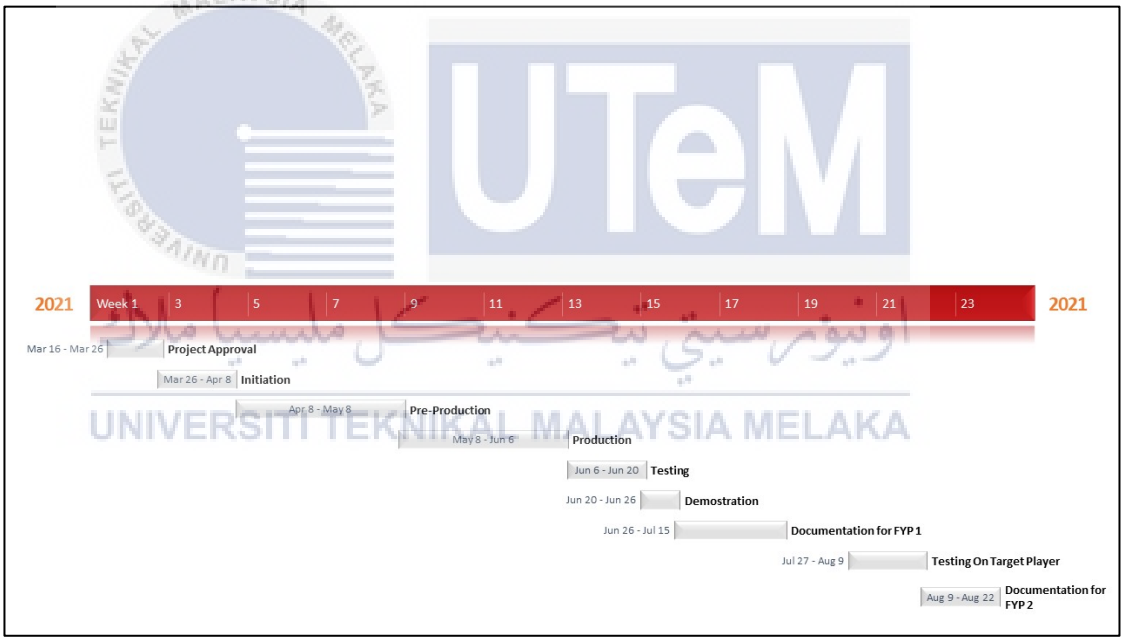

Figure 3.2 Project Schedule

PSM 1 MILESTONES | SEM 2 SESSION 2020/2021

WEEK	ACTIVITY	NOTE / ACTION
< W0 (< 21/3)	Select a suitable project topic and potential Supervisor	• Action - Student
W1 (15/3 → 21/3)	Proposal PSM: Discussion with Supervisor	• Deliverable - Proposal • Action - Student
Meeting 1	Proposal assessment & verification	• Action - Supervisor
W2 (22/3 → 28/3)	Proposal Correction/Improvement Proposal submission to Committee via email	• Action - Student
	Proposal Approval List of Supervisor/Title	• Action - PSM/PD Committee
W3 (29/3 → 4/4)	Proposal Presentation & Submission via PSM ULearn	• Deliverable - Proposal Presentation (PP) and **Completed Proposal Form** • Action - Student
Meeting 2	Chapter 1 (System Development Begins)	• Action - Student
W4 (5/4 → 11/4)	Chapter 1	• Deliverable - Chapter 1 • Action - Student, Supervisor
W5 (12/4 → 18/4)	Chapter 2	• Action - Student
W6 (19/4 → 25/4)	Chapter 2	• Deliverable - Chapter 2
	Project Progress	• Progress Presentation 1 (PK 1) • Action - Student, Supervisor
Meeting 3	Student Status	• Warning Letter 1 • Action - Supervisor, PSM/PD Committee
W7 (26/4 → 2/5)	Chapter 3	• Action - Student
W8 (3/5 → 9/5)	Chapter 3	• Deliverable: Chapter 3 • Action - Student, Supervisor
W9 (10/5 → 16/5)	**MID SEMESTER BREAK**	
W10 (17/5 → 23/5)	Chapter 4	• Action - Student
	Project Progress	• Progress Presentation 2 (PK 2) • Action - Student, Supervisor
Meeting 4	Student Status	• Warning Letter 2 • Action - Supervisor, PSM/PD Committee
W11 (24/5 → 30/5)	Project Demo	• Action - Student, Supervisor
Demonstration	Determination of student status (Continue/Withdraw)	• Submit student status to PSM/PD Committee • Action - Supervisor, PSM/PD Committee
W12 (31/5 → 6/6)	Project Demo PSM1 Report	• Action - Student, Supervisor
W13 (7/6 → 13/6) Meeting 5	Project Demo PSM1 Report Schedule the Presentation	• Action - Student, Supervisor • Action - PSM/PD Committee • Presentation Schedule
W14 (14/6 → 20/6)	Project Demo	• Deliverable - Complete PSM1 Draft Report • Action - Student, Supervisor
W15 (21/6 → 27/6) Final Presentation	**FINAL PRESENTATION** Submission of the PSM1 Report onto the PSM ULearn.	• Action - Student, Supervisor, Evaluator, PSM/PD Committee
W16 (28/6 → 4/7)	**REVISION WEEK** Correction on the draft report based on the Supervisor and Evaluator's comments during the final presentation session. Submit PSM1 Logbooks to PSM ULearn. Submit an EoS Survey form.	• Deliverable - Complete PSM1 Logbooks • Action - Student, Supervisor • EoS Survey • Action - Student
	Submission of overall marks to PSM/PD committee	• Deliverable: Overall PSM1 score sheet • Action - Supervisor, Evaluator, PSM/PD Committee
W17 & W18 (5/7 → 18/7)	**FINAL EXAMINATION WEEKS**	

Figure 3.3 Project Milestone

3.3 Conclusion

Finally, this chapter examines and discusses a project that is presently being developed in terms of gaming elements. The method described the methods and requirements for developing the app.

Chapter 4: DESIGN

4.1 Introduction

Game Architecture, Gameplay, Core Mechanics, Flow Board, Level Progression, User Interface, Game Art, Game World, Character Design, Camera Model, and Audio/Sound Effect will be discussed and explained in depth in this chapter.

4.2 Game Architecture

The diagram depicts the interaction of the gaming application between Android and the marker.

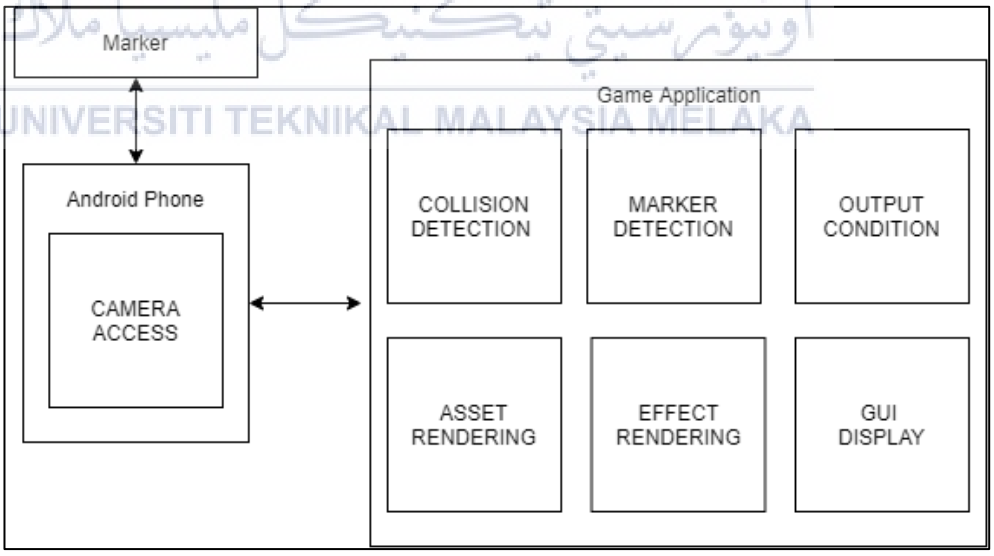

Figure 4.1 Game Architecture

4.3 Game Design

4.3.1 Gameplay

Mixed Reality Game for Secondary Form 3 Student: Metals Reactivity Experiment consists of 2 types of output that need to observe by the student.

4.3.2 Core Mechanic

Marker recognition and collision detection are the game's core mechanics. To begin, the Player must locate the marker, after which the handbook will educate the Player on how to continue with the simulation game. Multiple markers must be used to depict test tube, metal, potassium, cotton, and fire. The player must keep an eye on the Test Tube, which will interact with other items. The player will interact with Metal, Potassium, and Cotton in a Test Tube, then burn the element within the test tube and watch the result.

4.3.3 Flow Board

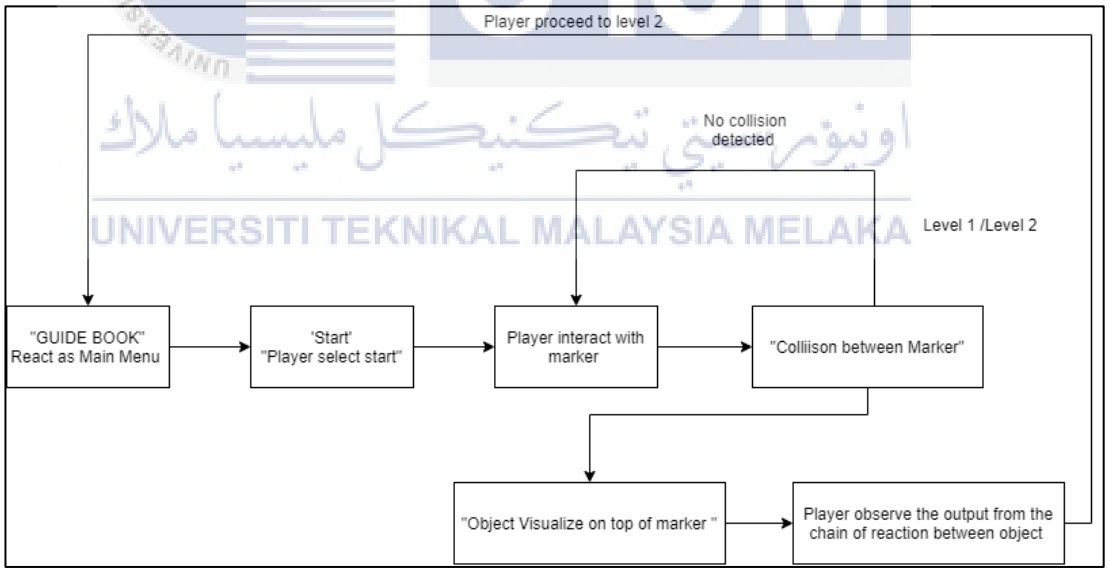

Figure 4.2 Flow Board Diagram

There were a few markers throughout the game that represented various objects. For instance, the Guidebook Main Menu has virtual buttons that the player may interact with. Cotton, Metal, Potassium, and Fire are examples of game objects that players may interact with.

4.3.4 Level Progression

The player's job in the game is to keep an eye on the output. To see the actual output in the first level, the player must solve the right sequence. The game mechanism was the same at the following level, but the outcome was different.

4.3.5 User Interface/Interaction Model

The UI of the game is designed on the marker. The Player will interface with the game menu through one marker which is the guidebook. A cursor will emerge on the application, the player will control the cursor by moving their head.

4.3.6 Game Art

Art from the game is free from Unity Asset Store.

4.3.7 Game World

The virtual environment of this project is built on the player physical reality. By utilizing the Mixed Reality method, the player will enter the game world where comprise of the real world and the virtual world.

4.3.8 Character Design

Metal, Potassium, Test Tube, Fire, and Cotton will be the only objects available in this game.

4.3.9 Camera Model

This game's camera is built on an Android phone camera that receives input from the marker and displays the results on the phone's screen.

4.3.10 Audio/Sound Effect

The game will include features such as button interactivity, fire ignition, and explosion sounds.

4.4 Conclusion

In conclusion, this chapter has covered game architecture and game design of the game application, as well as providing a picture of how the game architecture works. It also goes into gameplay, basic mechanics, flow board, level advancement, UI, Character Design, Camera Model, and Audio in depth. The application's implementation will be described in the next chapter.

Chapter 5: IMPLEMENTATION

5.1 Introduction

In this chapter, the activity includes the implementation phase, such as development of game art, visual production, audio and animation, game component integration and game configuration steps, which will be explained in great depth. This chapter is based on 4.4 Game Art and will concentrate on game art conversion and integration.

5.2 Creation Of Game Art

The 3D game art creation pipeline is design, creation and conversion. In the design phase, study into the concept of art is done to determine which concept of 3D art should be utilized in the game. In the creation process, the character or asset of the game is referred to in game art. Here are sketches of the character and setting of the game. In the conversion step, drawings are scanned and transferred to digital and color editing software.

5.2.1 Production Of Graphic

Game Asset in the game is based on tools from real life. Unity Asset Store provides free games assets. The world of the game was dependent on the player's surroundings due to various augmented reality. Free Asset is shifted to project suites. Marker approach for the detection that has been obtained from Google and is about to be imported to the library in Vuforia.

5.2.2 Production Of Audio

Sound effect is the ignition and feedback sound acquired via the free resource platform in this game. The audio is imported into the audacity software after choosing the suitable sound effect. Sound also impacts the modification to the 3D sound environment in the Unity Editor.

5.2.3 Production Of Animation

The aspect of animation in the game is the effect of the game. For instance, the impact of flame and metal reactivity effect. The effect is modified in the unit editor in which the call particle affects the effect, like flame and smoke.

5.3 Integration of Game Components

The interaction between markers is dependent on each marker's detection and interaction. Each marker is shown by each object. The interaction between each item is dependent on each object's collision. C# is inserted where the sample code indicated how the collision output was.

```
void OnCollisionEnter(Collision col)
    {
        if (col.gameObject.tag == "Potassium")
        {
            ItemPut.PlayOneShot(impact, 0.7f);
            if (MetalSpawn)
            {
                for (int i = 0; i < 3; i++)
                {
                    GameObject x = Instantiate(Material_1,
transform.position, transform.rotation);
                    x.transform.SetParent(parentObject.transform);
                }

                MetalSpawn = false;
                Step_1 = true;
                Obj_1 = true;
                p1 = 1;
            }}
```

5.4 Integration of Game Components

After everything is done, Game will be released for Android Device and Google Cardboard devices. In 5.4.1 configuration setup, the configuration setup is described.

5.4.1 Configuration Setup

To release the game, Select 'File > Build Settings' in the unit. Drag the level scene by arrangement. Select the platform and architecture of the target. Android is selected as the target platform for this project. Click on the 'Create' button next. Choose the folder and the game will start building. The game is ready to play after that. Open the application on your android phone and deploy the phone on Google Cardboard.

5.4.2 Version Control Procedure

The project's game version is tracked utilizing GitHub version control capabilities where developers may evaluate and commit the current work through a git hub desk and the progress will be stored via GitHub.

5.5 Implementation Status

Based on chapter 3 of the Gantt chart, the first job is to discuss and outline what and how the proposed game will be developed. It took a week to drive and ended in time. The second step is study in the literature review. Research is done to see whatever approaches and research have been conducted on technology for the game. It took two weeks to finish. The third step is the design of characters and assets. Character and asset design and implementation references are given here. It took 3 weeks to finish. The fourth job is to develop and debug. The execution of the game is done. Five weeks were needed to finish, and 3 weeks were necessary for Debug. The final job is to show the evaluator the finished game and it takes 1 week to accomplish it.

5.6 Conclusion

Briefly, the focus of this chapter is on the integration and development of game graphics, including asset, animation and audio production. The implementation of Collision Condition Output game components is presented as part of the sample code. The basic configuration steps are described in depth. The state of implementation is also indicated in the Gantt chart. The next chapter will be Chapter 6 on Testing.

Chapter 6: TESTING

6.1 Introduction

This chapter examines the game's testing with target participants. A total of 22 Form 3 students took part in the testing, including 13 females and 9 males. The test plan, as well as the testing techniques and how they are carried out, will be explained here. Not only that, but the data and outcomes will be thoroughly examined and discussed.

6.2 Test Plan

The aim of the testing is to assess the issue and goal set forth in Chapter 1. Testing is the fourth step of the Game Development Life Cycle. The testing will be conducted on secondary student who are enrolled in the topic. Surveys are suggested as a technique for game testing. The elements being evaluated include the player's experience and understanding of the game.

6.3 Test Implementation

Survey is used to test the game. The testing is performed on 22 students including 13 females and 9 males. The survey is performed using Google Forms. Google Form is utilised to ensure that data is recorded properly and pie charts and graphs are generated to better examine and analyze it. The questions requested will be presented in Table 6.1,Table 6.2 and Table 6.3.

6.4 Test Result and Analysis

Through the survey performed. Three results have been identified and addressed. The poll results will also be reviewed in depth. There are 4 parts of the survey, which included pre-test questions, games, post-game and post-test.In the pre-trial phase, there are 4 questions The question is given in the following table.

Table 6.1 Pre-Trial Survey Question

No	Description
1.	Gender
2.	Do you know about Metal Reactivity Experiment
3.	Do you know about the Potassium and Metal
4.	Are you interested in learning and knowing about the experiment

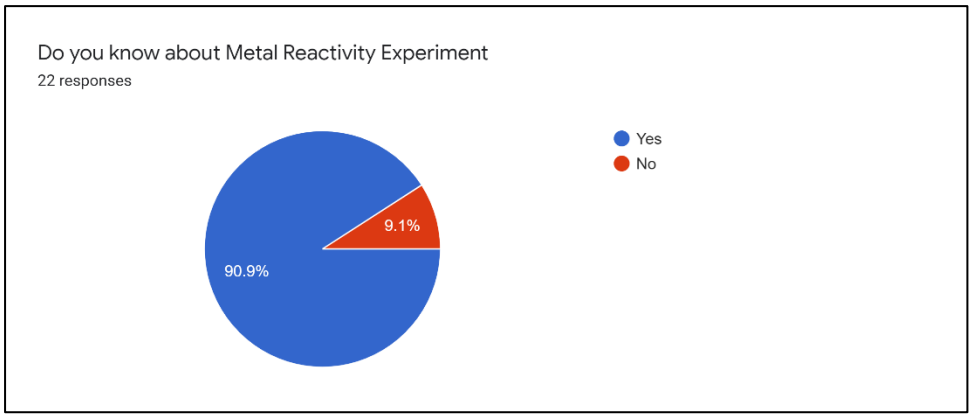

Figure 6.1 Overview data of the source of participants get to know about the metal reactivity experiment.

The findings in the current examination are as follows. On the basis of the second question, 90,9 percent of participants know about the metal reactivity test and 9,1 percent do not know about it. 81.8% of participants know about the element utilised in the experiment when metal and potassium are present, while 18.2% of individuals do not. This shows that the majority of the participant knows the experiment well. In the last question 90,9% of participants were interested in the experiment, while 9,1% of participants were not interested in the experiment, where most participants interested in learning about the experiment were shown.

The post-trial survey is split into three parts: part 1 of the experience in the game, part 2 of the experiment after game (IJsselsteijn, 2013)and part 3 of the post-trial survey. Part 1 Game Experience uses the Game Experience questionnaire by IJsselsteijn, W.A. et al. The questionnaire is partly adopted since certain questions are not appropriate for our purpose. This survey utilises a linear scale. Scale is 0 (no), 1(light), 2(moderately), 3(fairly) to 4. (extremely). There are 10 questions for the game experience and 6 for the post-game experience. There are not only 6 questions on the metal reactivity experiment and 1 questions on suggestion. The questions and findings of the questionnaire are given in the following table.

Table 6.2 Game Experience Questionnaire questions on in game and responses from participants

	Question	Scale				
		0	1	2	3	4
1	I felt content	-	-	45.5%	36.4%	18.2%
2	I was interested with the gameplay	-	4.5%	18.2%	45.5%	31.8%
3	I felt that I could explore things	-	4.5%	18.2%	50%	27.3%
4	It was fun	-	4.5%	9.1%	27.3%	59.1%
5	I was fully occupied with the game	-	-	22.7%	54.5%	22.7%
6	I felt happy	-	-	9.1%	59.1%	31.8%
7	I felt imaginative	-	4.5%	9.1%	36.4%	50%
8	I felt bored	36.4%	31.8%	18.2%	9.1%	4.5%
9	I felt annoyed	50%	40.9%	4.5%	-	4.5%
10	it gave me a bad mood	68.2%	22.7%	4.5%	-	4.5%

Table 6.3 Game Experience Questionnaire questions on post-game experience and responses from participants

No	Question	Scale				
		0	1	2	3	4
1	I found it hard to get back to reality	27.3%	31.8%	18.2%	18.2%	4.5%
2	I was interested with the gameplay	-	-	22.7%	59.1%	18.2%
3	I found it a waste of time	63.6%	18.2%	13.6%	4.5%	-
4	I felt energized	13.6%	31.8%	13.6%	27.3%	13.6%
5	I felt satisfied	4.5%	22.7%	22.7%	36.4%	13.6%
6	I felt regret	68.2%	22.7%	4.5%	4.5%	-

It can be concluded from the data collected from Table 6.3 that most of the students react positively to the application. Where most of the students scale the positive question from mildly to above. However, the negative question, like in question 8 to 10, was light and below for most students.

Data from Table 6.4 showing that most students are responding positively to the application. The results between Table 6.3 and Table 6.4 were significantly comparable and were positive for the student in this application.

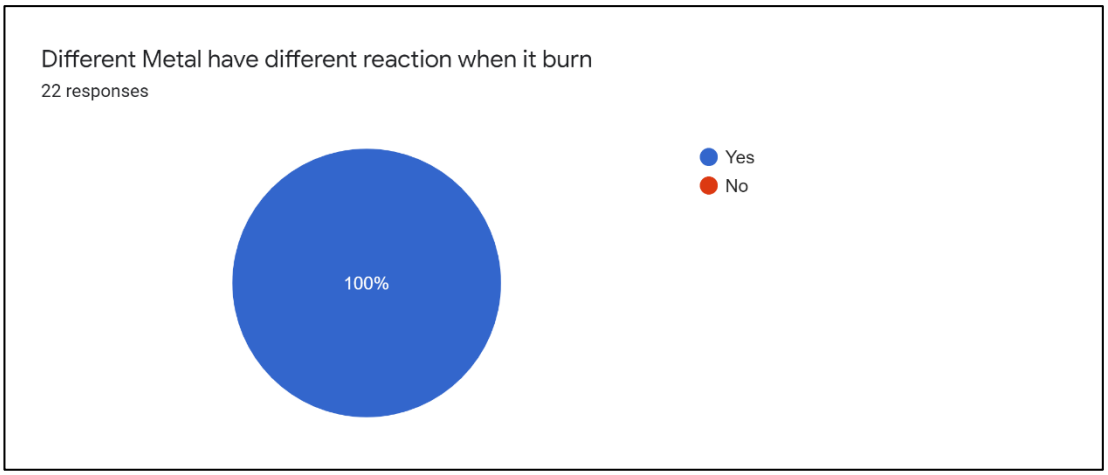

Figure 6.2 Overview data of participant toward understanding of element of the experiment

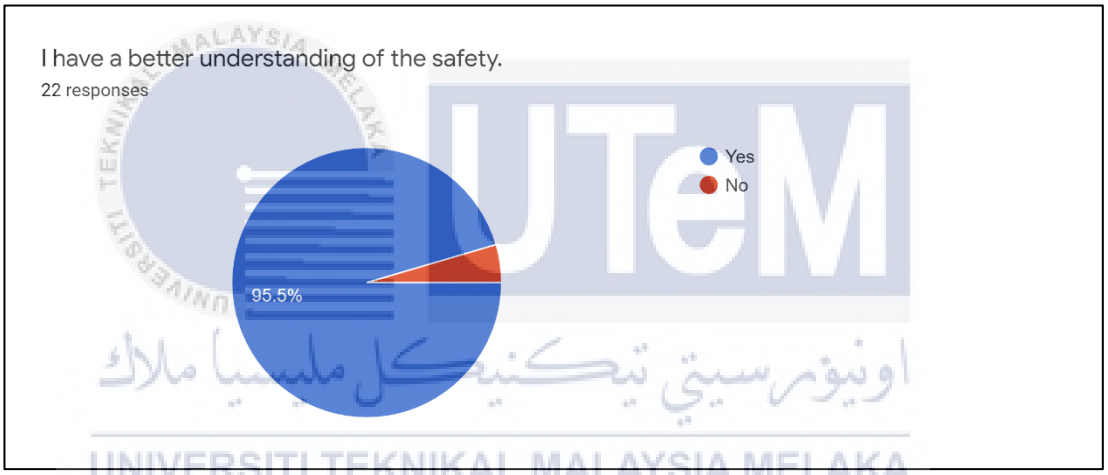

Figure 6.3 Overview data of the participant toward understanding safety element toward the experiment.

In the post-trial survey, all participants understood where metal reactions occur when they are burned. Up to 95.5% of participants had improved security knowledge after seeing the gameplay video. This shows that participants are better informed about the experiment and know well about safety even in the virtual world throughout the experiment.

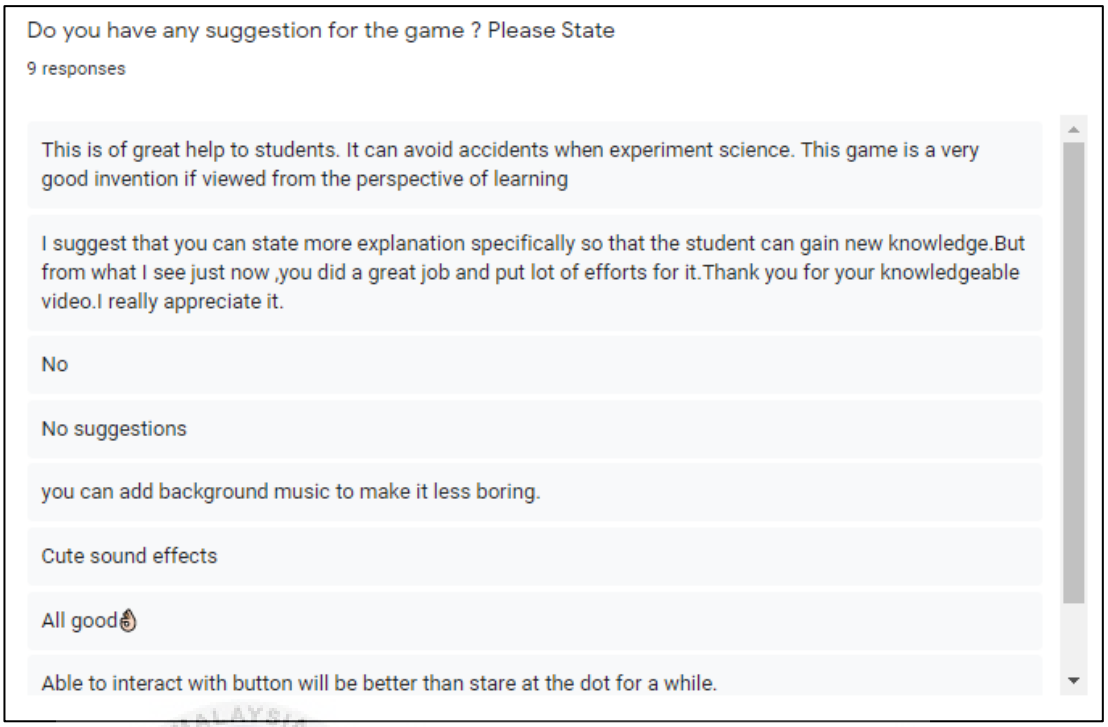

Figure 6.4 Suggestion of the participants towards the game in post-trial survey

In the final section of the survey, the participant remarks favourably on the gameplay footage. The gameplay video is fascinating and entertaining for most participants. There are also some suggestions on how the momentum may be given to gameplay, for instance by adding explanations and interacting buttons. Within conclusion. Most participants are pleased with the gameplay and may be improved via addition of additional features.

6.5 Conclusion

To conclude, this chapter described the tests performed for the game. The test strategy and execution of the test are detailed. The findings of the tests and the analyses are detailed. Three findings have been identified from the examination of the data gathered. The game may assist resolve problems and the game can have a good impact on the player and promote the new way of learning more attractively.

Chapter 7: PROJECT CONCLUSION

7.1 Observation of Strength and Weakness

By testing the target group, strength and weakness are identified. The strength is that it has an appealing gameplay that stimulates player interest. In addition, the mix of gaming and education will be a fantastic option for a more appealing learning process. As far as weakness is concerned, the hardware and installation time needed are more expensive and lengthier than conventional experiments by a group of students. Besides this, players with glasses are not user-friendly.

7.2 Proposition for Improvement

As said in 7.1 Observing strength and weakness, the game may include additional features like multiplayer, rather than single player. The hardware may switch to the newest technology, like HoloLens, to solve the glass issue. Contribution. This project promotes enjoyable learning. This is shown by the research where players exhibit an interest in studying and understanding the experiment. Not only that, the player comprehend the results of the virtual experiment and observe them. In addition, this initiative also enhances player safety awareness via the virtual experiment. This project promotes the new fascinating way of learning and resolves the issue during this epidemic.

7.3 Conclusion

This project has meet the objectives set which are to identify Mixed Reality Game component in the metal reactivity experiment, to develop Mixed Reality game simulation for the metal reactivity experiment and to evaluate student's understanding on metal reactivity experiment.

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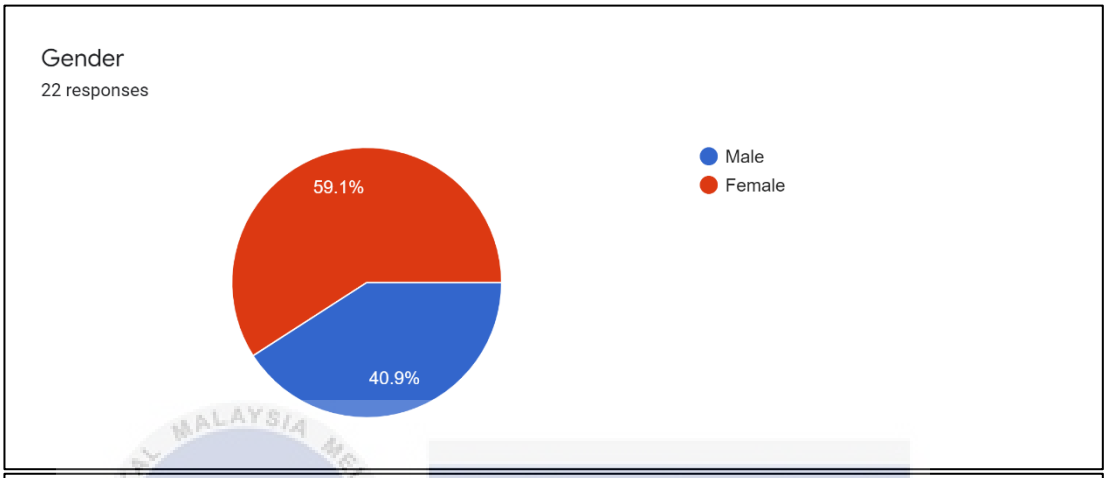
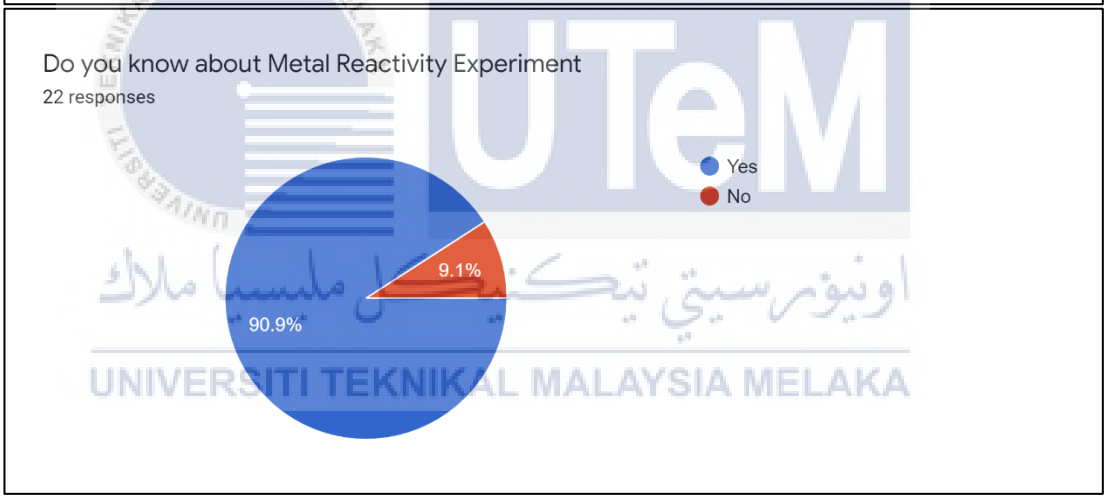
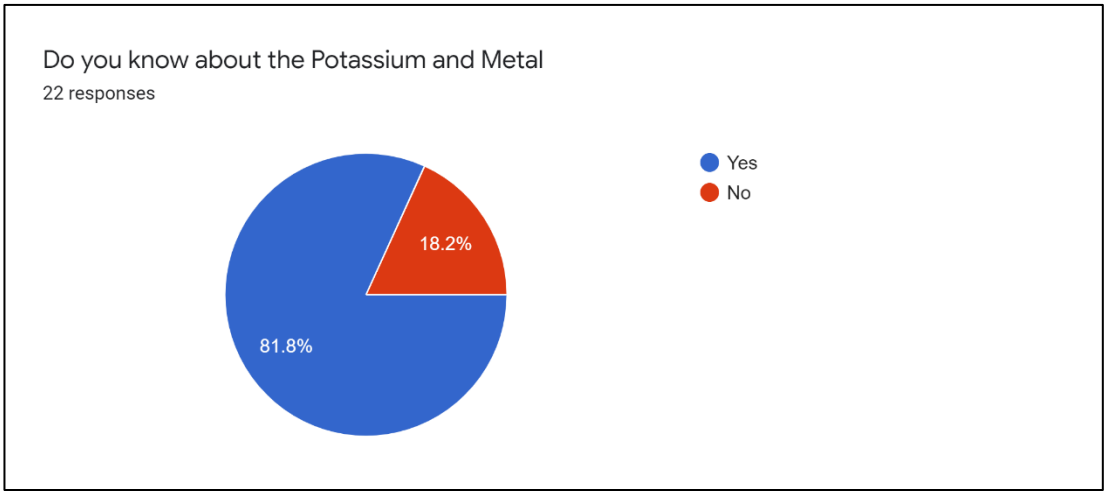
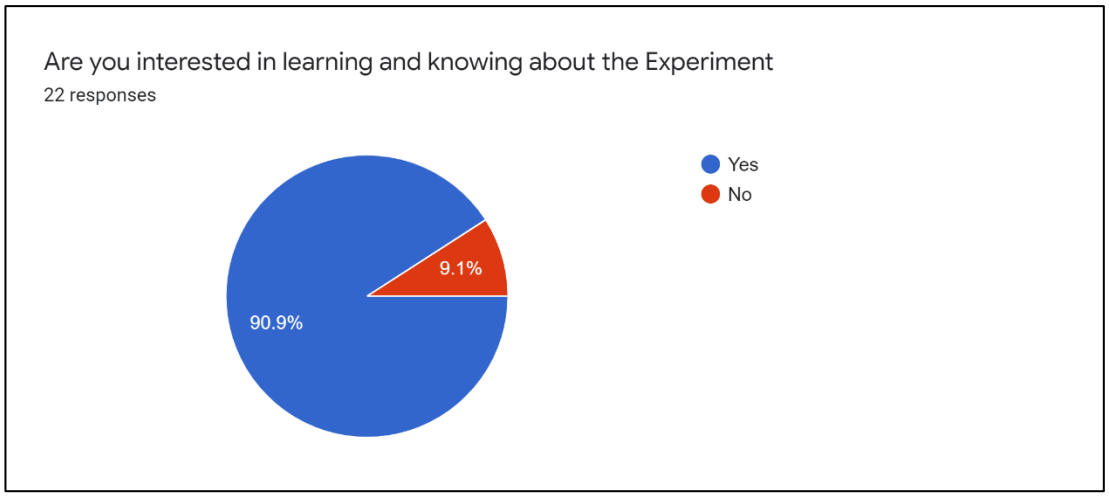
APPENDIX A: RESULTS OF PRE-TRIAL SURVEY

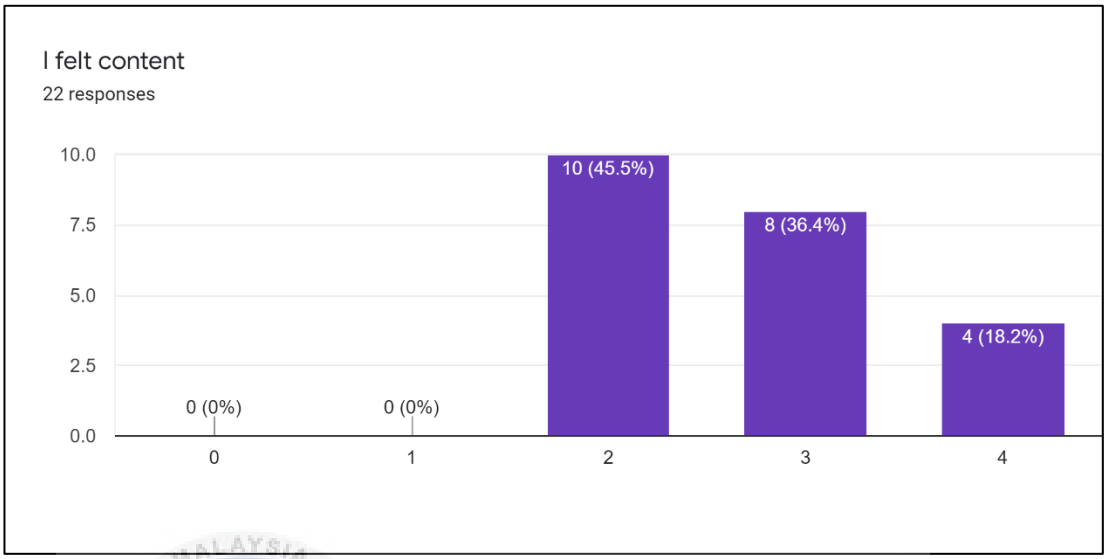


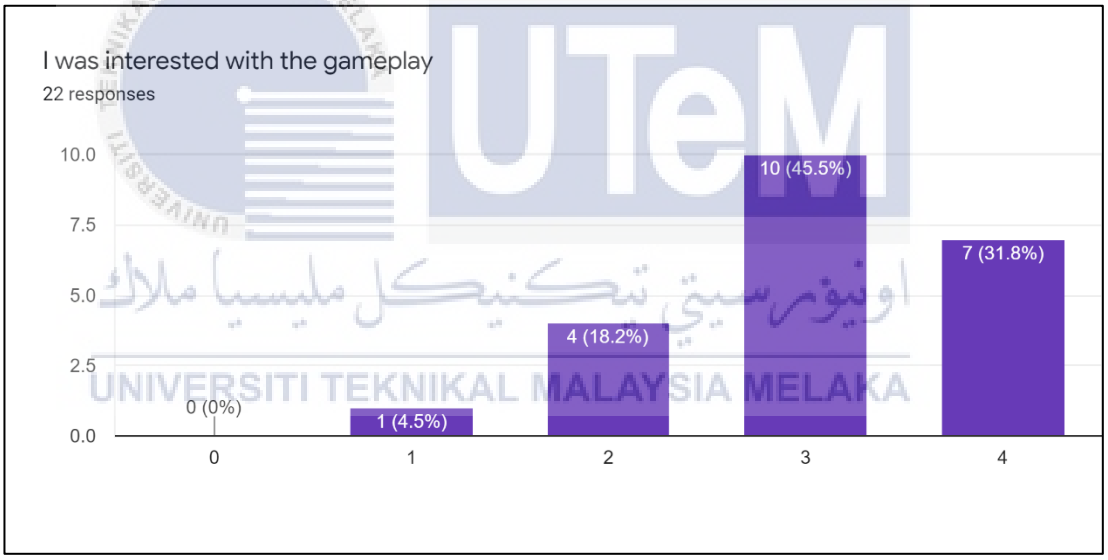


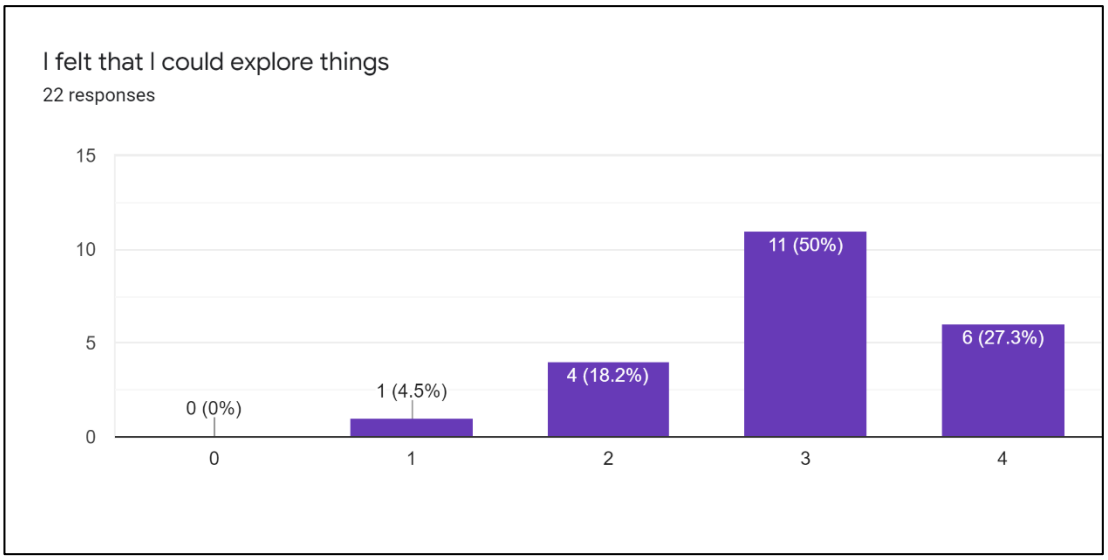


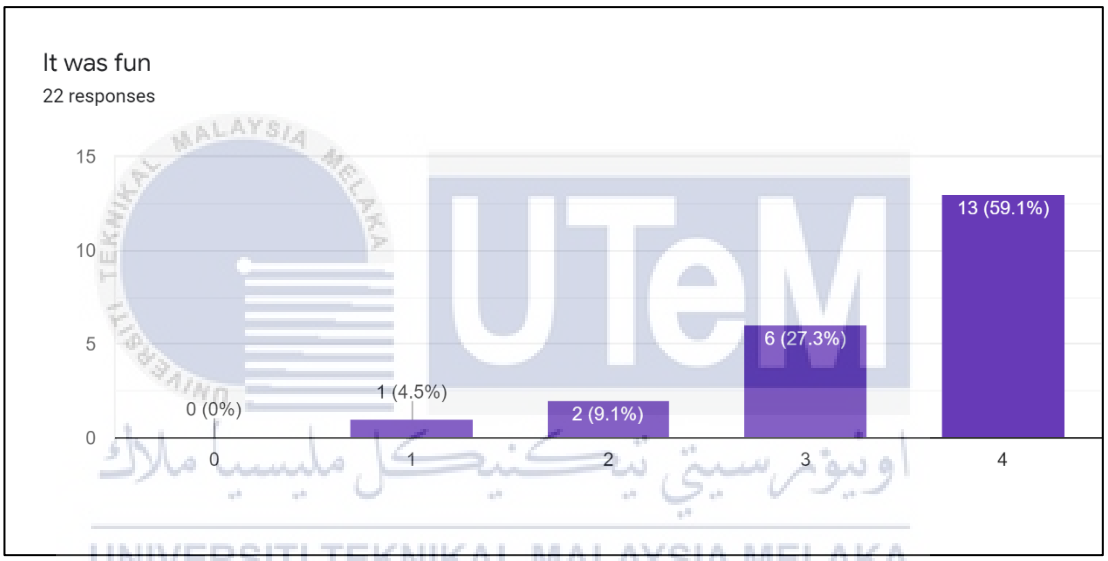


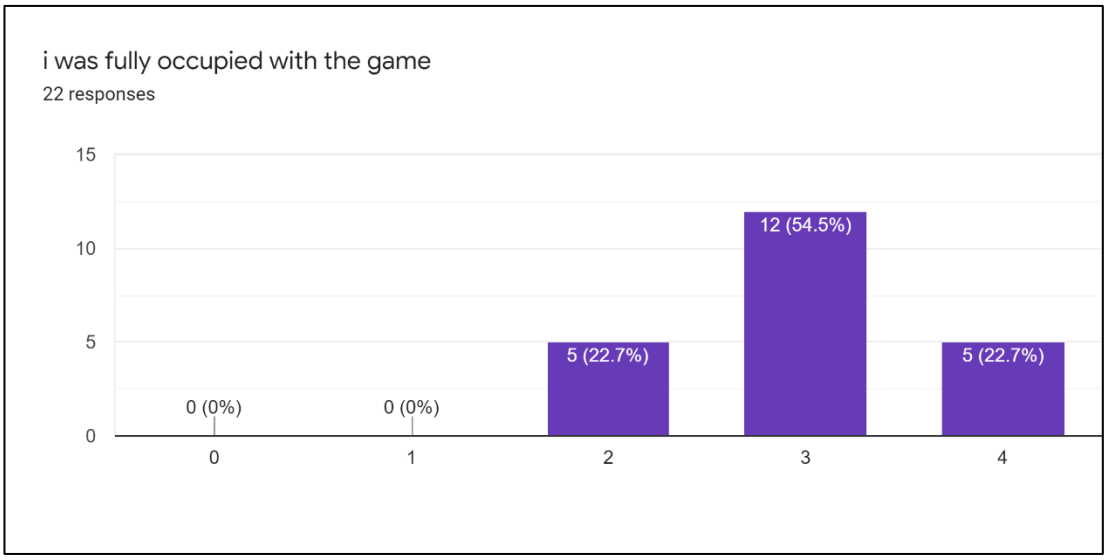
APPENDIX B: RESULTS IN GAME EXPERIENCE SURVEY

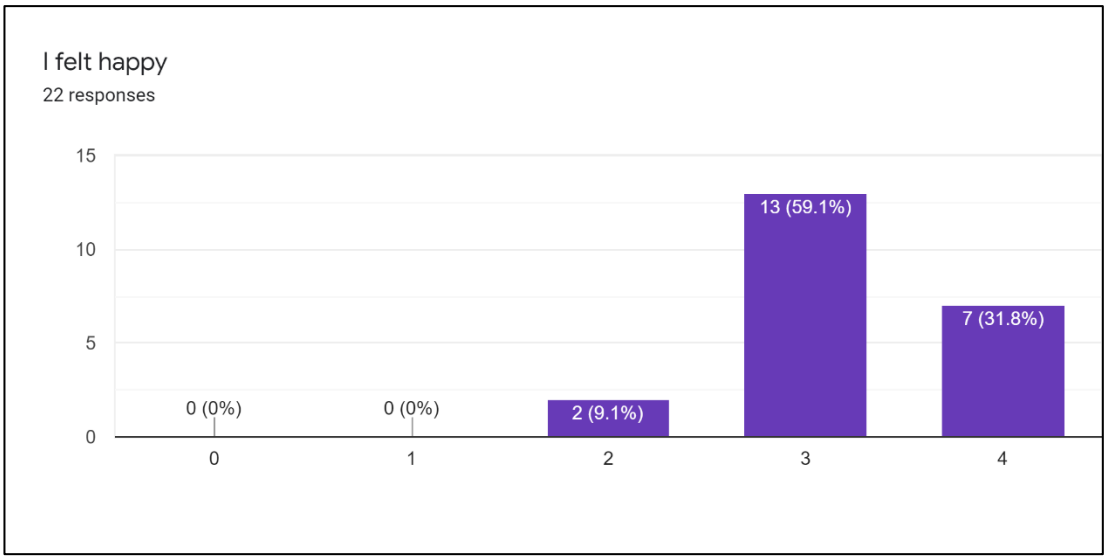


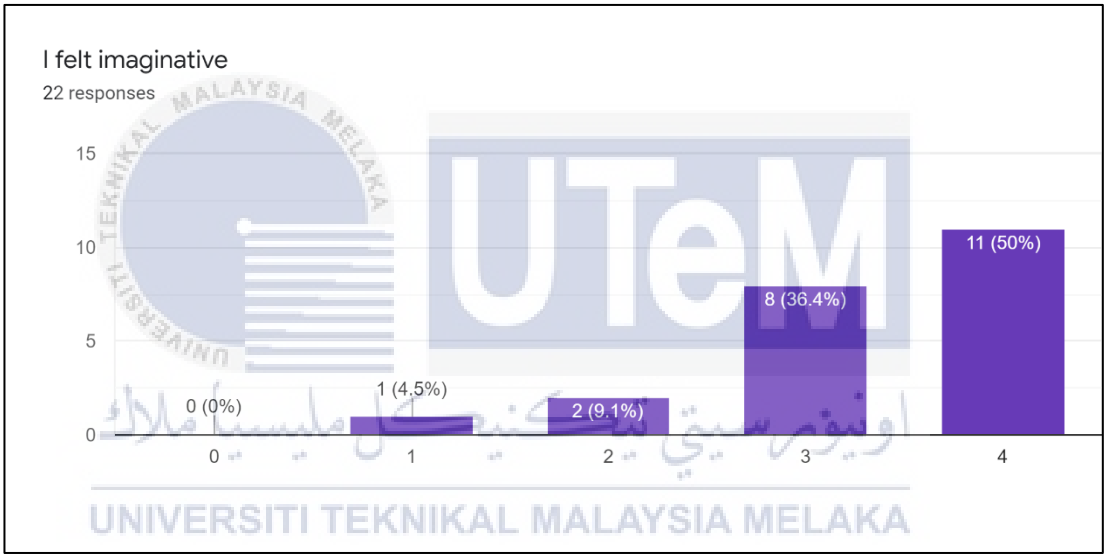


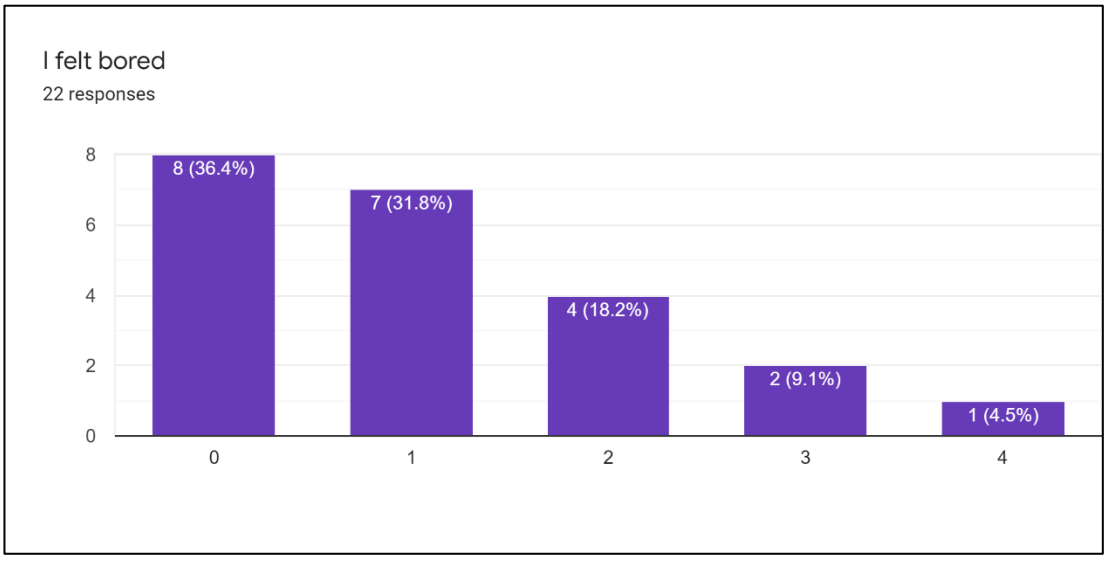


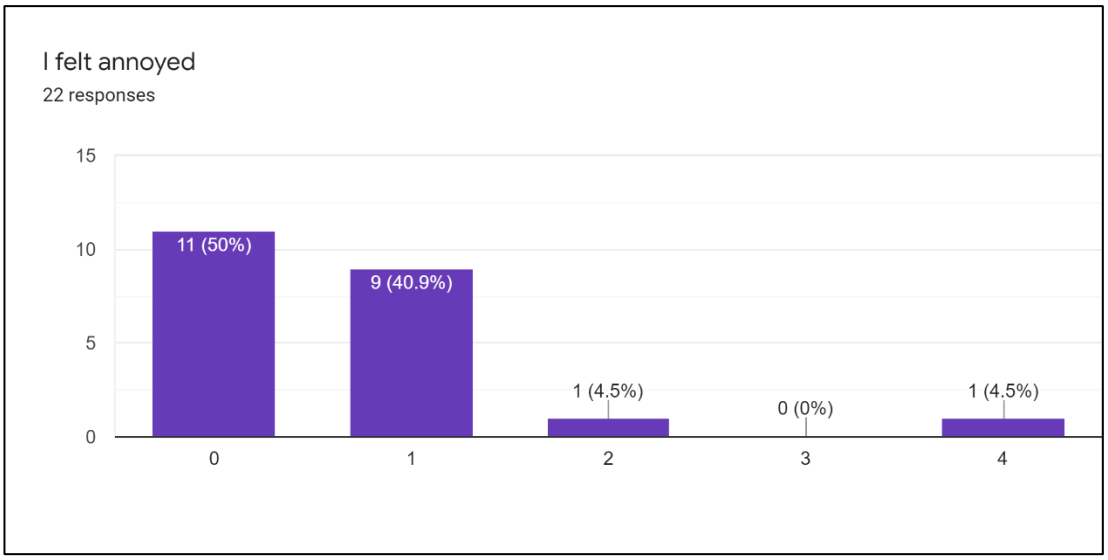


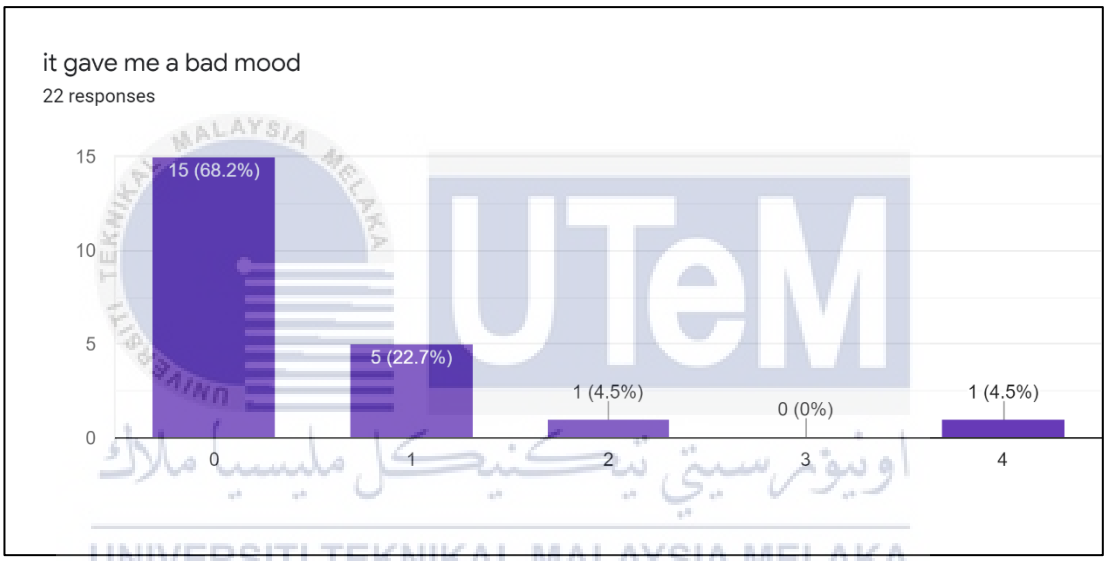




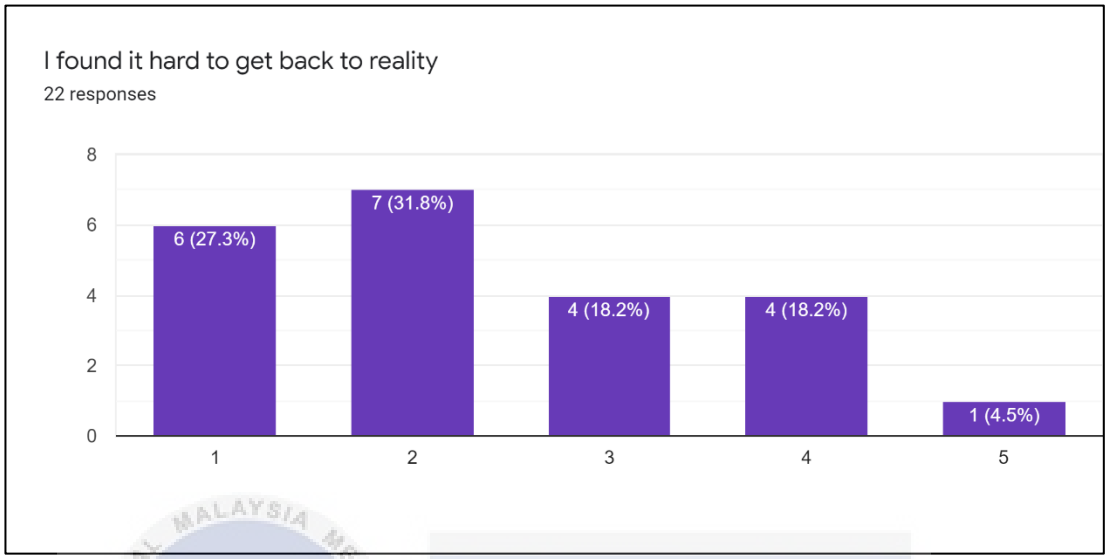


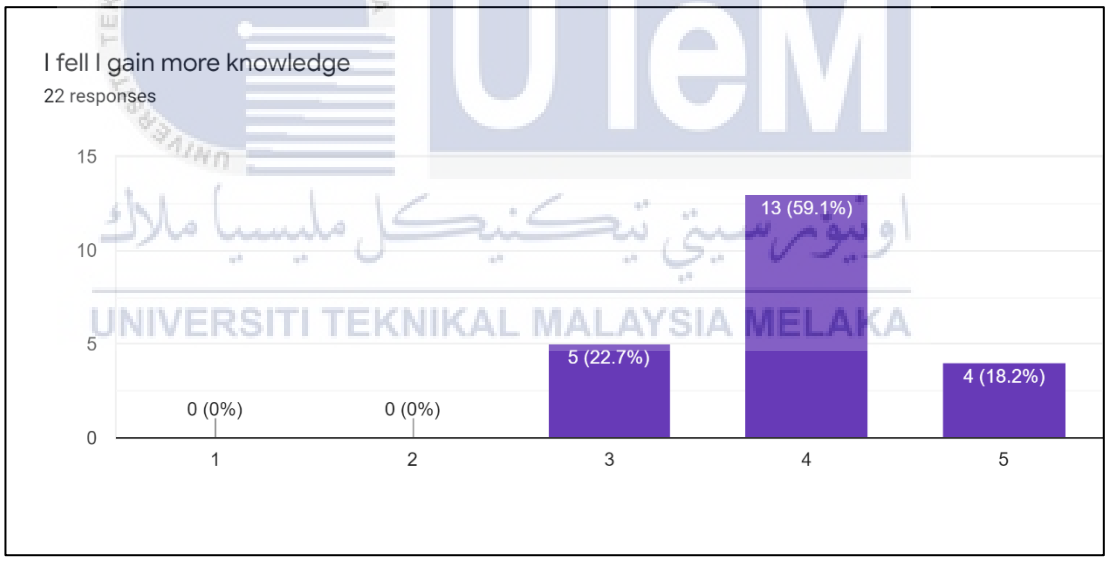


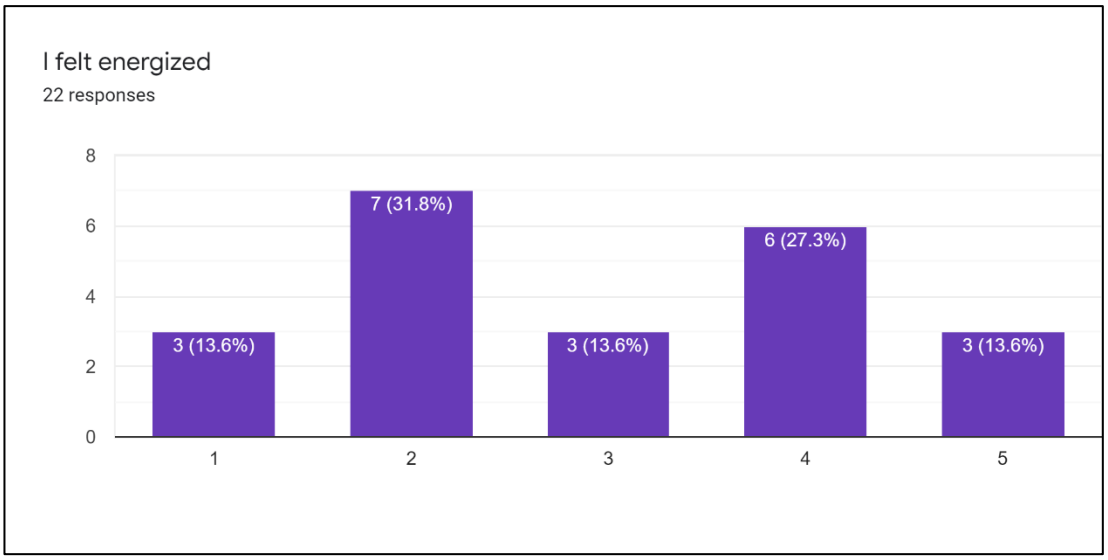


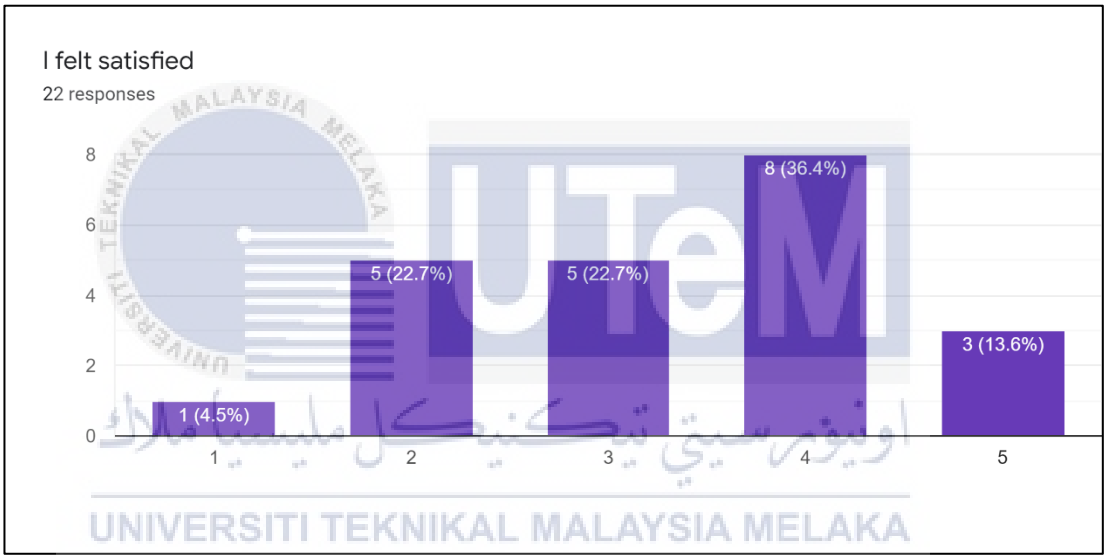


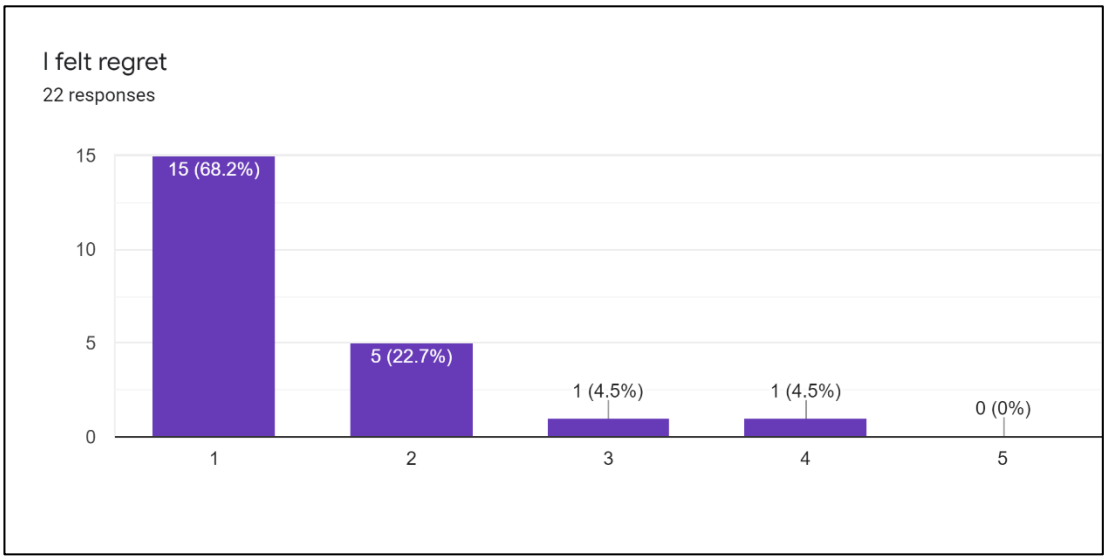
APPENDIX C: RESULTS POST GAME EXPERIENCE SURVEY



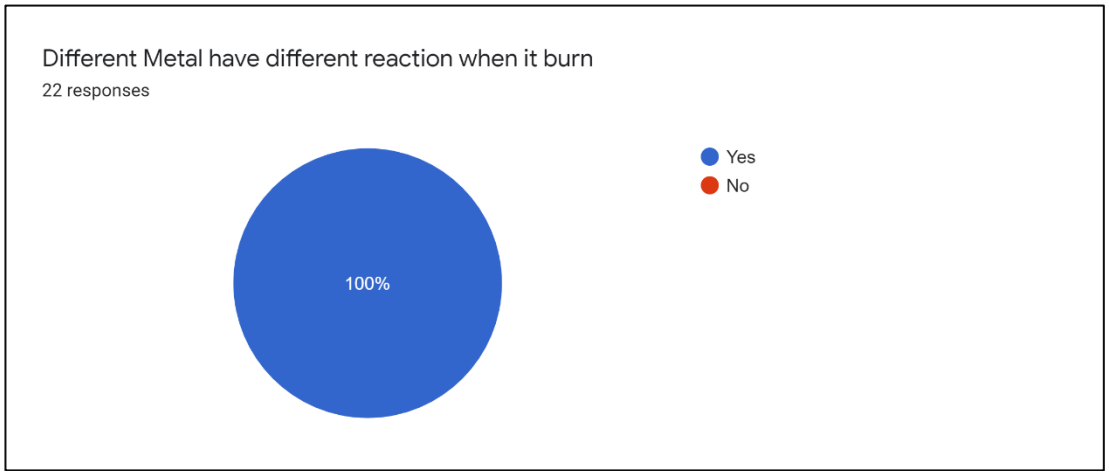


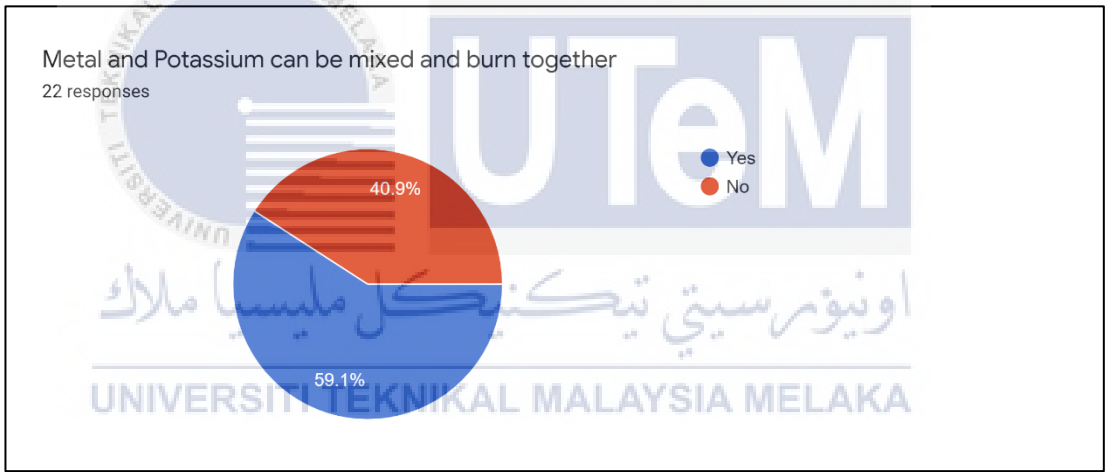


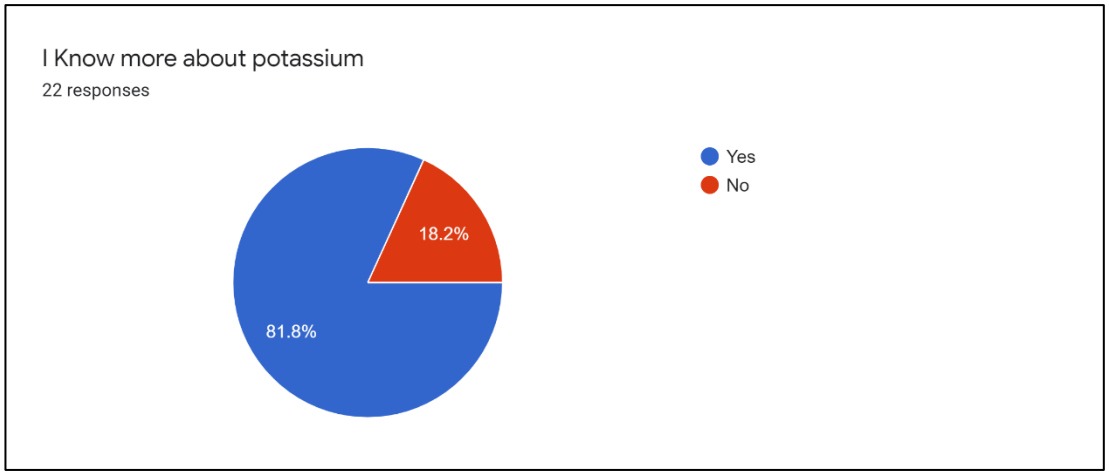




APPENDIX D: RESULTS POST GAME SURVEY

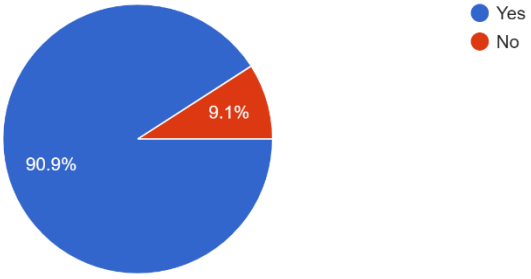






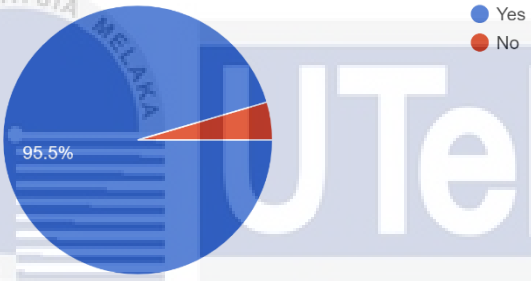
I Know more about metal

22 responses



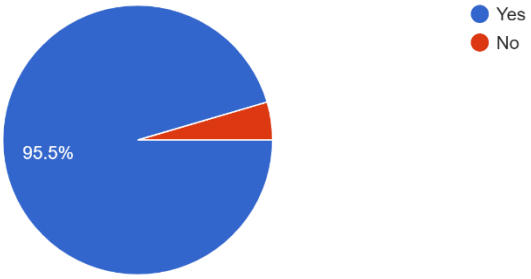
I Know more about the experiment

22 responses



I have a better understanding of the safety.

22 responses



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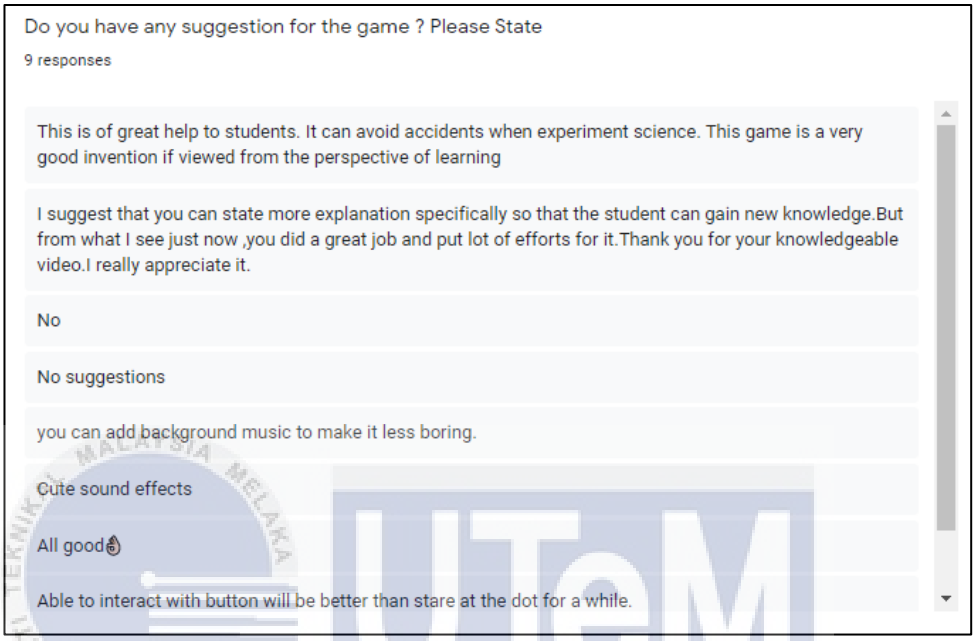
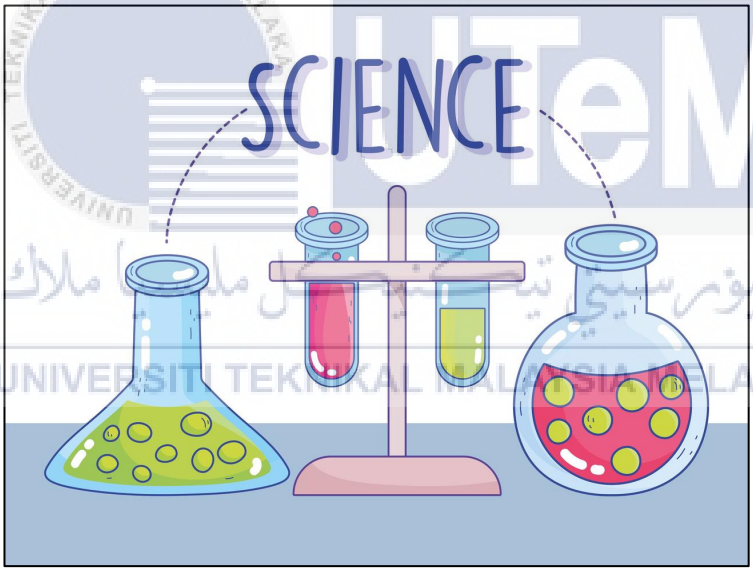
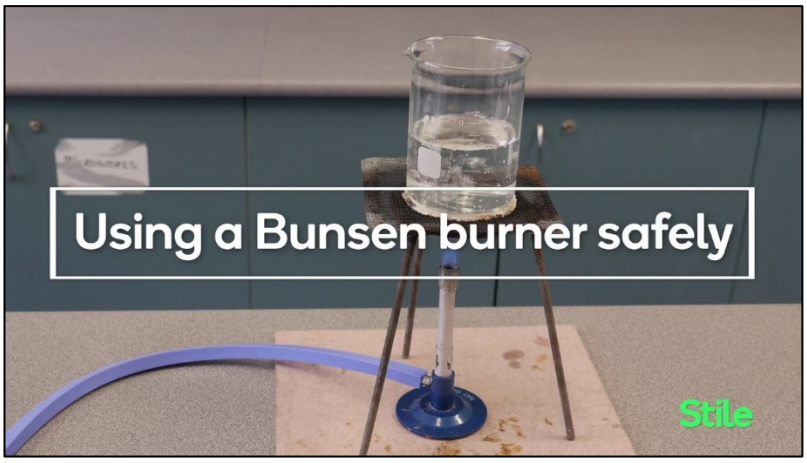


APPENDIX F: MARKER





APPENDIX G: GAMEPLAY